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PERCEPTIONS OF LANDSCAPE SERVICES
PROVIDED BY URBAN GREEN INFRASTRUCTURE.
THE CASE STUDY OF A CAMPUS OPEN SPACE

DOCTORAL STUDENT: **CARLA ANA-MARIA TUDORIE**

THESIS DIRECTOR: PROF. DR. MARÍA VALLÉS – PLANÉLLS
PROF. DR. ERIC GIELEN

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TESIS DOCTORAL

Perceptions of landscape services provided by urban green infrastructure. The case study of a campus open space

Percepciones de los servicios de paisaje suministrados por la infraestructura verde urbana. El estudio de caso de un espacio abierto en un campus

Presentada por: D. Carla Ana-María Tudorie

Diriga por: Prof. Dra. Dña. María Vallés-Planélls

Prof. Dr. D. Eric Gielen

Facultad o Escuela: Escuela Técnica Superior de Ingeniería Agronómica y del Medio Natural

Departamento: Departamento de Ingeniería Rural y Agroalimentaria & Departamento de Urbanismo

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De acuerdo con el Artículo 15 del RD 99/2011, esta Tesis Doctoral reúne los requisitos para optar a la mención «Doctor internacional», al concurrir, entre otras, las siguientes circunstancias:

a) Que, durante el periodo de formación necesario para la obtención del título de doctor, el doctorando haya realizado una estancia mínima de tres meses fuera de España en una institución de enseñanza superior o centro de investigación de prestigio, cursando estudios o realizando trabajos de investigación. La estancia ha sido realizada en "Università degli Studi di Catania" (Sicilia, Italia), en el grupo de investigación del Dipartimento Ingegneria Civile e Architettura, bajo la supervisión del Profesor Prof. Dr. Daniele La Rosa.
b) Que parte de la tesis doctoral, al menos el resumen y las conclusiones, se haya redactado y sea presentado en una de las lenguas habituales para la comunicación científica en su campo de conocimiento, distinta a cualquiera de las lenguas oficiales en España. A estos efectos, se incluye las siguientes partes en inglés:
    I. Resumen
    II. Introducción
    III. Materiales y métodos
    IV. Resultados
    V. Discusión
    VI. Conclusiones
c) Que la tesis haya sido informada por un mínimo de dos expertos doctores pertenecientes a alguna institución de Educación Superior o instituto de investigación no española. La tesis ha sido informada por dos expertos Doctores pertenecientes a instituciones de Educación Superior o instituto de investigación no española: "Ghent University" (Ghent, Bélgica) y "Universidad Técnica Federico Santa María" (Valparaíso, Chile).
d) Que al menos un experto perteneciente a alguna institución de Educación Superior o centro de investigación no española, con el título de Doctor, y distinto del responsable de la estancia mencionada en el párrafo a), haya formado parte del tribunal evaluador de la tesis. Dos de los expertos que forman parte del tribunal pertenecen a instituciones de Educación Superior o centro de investigación no española: "Ghent University (Ghent, Bélgica)" y "Università degli Studi di Cagliari" (Cerdeña, Italy).

According to point 15 of RD 99/2011, this Doctoral Thesis may opt to mention «International Doctor», complying, among others, with the following conditions.

a) During the training period necessary to obtain a doctor's degree, the student has made a minimum stay of three months outside Spain, in a higher education institution or prestigious research centre, studying or developing research works. The stay has been made in "Università degli studi di Catania" (Sicily, Italy) in the research group of Dipartimento Ingegneria Civile e Architettura, under the supervision of Professor Prof. Dr. Daniele La Rosa.

b) A part of the doctoral Thesis, at least summary and conclusions, has been written and presented in an accepted language for scientific communication, other than any official language in Spain. For these purposes, the following parts are included in English:

    I. Summary
    II. Introduction
    III. Material and methods
    IV. Results
    V. Discussion
    VI. Conclusions

c) That the thesis has been informed by a minimum of two expert Doctors affiliated with a non-Spanish Higher Education institution or research institute. The thesis has been informed by two expert Doctors affiliated with non-Spanish Higher Education institutions or research institutes: Ghent University (Belgium) and Universidad Técnica Federico Santa María (Chile).

d) That at least one expert affiliated with a non-Spanish Higher Education institution or research centre, holding a Doctoral degree, and distinct from the person responsible for the stay mentioned in paragraph a), has been part of the thesis evaluation committee. Two experts on the committee belong to non-Spanish Higher Education institutions or research centres: Ghent University (Belgium) and Università degli Studi di Cagliari (Italy).

"*Study nature, love nature, stay close to nature. It will never fail you*"

Frank Lloyd Wright

SUMMARY

Urban green infrastructure has emerged as a campus excellency instrument, which is desired to improve the quality of provided functions and services, and strengthen the relationships between campus and university community, and between campus and city. The university community members often interact with the campus landscape and experience a certain level of satisfaction with the benefits provided by the management of open space. In the literature, these benefits are known as landscape services. The public's profile and space physical parameters play a crucial role in determining the functions and perceived supplied services, which echoes in the public's preference and use of space.

This thesis contributes to the knowledge of the relationships between people and their close outdoor environment in the context of the university campus landscape of Universitat Politècnica de València. The aim of the study is to assess the functionality of urban green infrastructure within the campus setting. Furthermore, the thesis aims to understand how perceptions and satisfaction are mediated by the university community profile, and how services and satisfaction are related. This research examines whether the current typologies of campus open spaces meet the preferences of university community members.

To conduct this research, an online survey has been designed. A structural equation model has been built to identify the relationships between the perceived supply of landscape services, respondents' profile and satisfaction. Linear regression and path analysis have been conducted to analyse respondents' preferences for open space and explore the relationships among landscape services.

Results highlight that respondents perceive campus open spaces mainly for its benefits such as providing a space for relaxation, socialising with friends and passing through. Age, gender, branch of knowledge, frequency of use and preference for open space are factors influencing the perceived quality of landscape services. University community members prefer using larger open spaces that are placed close to common areas and provide easy access to campus services and facilities. When it comes to preference, varied space topography, diversity of trees and well-equipped urban furniture, are relevant features.

This research contributes to the knowledge on how psychosocial variables such as preference, perceptions and use, can be effectively applied in open space planning and design. Moreover, the results are helpful not only for universities, but also for all elements of urban green infrastructure that have yet to have a multifunctional landscape design and are adapting to the needs of their users.

RESUMEN

La infraestructura verde urbana ha surgido como un instrumento de excelencia del campus, que puede mejorar la calidad de las funciones y servicios suministrados, y fortalecer las relaciones entre el campus y la comunidad universitaria, y entre el campus y la ciudad. Los miembros de la comunidad universitaria interactúan a menudo con el paisaje del campus y experimentan un cierto nivel de satisfacción con los beneficios derivados de la gestión de los espacios abiertos. En la literatura, estos beneficios se conocen como servicios del paisaje. El perfil del usuario y los parámetros físicos del espacio juegan un papel crucial en la determinación de las funciones y servicios percibidos, lo que se refleja en la preferencia y en el uso del espacio por parte del público.

Esta tesis contribuye al conocimiento de las relaciones entre las personas y su entorno exterior cercano en el contexto del paisaje del campus universitario de la Universitat Politècnica de València. El objetivo del estudio es evaluar la funcionalidad de la infraestructura verde urbana en el entorno del campus. Además, la tesis tiene como objetivo comprender cómo la percepción y la satisfacción están mediadas por el perfil de los miembros de la comunidad universitaria, y cómo se relacionan los servicios con la satisfacción. Esta investigación examina si las tipologías actuales de los espacios abiertos del campus satisfacen las preferencias de los miembros de la comunidad universitaria.

Para llevar a cabo esta investigación, se ha diseñado una encuesta online. Se ha construido un modelo de ecuaciones estructurales para identificar las relaciones entre la oferta percibida de servicios del paisaje, el perfil de los encuestados y la satisfacción. Se han realizado regresiones lineales y análisis de rutas para analizar las preferencias de los encuestados por los espacios abiertos y explorar las relaciones entre los servicios del paisaje.

Los resultados revelan que los encuestados perciben los espacios abiertos del campus principalmente por sus beneficios como proporcionar un espacio para relajarse, socializar con amigos y transitar. La edad, el género, la rama de conocimiento, la frecuencia de uso y la preferencia por el espacio abierto son factores que influyen en la calidad percibida de los servicios de paisaje. Los miembros de la comunidad universitaria prefieren usar espacios abiertos más grandes que se encuentren cerca de las áreas comunes y que brindan fácil acceso a los servicios e instalaciones del campus. Las características que principalmente condicionan la preferencia del espacio son la topografía variada del espacio, la diversidad de árboles y el mobiliario urbano bien equipado.

Este trabajo contribuye al conocimiento sobre cómo las variables psicosociales, como la preferencia, la percepción y el uso, se pueden aplicar de manera efectiva en la planificación y el diseño de espacios abiertos. Además, los resultados son útiles no solo para las universidades, sino también para todos los elementos de la infraestructura verde urbana que aún no tienen un diseño de paisaje multifuncional y se están adaptando a las necesidades de sus usuarios.

RESUM

La infraestructura verda urbana ha sorgit com un instrument d'excel·lència del campus, que desitja millorar la qualitat de les funcions i serveis subministrats, i enfortir les relacions entre el campus i la comunitat universitària, i entre el campus i la ciutat. Els membres de la comunitat universitària interactuen sovint amb el paisatge del campus i experimenten un cert nivell de satisfacció amb els beneficis que brinda la gestió dels espais oberts. En la literatura, aquests beneficis es coneixen com a serveis del paisatge. El perfil del públic i els paràmetres físics de l'espai juguen un paper crucial en la determinació de les funcions i serveis subministrats percebuts, la qual cosa es reflecteix en la preferència i en l'ús de l'espai per part del públic.

Aquesta tesi contribueix al coneixement de les relacions entre les persones i el seu entorn exterior pròxim en el context del paisatge del campus universitari de la Universitat Politècnica de València. L'objectiu de l'estudi és avaluar la funcionalitat de la infraestructura verda urbana a l'entorn del campus. A més, la tesi té com a objectiu comprendre com la percepció i la satisfacció estan mediades pel perfil dels membres de la comunitat universitària, i com es relacionen els serveis amb la satisfacció. Aquesta investigació examina si les tipologies actuals dels espais oberts del campus satisfan les preferències dels membres de la comunitat universitària.

Per a dur a terme aquesta investigació, s'ha dissenyat una enquesta en línia. S'ha construït un model d'equacions estructurals per a identificar les relacions entre l'oferta percebuda de serveis del paisatge, el perfil dels enquestats i la satisfacció. S'han realitzat regressions lineals i anàlisis de rutes per a analitzar les preferències dels enquestats pels espais oberts i explorar les relacions entre els serveis del paisatge.

Els resultats revelen que els enquestats perceben els espais oberts del campus principalment pels seus beneficis com proporcionar un espai per a relaxar-se, socialitzar amb amics i passar. L'edat, el gènere, la branca de coneixement, la freqüència d'ús i la preferència per l'espai obert són factors que influeixen en la qualitat percebuda dels serveis de paisatge. Els membres de la comunitat universitària prefereixen usar espais oberts més grans que es troben prop de les àrees comunes i que brinden fàcil accés als serveis i instal·lacions del campus. Les característiques rellevants per a la preferència de l'espai són la topografia variada de l'espai, la diversitat d'arbres i el mobiliari urbà ben equipat.

Aquesta investigació contribueix al coneixement sobre com les variables psicosocials, com la preferència, la percepció i l'ús, es poden aplicar de manera efectiva en la planificació i el disseny d'espais oberts. A més, els resultats són útils no sols per a les universitats, sinó també per a tots els elements de la infraestructura verda urbana que encara no tenen un disseny de paisatge multifuncional i s'estan adaptant a les necessitats dels seus usuaris.

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INDEX

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Concepts

AdSS	Administration and services staff
BOE	Boletín oficial del estado
CFA	Confirmatory factorial analysis
CICES	Common international classification of ecosystem services
CGS	Campus green space
COS	Campus open space
EEA	European environmental agency
EFA	Exploratory factorial analysis
EPA	U.S. Environmental protection agency
ES	Ecosystem services
EU	European union
FAO	Food and Agriculture Organization
GI	Green infrastructure
GSI	Green stormwater infrastructure
KPI	Key performance indicators
LS	Landscape services
MA	The millennium ecosystem assessment
NBS	Nature-based solutions
PGOU	Plan general de ordenación urbana
POIs	Points of interest
SEM	Structural equation modelling
SES	Socio-ecological ecosystems
TEEB	The economics of ecosystems and biodiversity
TRS	Teaching and research staff
UGI	Urban green infrastructure
UGS	Urban green space
UNEP	United nations environment programme
UPV	Universitat Politècnica de València

WHO	World Health Organization

Sample data – Branches of knowledge

Agrifood&ForestE	Agrifood and Forest Engineering
Arch&BuildE	Architecture and Civil and Building Engineering
Art&Hum	Art and Humanities
Health&FoodSc	Health and Food Science
Industr&AeroE	Industrial and Aeronautical Engineering
Inf&CommTechE	Information and Communications Technologies Engineering
Sc&TechHealthE	Science and Technology for Health Engineering
Social&LegalSc	Social and Legal Science

Thesis background

This present research is presented as a doctoral thesis belonging to the candidate Carla Ana-Maria Tudorie, who has been co-supervised by the Doctor in Agricultural Engineering and Environment, Ms. María Vallés-Planélls, Professor of Department of Rural and Agrifood Engineering, and Doctor in Civil Engineering, Professor Eric Gielen, from Universitat Politècnica de València.

The doctoral thesis title is “Perceptions of landscape services provided by urban green infrastructure. The case study of campus open space”.

This doctoral thesis explores the assessment of the functionality of urban green infrastructure of the university campus open space of Universitat Politècnica de València (UPV), through the perceptions of the university community. Landscape services are the tool to establish the quality of open spaces on campus and the needs for their enjoyment. This thesis aims to be a contribution to the study of the relationships between people and open space, considering its use, preferences for types of urban green infrastructure, perceptions about the potential of open space to supply landscape services and the satisfaction of the university community with the current management of open space on campus.

The author is the beneficiary of a research contract within the framework of a European H2020 project called Green Cities for Climate and Water Resilience, Sustainable Economic Growth, Healthy Citizens and Environments, in short GrowGreen. This innovative project focuses on implementing nature-based solutions (NBS) to improve urban ecosystems and enhance citizens' quality of life. Valencia, Spain is one of the cities participating in the project, specifically in the Benicalap district.

The GrowGreen project in Valencia incorporates five NBS actions in the Ciutat Fallera neighbourhood: (I) vertical garden constructed on the wall of a local school, providing temperature regulation, soundproofing, and filtration of greywater, (II) a green roof designed for a senior centre, helping to reduce heat within the building and store rainwater, (III) a small sustainable forest aimed at managing rainwater and increasing biodiversity, and (IV) a green-blue corridor that includes permeable paved areas (SuDS - Sustainable Drainage System). The project also focuses on restoring the ancestral connections and preserving the cultural heritage of L'Horta de Valencia, an ancient agricultural landscape integrated into the Mediterranean orchard. This unique agroecosystem has been recognized as a Globally Important Agricultural Heritage System (GIAHS) and is managed as part of the green infrastructure of the metropolitan area of Valencia.

The author has been actively involved in multiple activities pertaining to the assessment and monitoring of environmental, structural, and social indicators (KPI - Key Performance Indicators) associated with two urban challenges: the management of green spaces and promoting justice and social cohesion. Additionally, the author has played a role in various activities related to the GrowGreen APP. These activities encompass app's content development, dissemination of information, organising workshops involving the app, conducting geostatistical analyses on the information collected through the GrowGreen APP, and evaluating the app's impact on the educational population of the Benicalap district.

As a result of the significant delay in implementing the planned actions for the pilot projects, exceeding a year from the original timeline (June 2021), it will not be possible to achieve the objectives for the post-greening state before 2023. Consequently, the objectives of the doctoral thesis associated with the project have been reevaluated, focusing on a new green infrastructure area, specifically the UPV campus. This decision stems from the necessity to apply the objectives within an already established and consolidated green space.

Chapter 1. Introduction

1.1. General context

The scale of the climate change problem is like no other we have faced and it affects all landscapes, both natural and urban ecosystems. Urban areas are major contributors to climate change through their huge concentrations of human assets and activities, which generate high CO2 emissions, increased rainfall intensity, storm surges, flooding, urban heat island effects, habitat fragmentation, and biodiversity and connectivity loss (EPA, 2015; EU, 2013a; UNEP, 2021).

The unprecedented urban growth presents a threat to urban green spaces. The theory of urban dynamics conceptualises the city as an intricate social and economic system shaped by the interplay of individual endeavours in the pursuit of personal objectives (Alfeld and Graham Alan, 1976). An urban crisis arises from a general shift in population preferences regarding their residence. With a focus on improved quality of life and enhanced well-being standards, people prefer to live in smaller, 'natural,' and tranquil environments outside the inner city. The conventional inner city is perceived as large, dense, and compact (García Docampo 2014). In the peripheral locations, the common process of shifting residence preferences is known as deconcentration.

According to Bierens and Kontuly (2008), the deconcentration perspective with individual residential preferences as key factors is one of the five explanatory causes of territorial dynamics. The other factors include (1) regional restructuring, which emphasises the relocation of companies and their outcomes; (2) periodical effects explained by expansive cycles for cities and temporary crises due to saturation; and the last two related aspects, (3) governance issues (e.g., noise, crime, and cleaning problems); and (4) the cost of housing, encompassing prohibitive prices and/or deficits in supply.

The restoration of nature functions in urban environments and encouraging relationships between people and urban nature are huge challenges for urban planners. A proper and good quality urban environment design involving UGI elements can improve the landscape's health and resilience and people's well-being. UGI is a useful urban design tool and landscape management process and represents the backbone of cities and their planning. For this reason, cities are investing heavily in open spaces, especially in parks, gardens and greenways (EU, 2014; Walmsley, 1995).

Within this context, campuses are seen as independent small cities or towns regarding their planning, but still embedded in the urban space. Campus landscapes can be considered green laboratories within cities providing an opportunity to analyse the influence of UGI on space use and services at smaller scales with the aim of inferring design criteria for larger urban areas, such as cities, districts, or neighbourhoods. Urban green infrastructure has become a campus excellency instrument, which is desired to improve the quality of functions and services to strengthen the bonds between campus and university community members and between city and campus.

Many universities are currently struggling to reach the expectations of the high international standard of excellence of Green Flag Award (Ellicott, 2016) and become the world's greenest universities. Accordingly, universities endeavour to ensure a proper management and maintenance of green space and recreational outdoor spaces. Many of the observations, analyses, and recommendations of campus planning are related to preserving, restoring or creating green infrastructure.

Green infrastructure planning strives to incorporate ecological, social, and economic dimensions, encompassing the abiotic, biotic, and cultural functions inherent in green spaces. Green infrastructure ecosystem services concept contributes to environmental planning improvement in urban areas by providing a more holistic understanding of the intricate interrelations and dynamics within social-ecological systems (Hansen and Pauleit, 2014). According to Hansen and Pauleit (2014), green Infrastructure planning is a domain where various innovative approaches in nature conservation and green space planning converge and blend together.

The core principles to a compliant UGI planning approach are based on multifunctionality, connectivity and collaborative planning (Pauleit et al. 2011). Multifunctionality emphasises the delivery and enhancement of multiple functions, services and benefits by integrating and combining green, blue, and grey infrastructure elements. Additionally, it highlights the importance of functional and structural connectivity through the creation of networks of green spaces.

Campus urban green infrastructure represents a combination of natural and designed features that are connected and integrated across campus landscape and provides many services which community members enjoy, such as space to develop all their daily basic needs, to do sports, to relax, to get together with their friends and colleagues, but also provides aesthetic enhancement, good quality air, heat island reduction, increased biodiversity, water conservation, and stormwater management. Campus open space supplies habitats for species, provides accessible and attractive teaching or learning outdoor spaces and extends the university community's knowledge about the nature environment. According to Kaplan and Kaplan (1989), greenery allows people to get close to nature and enjoy its benefits. As society has become increasingly disconnected from nature, the well-being of society could face significant consequences. Therefore, a well-designed UGI could encourage people to spend more time outdoors rather than opting for indoor entertainment.

Urban open space and urban green infrastructure are close concepts, and certainly synonyms when it refers to campus open space (COS). The importance of campus open space for the well-being of the university community has been stressed more and more in the literature. Campus open space facilitates recreation and attention restoration, a place of identity, social encounter and exchange (Foellmer et al., 2021). Campus open space is considered a meaningful place for experiencing everyday life (Cooper & Wischemann, 1990). Sometimes a university campus can be one of the most important green spaces of cities, like Forest City University of Indonesia in Jakarta (Anis et al., 2018).

In the context of urban landscape dynamics, there is an increasing need of understanding the importance of people's preference and use of open space and the public participation in the evaluation of functions, services and benefits provided by open space.

Cities serve as dynamic environments where various social differences, including but not limited to ability status, age, class, citizenship, ethnicity, gender, race, sexual orientation, and socio-economic position, are not inherent or fixed but are social constructs. These differences are actively created, maintained, resisted, and contested, shaping the urban landscape (Short, 2021).

Promoting social inclusion has become a prevailing priority. Social inclusion is another UGI core principle which can be achieved by promoting collaborative and participatory planning (EU, 2000). Unfortunately, most cities are built around the needs, desires and preferences of certain groups (Short, 1989). The urban theorist Henri Lefebvre proposed the concept of a 'right to the city,' advocating for the collective freedom to shape the city in accordance with everyday human needs, rather than being dictated by the logic of capital or state mandates (Lefebvre, 1996, 2003). According to Lefebvre (2003), the right to the city involves access, utilisation, and enjoyment of urban spaces, along with active participation in their creation. This participation includes the right to 'oeuvre' or engage and appropriate, with emphasis on use value rather than mere ownership (Lefebvre, 1996).

The public participation process is fundamental in the planning and designing of open space, as it directly engages the public in the process of decision-making. Engaging in the environmental transformation process not only empowers individuals with a sense of self-effectiveness and self-esteem, but also sparks a genuine concern for their surroundings (McMillan and Chavis, 1986). In the field of urban planning studies, it is crucial to recognize the multi-dimensionality and interdependence among human concerns about landscapes (Gobster and Westphal, 2004). As principal users of spaces and consumers of their benefits, people's evaluation of space's functions and services helps to guide urban planners to develop a proper design of space according to their personal experiences, needs and desires, as well as their utility functions for using the landscape, and socio-cultural contexts. Therefore, open spaces design should be closely associated with people's daily activities. Some studies highlight the importance of analysing individuals' profiles as factors that influence their perceptions and relationships with green spaces. Kaplan and Kaplan (1989) affirmed people tend to search for and prefer places that are easy to understand and provide relevant information for their existence.

According to Fors et al. (2015), green space governance aligns theoretically with deliberative democracy and communicative planning, promoting participation throughout various development phases. However, there is limited evidence regarding the impact of users' physical participation in maintenance tasks on green space quality (Conway et al., 2011) and how the participation process determines people's satisfaction and usage of green space (Glover et al., 2005; Huang, 2010). Fors et al. (2015) emphasises the need for case-level research to assess outcomes, particularly in establishing direct links between participation and the physical quality of green spaces.

The government's Declaration on the climate and environmental emergency commits to strengthening existing participation mechanisms through the creation of a Citizen Assembly for Climate (Gobierno de España, 2020). This commitment is reflected in Law 7/2021 of May 20, on Climate Change and Energy Transition, which expands the influence of citizen participation in various areas, including action and consideration of their opinions (BOE, 2021).

The Citizen Assembly for Climate is acknowledged as a model of good practices, characterised by its inclusive and participatory approach in addressing the climate and environmental emergency (La Asamblea Ciudadana para el Climaa, 2022). This initiative emphasises citizen participation, diversity, transparency, and access to information, fostering open dialogue and continuous engagement. The assembly follows a structured process involving learning, deliberation, and decision-making phases, culminating in a comprehensive report with recommendations submitted to the government and the Congress of Deputies (La Asamblea Ciudadana para el Clima, 2022).

Promoting green and sustainable architecture is a priority for the Citizen Assembly for Climate within *Consume,* one of the thematic areas of Life and Society Areas. These areas reflect citizen priorities and encompass ecosystems, community, health, care, consumption, food and land use, and work, highlighting the multi-scale nature of the required social changes. Their primary objective is to integrate into participants' daily experiences by employing concepts closer to citizens, fostering a sense of agency in the social changes necessary to address the main question (La Asamblea Ciudadana para el Clima, 2022).

Due to the large diversity of university community members and in general of the society, the design of high-quality campus open space should consider the profile of members and the variety of their interests and demands. These mediating variables influence the continuing transactional process between the perceived values of space and the responses of persons towards them, so their study contributes to adapting the open spaces design to their users.

In the case of Valencia city, it is important to note that campus landscapes and urban spaces have historically been developed, managed, and maintained separately. However, the new UGI proposal for Valencia city should consider connecting with the UGI of campuses. Recognizing the potential synergy between campus landscapes and urban spaces can lead to more integrated and cohesive UGI planning and implementation.

Valencia City, the centre of a wide metropolitan area with over 1.5 million inhabitants, has 792.086 inhabitants and serves as the capital of the autonomous community of Valencia, representing 16% of the total population of the Valencian Region. It is demographically and economically the third biggest city in Spain after Madrid and Barcelona and is located in the centre of the Spanish Mediterranean Corridor with one of the most important ports in the Mediterranean region.

Valencia has a Mediterranean climate with long, hot, and dry summers and mild and wet winters (Caselles et al., 1991). This city sits on an alluvial plain, formed through a repeated depositional sequence of the Turia River. It includes a big variety of habitats, represented by a unique combination of parks and gardens located in every neighbourhood of the 19 districts, which form this modern and cosmopolitan city. This mosaic is completed by the Turia River green channel, a big surface of peri-urban orchards and the biggest number of good quality beaches (24 kilometres), which hosts plenty of bird species.

The singularity of this zone is given also by the existence of an important place for bird migration, which is L' Albufera Natural Park. Not only do the surroundings receive attention and host a big biodiversity of species, but also in the urban centre of the city strategic decisions are made concerning urban wildlife and flora to increase and conserve it. Biological diversity underpins ecosystem functioning and the provision of ecosystem services (ES) essential for human well-being. Valencia's wildlife was described by Lourdes Bernal Sanchis, as diverse, hidden, colourful, silent and at the same time loud, but without any doubt surprising (García-Atienza et al., 2014).

L'Horta de Valencia, together with Albufera Natural Park, Turia Natural Park, and the Mediterranean Sea coast, is considered as one of the main environmental and cultural assets, that articulates Valencia's green infrastructure. L'Horta de Valencia forms a unique landscape integrated into a well-known Mediterranean orchard. This singular agricultural system has been declared a protected landscape and part of the city's cultural heritage (Muñoz Criado & Doménech Gregori, 2012). It has been recently (2019) recognised as a Globally Important Agricultural Heritage Systems (GIAHS) as highlights a 1.200-year-old productive farming system in which agricultural and hydraulic heritage and culture are integrated (FAO, 2022).

The research area is the campus of Universitat Poliltècnica de València (Valencia, Spain). The campus is situated in the neighbourhood of L'Horta de Valencia and is the new northern urban limit of the city and a transitory space between urban and rural environments (Figure 1).

The UPV's campus was built in three phases, extending from the western to the eastern part of the emplacement. It began in 1970 with the construction of the Higher Technical School of Building Engineering, progressed with the development of a green central axis and concluded in the 1990s with the establishment of the Polytechnic City of Innovation (Blasco Sánchez & Martínez Pérez, 2013). These places have suffered many changes along time being influenced by some factors, e.g., university's priorities. For example, the increase of the number of schools did not facilitate the creation of a natural ecosystem. Thus, green elements have been added over the course of time to cover residual spaces.

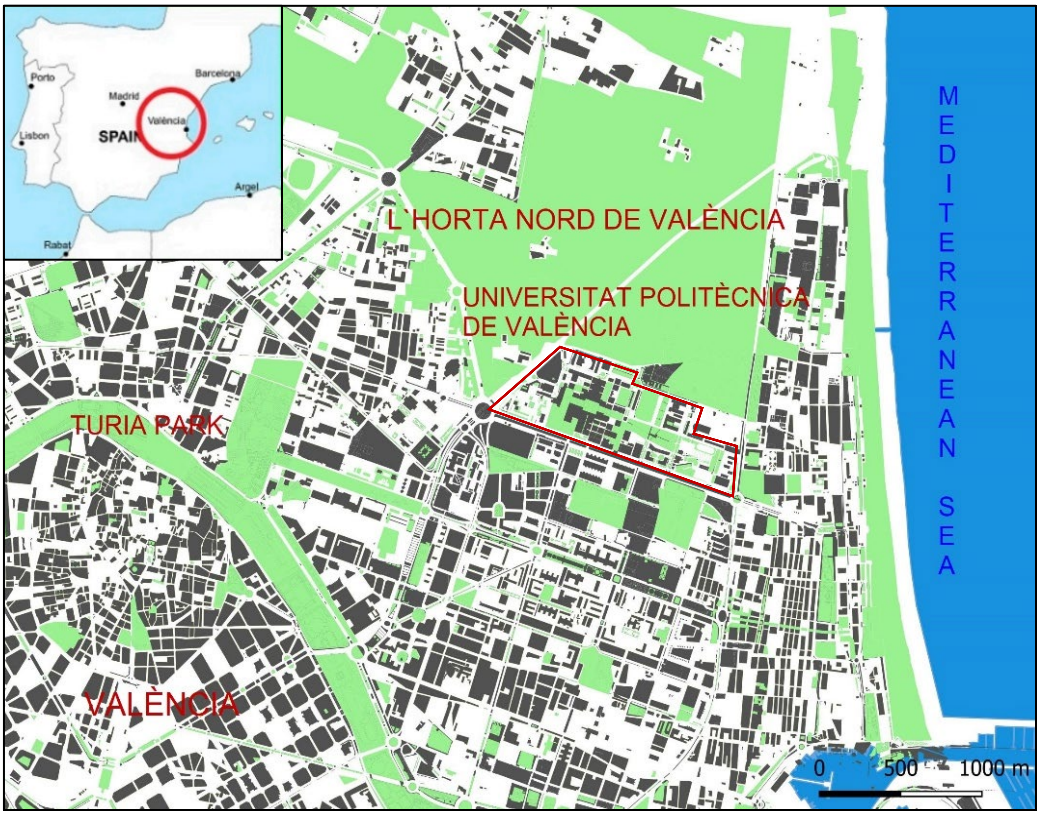


Figure 1. Location of campus of Universitat Politècnica de València

At the beginning, without an initial sustainable design, UPV's outdoor areas went through functional remodelling at each stage, followed by the creation of a green axis, which made up a large central park. Its main purposes were the following: to facilitate crossing the campus, to guide the pedestrian flow, and to improve the connectivity of the common areas with open spaces associated with each school. In the last decades, there has been a trend towards restoring the green areas and reducing the paved surfaces. In the last building phase, a number of non-native species were introduced with the intention of creating an arboretum of exotic trees. Vegetation has been introduced in a dispersed way to increase the diversity of tree species (Esteras Pérez et al., 2014) and the campus has few areas which mimic a semi natural forest structure. The campus open spaces include the Campus Botànic UPV, where approximately 2.300 trees from 251 different species from five continents create the botanical heritage of the campus. The species have been classified into bushes (31.87%), deciduous (26.29%), evergreen (12.75%), and semi-evergreen trees (12.75%), herbaceous plants (10.36%), conifers (6.37%), palm trees (6.37%) and other species (5.98%) (Esteras Pérez et al., 2014).

This thesis aims to contribute to the knowledge of the interplay between people and their nearby outdoor environment in the context of the university campus landscape of Universitat Politècnica de València (UPV). The human-landscape relationships analysis helps to understand how campus open space impacts individuals through their perceptions regarding the functions and services offered by campus landscape and urban green infrastructure elements. This research also pretends to study if the present design of campus open space of Universitat Politècnica de València and the UGI elements are perceived as providing multifunctionality and good quality services. These services are desired to reach the university community members' preferences and to facilitate a high level of use of campus landscape. To express the perceived potential of campus landscape to supply benefits, the landscape services concept is used. This thesis examines whether people's profiles influence the way they perceive the benefits provided by the campus landscape and their satisfaction with the condition and management of the environment.

1.2. Structure of doctoral thesis

This doctoral thesis is structured in 9 chapters and organised as a research framework. Therefore, the introduction begins with the current overview of the thesis, emphasising the relationships between Green Infrastructure (GI) within the city and GI on university campuses. It outlines the GI principles for Urban Green Infrastructure (UGI) planning, followed by a brief introduction to the research area and the city background. *Chapter 2* presents the general and specific objectives of the research and *Chapter 3* exposes research hypotheses and sub hypotheses. The conceptual frameworks are designed to answer the research questions presented in the same chapter. *Chapter 4* introduces a review of current situation of urban green infrastructure at different scales, the importance of green campus for city sustainability and community's well-being and the impact of persons on evaluating the perceived services provided by campus open space. Next, the context of campus open space according to literature references is presented in detail. The approaches of different authors in terms of urban green infrastructure, open space and landscape services concepts considering the relationships between people and environment and their influencing factors (socio-demographic characteristics and physical parameters) are explored. Finally, the role played by landscape services in explaining the evaluation of current condition and management of campus open space, and also their relationship with psychosocial variables (preference, perceptions and use of space) are examined. The main theoretical perspectives which have inspired the present research are also highlighted in this chapter. In parallel, a set of concepts related to campus landscape, its supplied benefits and university community is introduced and defined. In *Chapter 5*, materials and methods used are presented. The methodology used to conduct the research is explained in two parts. On one side, the methods used to describe the setting of survey and the typology of campus open space, and on the other side, the analyses and variables related to perceptions, preferences and use of campus open space are studied. In *Chapter 6*, the thesis' results are exposed and analysed at a broad scale (campus) and smaller scale (open space level). First, the analyses used to validate the landscape services evaluation scale proposed to assess the relationships between users' profile, their perceptions and satisfaction with the present condition of campus landscape are presented at a general campus level. Secondly, results of analyses which explore preference and use of space together with their predictors, are displayed at specific campus level. Finally, a method to link COS's perceived uses and landscape services by using path analysis is exposed. *Chapter 7* focuses on the discussion of results by considering the typology found in campus open space, the proposed models and the causal relationships raised in the hypotheses. Chapter 7 ends with a list of design and planning outcomes for open space. *Chapter 8* presents the summary of the research, as well as the main conclusions of the study. In *Chapter 9*, limitations and future lines of research are described.

Additionally, annexes are included. *Annex 1* presents the production of the thesis, which includes the publications derived from it. *Annex 2* provides the values and details of the questionnaire used for the research. It also includes the design of the survey conducted in the UPV campus, which served as the basis for the two levels of analyses related to perceptions, preference, and use of space. *Annex 3* presents the process and details of creating a tree cover map. *Annex 4* contains values of physical parameters which were necessary to characterise campus open space typologies. *Annex 5* includes a description of the profile of the university community sample. *Annex 6* presents the results of perceptions, satisfaction and needs related to campus open space. Finally, *Annex 7* and *Annex 8* contain the factors that influence or predict the preference and use of campus open space.

Chapter 2. Thesis objectives

2.1. General objective

The overall objective is to assess the functionality of urban green infrastructure within a campus setting by analysing the perceived landscape services experienced by the university community. This evaluation is mediated by the relationships between university community members and the open space, which encompass their preferences, the use of space, and their satisfaction with the current state and management of the outdoor areas.

2.2. Specific objectives

1. To conduct a comprehensive review of the current literature on people's perceptions in the urban and landscape planning-related work, with a specific focus on campus environments. This review encompasses some of the aforementioned variables and aims to identify the most relevant theories in environmental psychology that can help explain the relationships between these variables and their impact on people's preference for a space.
2. To make a characterization of the campus setting of Universitat Politècnica de València (UPV) and to discover which types of open space can be identified. Also, to test the validity of the factors that are involved in the classification of different typologies of campus open space.
3. To discover the level of satisfaction and needs of university community members toward campus open space and to assess how their different profiles perceive the quality of landscape services (LS) provided by campus open spaces, by considering the current state and management of the UPV's outdoor areas.
4. To analyse if respondents' opinions, recommendations and needs with current state and management of the UPV's outdoor areas influence their perceptions of LS.

5. To test the use of the whole range of LS (regulating, provisioning, and cultural) as an instrument to assess the perceived quality of the benefits provided by COS through rigorous methods (EFA, CFA) in UPV campus.
6. To test a model of predictive relationships between the socio-demographic characteristics of university community members, their perceived supply of benefits and their satisfaction.
7. To determine which structural characteristics, contribute to a higher level of preference and use of open space, and to search for the relationships between the preference and use of space.
8. To analyse the causal relationships between the preference of university community members for spending free time in specific open spaces and the activities they engage in within their favourite open space. Additionally, this objective aims to observe the relationships among the various activities developed within these spaces.
9. To analyse the causal relationships between the preference for a space of university community members and the perceived LS-related reasons involved in their selection. In addition, to see the relationships among the reasons that influence their preference for these spaces

Chapter 3. Research hypotheses and Conceptual Framework

Considering the proposed objectives and building upon the available theoretical frameworks, as well as the studies that address perceptions regarding the benefits of green infrastructure services, the influencing factors of preference for open space, and the relationships between nature and people (Chapter 4), several hypotheses are formulated to guide the research. The first hypothesis is related to the sixth objective. Hypothesis 2 and hypothesis 3 are connected to the seventh objective, while the last two hypotheses 4 and 5 attempt to achieve the eighth and ninth objectives.
To achieve these objectives, I would like to answer the following research questions:

1. Hypothesis 1: The perceived supply of LS and satisfaction with campus landscape are expected to be mediated by the profile of university community members.

    1.1. Hypothesis 1.1: Users' socio-demographic variables (e.g., age, occupation and branch of knowledge) and user-related characteristics (e.g., frequency and preference for spending free time in outdoor environment) are expected to influence the perceived supply of LS of campus landscape.

    1.2. Hypothesis 1.2: There is a relationship between the profile of respondents, especially their occupation and branches of knowledge, and the level of satisfaction with the current condition of the campus landscape.

    1.3. Hypothesis 1.3: The higher perceived supply of benefits delivered by COS, the higher the satisfaction of university community members.

2. Hypothesis 2: Structural characteristics of COS are expected to have an impact on the use of space.

3. Hypothesis 3: Structural characteristics of COS are expected to exercise an impact on the respondents' preference for outdoor areas.

4. Hypothesis 4: The activities undertaken by the community are expected to influence participants' preference for open space when considering their free time in the context of COS.

5. Hypothesis 5: LS-related factors are expected to serve as influential factors in the preference of the university community

Conceptual framework

The conceptual schemes present the study's hypotheses related to variables' relationships, which were inspired by significant literature theories in environmental and social psychology, as well as landscape planning. There are two complementary conceptual frameworks (Figure 2 & Figure3) designed to comprehend the functionality of campus UGI considering perceptions, preferences and use of open space. The conceptual frameworks were conceived considering two levels of research of campus analysed at a broad and smaller scale (open space level). These analyses are derived from a general approximation of the entire campus open space and a specific differentiation considering campus open space typology and UGI elements.

The first conceptual framework focuses on the general situation of campus open space. Its design is based on respondents'profile (socio-demographic and user-related characteristics), their satisfaction with the open space's condition and management and the perceptions of benefits of open space. The interrelationships of the conceptual framework model studied are: (H 1.1) users'socio-demographic and user-related characteristics in terms of COS, and the perceived LS classified according to Vallés-Planells et al. (2014) (H 1.2) socio-demographic characteristics and satisfaction with COS, (H 1.3) perceptions of LS and users ‘satisfaction with COS in relationship to the benefits provided (Figure 2).

According to various psychological theories focused on people-environment bonds (Kaplan & Kaplan, 1989; Ulrich et al., 1991; Tuan, 1974), nature provides benefits for the society's well-being. Simultaneously, there exists a connection between the value attributed to a space and the benefits derived from it, as the value of a space is associated with the functions it fulfils and its capacity of delivering services, as stated by the Structure–

Function–Value Theory (Termorshuizen & Opdam, 2009). This value is conditioned by the space's physical characteristics and people's profile, in accordance with the Human-Landscape Transactions Theory (Zube, 1987), as well as previous studies that have been reviewed (Andrade et al., 2021; Liu et al., 2022; Mao et al., 2020; Tian et al., 2020).

With regard to satisfaction, it is a subjective evaluation of space's quality, which is related to space's capacity of supplying services (Andrade et al., 2021; Mao et al., 2020). According to Campbell et al. (1976), satisfaction is a measure of human well-being, as it reflects how people experience their neighbourhood environment. This could lead to a pro-environmental behaviour and involvement in the space's management decisions (Antrop, 2000). The socio-demographic characteristics of users and their perceptions of biophysical properties of the environment are factors that can influence users' satisfaction with the environment (Veenhoven, 2000).

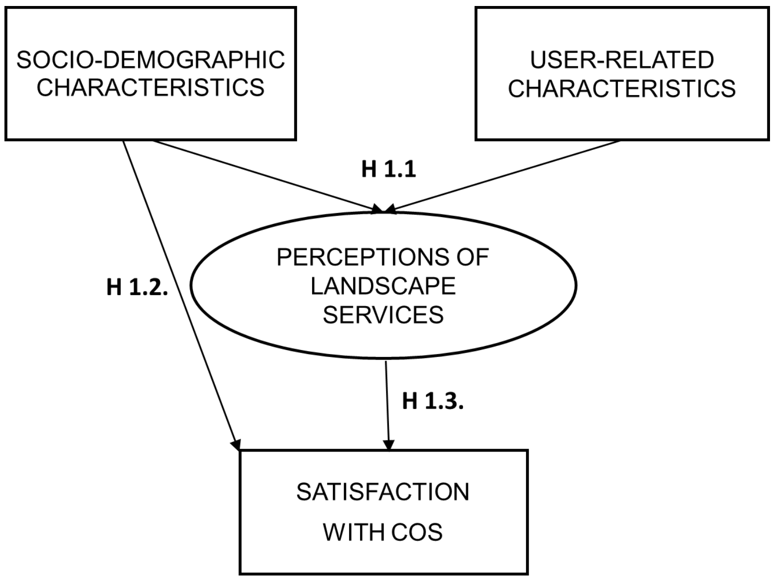


Figure 2. Conceptual framework model of the interrelationship between the variables of campus respondent groups and satisfaction with COS

The second conceptual framework focuses on the preference and use of specific spaces, and their associated attributes (Figure 3).

Its design is based on the previous psychological reviewed theories of landscape assessment and studies, concretely brings together frameworks that study the relationships between people and environment. These are the following: Landscape Services Framework (Vallés-Planélls et al., 2014), Knowledge Framework Structure–Function–Value chain

(Termorshuizen & Opdam, 2009), Spatial configuration, Spatial cognition and Spatial behavior Framework (Kim, 1999), and Depth of a place (Relph, 1976). The second conceptual framework is also inspired by ideas proposed by Human-Landscape Transactions Theory (Zube, 1987) and by some related-studies and theories regarding psychosocial variables (Gibson, 1986; Gulwadi et al., 2019; Kaplan & Kaplan, 1989; Liu et al., 2022; Sevenant & Antrop, 2010).

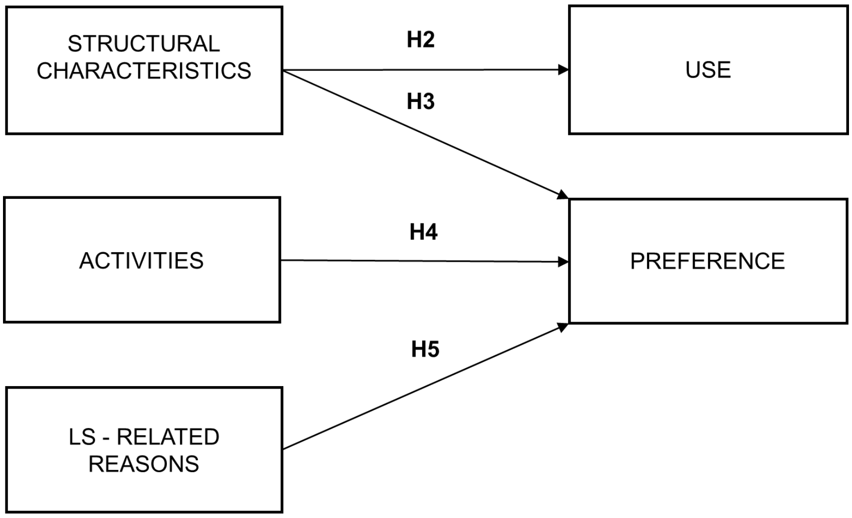


Figure 3. Conceptual framework model of the interrelationships between the research factors, use and preference of COS

Preference, similar to satisfaction, is a form of subjective evaluation of the environment. People's preference for a space is influenced by a previous space judgement, which is performed through senses and perceptions. The spatial dimension of landscape determines how people perceive, value and use the space. Spatial composition and organisation influence users'perceptions and cognition, which conditions their experience and behaviour with a place (Spatial configuration, Spatial cognition and Spatial behaviour framework (Kim, 1999). On one side, landscapes are valued for their structural characteristics, which influence the landscapes' functionality (Structure–Function–Value chain Theory (Termorshuizen & Opdam, 2009). On the other side, landscapes values are due to their perceived utility and other reasons that satisfy people's needs and desires (Zube, 1987). According to their type, needs and desires could be met through carrying out different activities or enjoying the landscape's services. In UPV'campus case, is analysed how people perceive their favourite places by considering the carry-out activities and the LS-related reasons. These involve environmental, utilitarian and psychological elements and attributes. According to Depth of a place framework (Relph, 1976), the identity of a place is better understood through the synergies that are established between the physical setting, activities and the meanings respondents gave to a place, by considering their previous experiences and preferences in regard to that place.

The second conceptual framework model is created at specific COS level analysis according to four hypotheses (H2-H5). The aim is to research the interrelationships between: (H2) structural characteristics of space and use, (H3) structural characteristics and preference for space, (H4) preference and activities, and (H5) preference and LS-related reasons.

Chapter 4. State of art

4.1. Green Infrastructure in territorial planning instruments

The European Union (EU) (2013a) recognizes the importance of green infrastructure in addressing urban challenges and promotes the development of international, national and local strategies and planning instruments that incorporate green infrastructure.

4.1.1. Green Infrastructure at European and national scale

The origins of urban green infrastructure concept belong to two continents (Europe and North America) and are based on two different visions (ecological and social) (Seiwert & Rößler, 2020), from which related disciplines have emerged, like landscape ecology and urban planning. Both perspectives present connectivity as a fundamental feature of urban green infrastructure (UGI) for ecosystem health and for the well-being of persons.

In Europe, green infrastructure (GI) has its roots in the EU Biodiversity Strategy (EU, 2013a), which orientates towards biodiversity conservation. The EU Biodiversity Strategy seeks to improve the general state of conservation of ecosystems and strengthen their ecological functions, which are responsible for providing multiple and valuable services. This vision promotes healthy ecosystems where the functional or ecological connectivity considers the behavioural response of species to the structure of the landscape. Connectivity plays a significant role in providing natural ecological functions, such as the establishment of wildlife corridors. The GI is defined as an "ecologically coherent and strategically planned network of natural and semi-natural areas with other environmental features, like green and blue spaces and other physical elements in terrestrial areas (natural, rural and urban) and marine" (EU, 2013a).

The North American perspective is dominated by an anthropocentric rationale that focuses on the socio-economic benefits for humans (Wright, 2011). The father of the greenway movement (Florida Greenways Commission, 1994) was Frederick Law Olmsted. He was a landscape architect who gained fame for co-designing several well-known urban parks including the Emerald Necklace in Boston, Massachusetts and Central Park in New York. He believed that parks could serve as meeting grounds for people of different backgrounds and classes. Mazza et al. (2011) defines structural connectivity as “the physical relationship between components of an ecological network, such as habitat patches or corridors". In addition to facilitating connections between ecosystems, UGI also provides structural connectivity. This involves establishing interconnections between urban, suburban, and rural landscapes at various scales, as well as establishing links between different sites, neighbourhoods, cities, and regions (Rouse, 2013). Thereby, UGI promotes social justice through facilitating access to green and open spaces for all demographic groups (EU, 2013a) and helps to meet economic and social demands. Spatial concepts inspire and communicate the planning strategy designed to provide specific functions and benefits. In order for the public to understand the planning process, common names are used to define spatial concepts, like Emerald Necklace (Boston, USA), Green Heart (Amsterdam, Netherlands), Sustainable Small Forest (Valencia, Spain), Green Ring (Vitoria-Gasteiz, Spain), Iron Curtain or Green Belt (Central European section, from the Baltic to the Adriatic Sea).

The principles of UGI planning are related to multi-scale, multi-object and inter-transdisciplinary. UGI operates at all scales and is capable of creating a comprehensive system which links different spatial levels ranging from metropolitan regions to individual sites. According to the multi-object principle, all types of urban green and blue spaces are considered integral components of a green infrastructure network. This includes spaces that exhibit good quality and play a consistent role within the interconnected network (EU, 2013a). These spaces range from very large landscape elements such as parks, natural areas, or greenways to smaller elements, like green roofs and walls, trees, rain gardens, infiltration planters, and others (EU, 2013a). The inter- or trans-disciplinary principle in UGI planning involves collaboration across disciplines as well as the integration of knowledge from landscape ecology, urban and regional planning, and landscape architecture. This principle promotes the collaboration between science, policy, and practice and emphasises the importance of fostering relationships between local authorities and other stakeholders.

Green infrastructure is linked to the natural capital concept that is designed and managed to provide a wide range of ecosystem services (ES) such as ecological, economic and social benefits (EU, 2013a).

The European Union Strategy on Biodiversity for 2030, which was approved in 2020, recognizes and reinforces the development of GI as one of the main tools for achieving the environmental objectives of the European Union (EU). The strategy urges member states to map and assess the ecosystem conditions and the services they provide. It also calls for the evaluation of the economic value of ES and promotes the integration of this value into accounting and information systems at national and non-European levels.

The GI is incorporated into existing national legislation, which was published in the State official newsletter (Boletín Oficial del Estado: BOE) on July 13, 2021 (BOE, 2021b). According to the National Strategy for Green Infrastructure and Ecological Connectivity and Restoration, GI holds a major environmental, cultural and visual value that is designed and managed for the conservation of ecosystems and the maintenance of the supplied services. The aim of this strategy is to provide guidelines for the identification and conservation of terrestrial and marine elements that constitute the green infrastructure of the Spanish territory. The strategy seeks to ensure that the territorial and sectoral planning conducted by Public Administrations enables the conservation of biodiversity, ecological connectivity, and the functionality of ecosystems and their services. It also aims to address the mitigation and adaptation to the effects of climate change and the integration of biodiversity in the territorial planning of other sectoral policies (BOE, 2021a).

<u>4.1.2. Green Infrastructure at a regional and local scale</u>

The GI plays an important role in enhancing urban planning and improving the quality of life as well as contributing to the achievement of city sustainability within regional strategies on climate change in accordance with European targets for 2030, e.g., Smart City Strategic Plan for Valencia (VLCi Strategy) (BOE, 2021b; Muñoz Criado & Doménech Gregori, 2012). These consider green space effective for climate impacts and heat wave mitigation, and promotes nature-based solutions (NBS), e.g., green walls or water-saving green area management techniques together with vegetation implementation (trees and shrubs).

The Territorial strategy of the Valencian Community, initiated in 2004, is actually incorporated into Legislative Decree 1/2021 (Territory, urban and landscape planning law) (BOE, 2021b).

GI at a regional level

At the regional level, green infrastructure is the “basic territorial system which is composed by the following spaces: areas and places with the most relevant environmental, cultural, agricultural and landscape value; critical areas of the territory whose transformation implies environmental risks or costs for the community; and territorial network of ecological corridors and functional connections which links all these elements” (BOE, 2014).

Regional green infrastructure is also represented by the urban and developable land including open spaces and public green areas as well as plans that allow their connection. All these spaces perform environmental and territorial functions. Some of them are protected by specific regulation while others do not have such protection. To identify and characterise the elements of Valencian Community's green infrastructure, territorial urban planning instruments are used at regional, supra-municipal, municipal and urban scales.

GI at a local scale: The Green Plan of Urban Biodiversity

The EU develops local strategies and planning instruments that use GI as an effective tool against the urban challenges. At the city scale, UGI is the backbone of GI and urban green space (UGS) are its structural components. The UGI refers to the natural spaces in a city that improve urban ecology and bring social, economic, and environmental benefits to residents and communities. Due to its multi-functionality, UGI is proposed as a valuable urban design tool and landscape management process that integrates various disciplines including environmental science, urbanism, geography, botany, architecture and economics.

Given the diverse range of UGI elements such as urban, neighbourhood parks, gardens, boulevards, landscaped walkways, and public facilities-related green areas there emerges the need of an urban planning tool. This tool helps to identify the current state of green areas and to guide the municipal management of GI, natural heritage and urban biodiversity (Ayuntamiento de Valencia, 2021). The Green Plan of Urban Biodiversity seeks to lay the foundation for the future UGI of Valencia through a more responsible model of GI management, and in line with European sustainability policies. This Green Plan of Urban Biodiversity is a strategic tool with a metropolitan vision that considers the climatic emergency situation, which is a key factor across the implementation of all city's actions (Ayuntamiento de Valencia, 2023). This document is the first one that addresses the green spaces of Valencia collectively, as a previous plan was drafted in 1994 but it was not approved.

Another document that aims to guide UGI management at municipal planning scale is the the general urban masterplan and its modifications (*Plan General de Ordenación Urbana* (PGOU)) (Ayuntamiento de Valencia, 2010). The PGOU created some strategic proposals on the city model, the urban structure and infrastructure, considering the previous planning efforts and future urban challenges. These proposals are: (I) to classify the land for the establishment of the corresponding legal regime; (II) to define the elements of the general structure adopted for the urban planning of the territory; and (III) to establish the program for its development and execution.

One of the objectives of PGOU is to arrange urban spaces considering the complexity of uses and activities. In this respect, green areas of public domain and use, like parks, should be used for outdoor recreational activities carried out in land equipped with trees, gardening and urban furniture (Ayuntamiento de Valencia, 2010).

4.2. Landscape services vs. ecosystem services

The most popular concept to refer to the different ways in which natural ecosystems provide benefits to human well-being is the term ecosystem services (Costanza et al., 1997). The ES approach argues that humanity becomes a direct beneficiary of the ecosystem quality and plays an important part of the ecosystem and its conservation. Due to the interdependency between the societies and ecosystems, the socio-ecological ecosystems concept (SES) has emerged in the literature. SES refers to a "coherent system of biophysical and social factors that regularly interact in a resilient, sustained manner, that is defined at several spatial, temporal, and organisational scales, and which may be hierarchically linked" (Redman et al., 2004). However, more recently the term landscape services (LS) has arisen (Termorshuizen & Opdam, 2009) and it appears to be more appropriate in certain cases, especially when the services are supplied by other landscape elements different than those supplied by ecosystems (Bastian et al., 2014).

ES are closely linked to ecosystems, which encompass the relationships between a biocoenosis and its habitat or environment (biotope), while LS represent the output of natural and other forms of capital (Lamarque et al., 2011; Vallés-Planells et al., 2014). The concept of ecosystem services constitutes a very useful tool to integrate ecological, social and economic perspectives in the management of ecosystems and a framework for planning strategies, implementation and verification of actions related to GI connectivity and ecological restoration.

The classification of ES helps to assess the multiple benefits that ecosystems provide through processes and functions (Daily, 1997). It varies according to the criteria used for the grouping of the different services like the object or interest of the classification.

According to the international nomenclature of ecosystem services (CICES) there are three categories of ES that avoid redundancies and overlaps: Provisioning ES, Regulation and maintenance ES, and Cultural ES (Haines-Young & Potschin, 2018). The classification proposes a comprehensive and exhaustive count at different levels of integration related to structures, processes and functions that generate them. Thus, each category has nested service classes, groups and types. The Millennium Ecosystem Assessment (MA) (MA, 2005) continues with The Millennium Ecosystems Assessment (Finlayson, 2016) and estimates 22 services ecosystems (8 supply, 7 regulation and 7 cultural), based on 400 indicators, in 14 operational types of ecosystems.

Provisioning services make the distinction between biotic and abiotic outputs. Provisioning services are all “nutritional, non-nutritional material and energetic outputs from living systems as well as abiotic outputs (including water) referring to food products, the supply of materials and the energy sources provided by living systems” (Haines-Young & Potschin, 2018). Regulation and maintenance services describe all ways that living organisms can mediate or moderate the environment and affect human activities and well-being. The division at the class level covers the transformation of biochemical or physical inputs in the form of wastes, toxic substances and other nuisances and the regulation of physical, chemical, biological conditions. Regulating services are benefits, less tangible than goods, but important for human beings. Cultural ES include “non-material and non-consumptive outputs of ecosystems (biotic and abiotic) that affect physical and mental states of people” (Haines-Young & Potschin, 2018). Cultural services of an ecosystem or a landscape are in general less directly linked to human well-being than provisioning and regulating services and their values are irreplaceable when compared to the other types of services. A fourth class would correspond to support services, but considering the assessment of ES, the double consideration is an error. Instead, support services are typically evaluated within the category of regulation services. According to TEEB (2010), supporting services should rather be classified as “ecosystem functions” underlying the production of provisioning, regulating, and cultural services.

Landscape services show special features, making them one of the highly discussed topics among the literature references (Vallés-Planélls et al., 2014). In Willemen's (2010) view, landscapes are spatial systems in which humans interact with their environment. Bastian et al. (2014) define LS as the contributions of landscapes and landscape elements to human well-being. Therefore, the LS term has often been used in social sciences. When it comes to components related to perceptions and aesthetics, the LS concept is used as a marketing tool that defines them as spaces fit for recreation, living or working, or supporting rural development (Wascher, 2005).

LS are seen as a bridge between landscape ecology and sustainable development, serving as a unifying common ground. LS can encourage the collaboration and communication between scientists from various disciplines to create a common knowledge base that can be integrated into multifunctional actor-led landscape development (Termorshuizen & Opdam, 2009).

In some cases, the ecosystem and landscape services concepts may overlap and both terms can be used. For example, when there are services supplied by an ecosystem, but some landscape-related factors such as landscape character or landscape units are significant. Still, there are situations where one concept better fits than others, as the others terms become obsolete. For example, the LS concept has more relevance than the ES term when services depend to a high degree to be supplied by landscapes or by landscape elements (which are not ecosystems).

Landscape planning covers landscape related-aspects. LS uses landscapes as spatial reference units, which simplifies the understanding of the complex inter-relationships of characteristic conditions in different areas. According to Fisher et al. (2009), ‘‘service production areas” and ‘‘service benefit areas” are two different concepts. It is possible for the location where services are provided to coincide with the location where benefits are received, or for the provided services to benefit a different location. Bastian et al. (2014) identify that spatial aspects (e.g., the size or the pattern of the ecosystems or landscape elements), the specific landscape character that plays for the service, and the relevance of LS for landscape planning are important factors in distinguishing the context-specific use of both concepts rather than substituting them.

As main theoretical perspectives relevant for this research, Landscape Services and Structure-Function-Chain Frameworks are presented below.

Landscape Services Framework

According to De Groot et al. (2002), humans are seen as an integral part of the landscape and they have the ability to value goods and services provided by ecosystem functions, which places them in a central position in the landscape assessment. The LS concept involves the social dimension of landscape and the spatial pattern resulting from both natural and human processes in the provision of benefits for human well-being (Vallés-Planélls et al., 2014). Since urban open space provides some particular benefits which are a product of current community's activities, the LS concept is more applicable to urban outdoor environments than the ES, which is exclusively derived from natural capital (Haines-Young & Potschin, 2018). Not only the natural area and green elements contribute to people's well-being, but also cultural landscapes or urbanised areas, such as rural, urban, and peri-urban areas.

Structure–Function–Value Chain Framework

Termorshuizen and Opdam (2009) have proposed the Structure–Function–Value chain as a based-on landscape concept-knowledge framework where the three entities of the chain are represented by measurable and quantitative indicators (Figure 4). According to the human–ecological view of the landscape, GI's functions are independent of people, while LS are not. The detailed pattern of landscape elements is perceived by people who are able to value and manage. Thus, “functions” can be translated into “services” when they are valued by people and one function can offer several services. The function refers to the potential or capacity to deliver a service (e.g., runoff coefficient in relation to precipitation quantities or recreation potential). The value indicators are connected to the benefit for people, which could be economic or non-economic (e.g., economic benefit of reduction of storm water to be treated in public sewerage systems).

This model highlights the need for interdisciplinary research and the integration of knowledge within the chain in order to facilitate linking of the physical structure and functioning of the landscape to the economic, sociocultural, and ecological values. The model chain is a process that reveals the appropriate structure and level of functioning necessary to achieve the desired value and functions in goal-setting and design. It facilitates the development of a suitable framework that aligns with the desired objectives. The structure–function part of a chain may be the domain of ecologists, geographers or engineers and architects for urban open spaces, while the function–value part requires cooperation with economics and sociology.

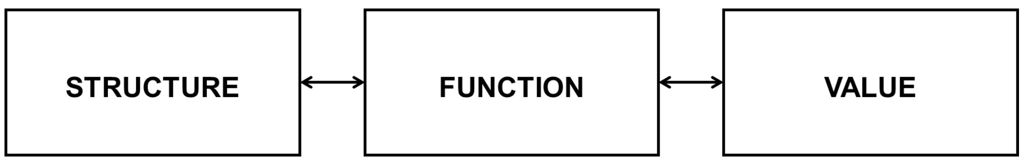


Figure 4. Structure–function–value chain Framework. Source: Termorshuizen and Opdam (2009)

4.3. Urban green infrastructure in the literature

There is evidence about the role GI plays in outdoor and indoor environments. Numerous studies indicate the positive impact of UGI on achieving city sustainable development, through a strategic coordination of the whole range of urban landscape benefits (Apostolopoulou & Adams, 2015; Cortinovis & Geneletti, 2018; De Valck et al., 2019). As a big supporter of healthy lifestyles, urban livability and well-being, UGI facilitates mobility, health, education and economic growth by involving leisure and social facilities, which are of interest for different stakeholders. GI has the potential to enhance the recognition of social and economic benefits of urban space (Bastian et al., 2014; de Vries et al., 2003; Hartig et al., 1997; Ulrich et al., 1991; Vallés-Planells et al., 2014). Other authors have also highlighted the potential impact of UGI on property values and energy costs (Agencia d'Ecología Urbana de Barcelona, 2007; Mullaney et al., 2015). By enhancing the environmental quality of places, they attract tourists, consumers, and investments. Consequently, this leads to significant economic benefits for surrounding areas and contributes to the sustainable development of the regional economy (Ma et al., 2021).

Some recent studies highlight the importance of greenery's functions within the urban challenges. There is a growing body of analytical work on the beneficial impacts of UGS on biodiversity (Agencia d'Ecología Urbana de Barcelona, 2010; Gilbert, 1989; Schebella et al., 2019b; Whitford et al., 2001). UGI is presented as an important agent against climate change by contributing to thermal comfort and temperature regulation in order to compensate for the negative effects of densification (Anderson & Gough, 2022; Baró et al., 2014). A great amount of literature demonstrates the cooling function of trees for fighting against the urban heat island effect (Pauleit, 2021; Privitera & La Rosa, 2018; Zölch et al., 2016). In addition, green walls and green roofs are very effective mitigation NBS solutions at the building scale (Evola et al., 2021; Palme et al., 2020). UGI contributes to pollution mitigation (Livesley et al., 2016), carbon storage and sequestration (Baró et al., 2014; Burnell Fischer et al., 2007), greenhouse emissions and heat stress (Baró et al., 2014; Nowak & Crane, 2000). Among the grey reports and literature references, urban trees are known for coping with reducing runoff volume (Burnell Fischer et al., 2007; La Rosa & Pappalardo, 2020; Pauleit & Duhme, 2000). In fact, case studies have demonstrated UGI's effectiveness related to water management (Ahern, 2007; Yang et al., 2021). Water elements are an important aspect of robust climate urban design due to provided services, like decreasing the environmental degradation and upholding the social cohesion (Smaniotto Costa et al., 2015). Regarding the relationships between people and urban green space, greenery provides opportunities to get people close to nature (Kaplan & Kaplan, 1989), enhances landscape aesthetics (Lau et al., 2014) and promotes social equality (Baró et al., 2019; Lovell & Taylor, 2013). Mao et al. (2020) argue that there is a relationship between between people's satisfaction with residential green spaces and their capacity of supplying cultural services (e.g., sense of place and neighbourhood relations). Dzhambov and Dimitrova (2015) have researched the preventive impact of green spaces on noise perceptions and have learned people who live closer to green spaces and in a greener environment are less sensitive to noise than those who live further and proximate to less green space.

By considering the type of study approach researchers have adopted regarding UGI, literature references could be split in two large categories. First, the studies whose focus is on the UGI, the ES and LS concepts, which are carried out at theoretical level without bringing any evidence of UGI's multifunctionality, and, secondly, those studies in which researchers are struggling to demonstrate practically the UGI's benefits for the people's well-being through qualitative and quantitative evaluations.

The first branch of scholars focuses on the evolution of the concept and the core value of UGI. Generally, these papers involve interesting proposals of UGI implementation (Hansen & Pauleit, 2014; Artmann et al., 2019), NBS (Babí Almenar et al., 2021), green indicators (Tudorie et al., 2019), green index (Pakzad & Osmond, 2016; Anguluri & Narayanan, 2017) and ES/LS (Cortinovis & Geneletti, 2018; Vallés-Planélls et al., 2014) in planning practices without having real results of measured benefits provided by green elements. Some of the reviewed works (Pakzad & Osmond, 2016; Artmann et al., 2019) emphasise the potential of GI Indicators, or KPI (Key Performance Indicators) (GrowGreen, 2016), as a planning tool with the aim of establishing goals, estimating the performance, synthesising and conveying the information. Hansen and Pauleit (2014) create a system based on the connectivity of the green infrastructure network and the quality of its elements to help urban planners make decisions. According to this decision support matrix, strong integrity of the GI network and a high integrity of GI elements lead to the conservation of the GI network. However, for the enhancement of GI elements, acceptable and moderate levels of integrity are sufficient (Hansen & Pauleit, 2014).

The second branch of scholars tackles the assessment of GI's performance within case studies. The evaluation of open space through considering the supply or demand of LS (Burkhard et al., 2009; Mcdonald, 2009) can be done using indicators (Schebella et al., 2019a), experts (S. Zhang & Muñoz Ramírez, 2019) and by the general population (Martín-

López et al., 2012). Now, there is an increasing concern of the relevance of providing evidence of the benefits delivered by GI in order to prove that an increase of urban green space would provide a proportionally larger number of ecological, economic and social benefits and services (Tudorie et al., 2019). For the UGI management and UGI properties assessment, green indicators are relevant. The main purpose of using indicators in a policy context is to provide evidence about the benefits of UGI for the human well-being that can be understood by stakeholders and policy actors.

Spatial mapping is an effective way to include people in landscape/urban planning, especially when it is about the evaluation of the supply LS (Xu et al., 2020). At a region scale, existing literature shows interest in spatial distribution of different types of LS, especially in rural landscapes (De Vreese et al., 2016; Fagerholm et al., 2012; Fagerholm & Käyhkö, 2009; Plieninger et al., 2013; Xu et al., 2020; Zoderer et al., 2016) and in study areas that combine both types of land use, e.g., urban and rural (Martín-López et al., 2012; Queiroz et al., 2015). There are some literature references which develop complex cartographies of provisioning, regulating and cultural LS at a regional scale with the aid of indicators (Queiroz et al., 2015) or through public preferences and evaluations (Zoderer et al., 2016). Plieninger et al. (2013) and Queiroz et al. (2015) find out the municipalities around lakes are hotspots for provisioning and cultural LS, while Martín-López et al. (2012) and Queiroz et al. (2015) suggest a higher distribution of cultural services in and around the urban nucleus. According to the findings of Martín-López et al (2012), Plieninger et al. (2013) and Queiroz et al. (2015) the high multifunctionality of landscape and the production of LS bundle, at a municipality scale, are due to the combination of physical, ecological, and social factors.

Mapping socio-cultural values at urban scale is more common than regulating and provisioning LS cartographies.

The participatory mapping (Fagerholm et al., 2012; Plieninger et al., 2013) is complemented by other tools like sociotope (Łaszkiewicz et al., 2020; Ståhle, 2016) and behaviour mapping (Marušić, 2015). Ståhle and Sandber (2016) develop sociotope maps (sociotope means place diversity from Greek *topos* = place) in order to explore the open space and its multiple use values in urban and landscape planning. Marušić (2015) proposes the behaviour map to analyse the relationship between urban squares/parks use and the physical characteristics of open space, thus, promoting the social inclusion and the well-being of inhabitants as indispensable factors of actual use of urban public places.

4.4. Current situation and literature review of open space and UGI elements

4.4.1. Nomenclature

In urban areas, the term of open space is increasingly used to refer to the whole of the external environment outside the buildings, while green space is a more recent term whose origins are related to urban nature conservation's movement associated to green space planning.

In the literature, terms like open space, public space, green space, or greenspace are commonly used and sometimes used interchangeably. Swanwick et al. (2003) and Al-Hagla (2008) were responsible for making the distinction between the green and grey space, which led to considering the green space as a subset of open space.

In the 19th century, public open space was created in the United Kingdom and United States with a view of improving the health and life quality of the working classes living in squalid and crowded living conditions (Giles-Corti et al., 2005). According to Swanwick et al. (2003) “open space [is] defined as [the] part of the urban area which contributes to its amenity, either visually by contributing positively to the urban landscape, or by virtue of public access”. It is therefore defined as combining urban green spaces and civic spaces.

Open space (OS) can be a conventional landscape including green elements, like parks, gardens, street trees and other types of green space (EU, 2013c), but can also comprise more innovative solutions in terms of urban challenges and climate comfort like NBS (e.g., rain gardens, planter boxes, permeable pavements, vertical gardens, bioswale, green roofs and green parking) (EPA, 2023). According to Stanley et al. (2012), open spaces are further categorised along a spatial scale continuum: city-wide, intermediate, and individual building. Other inventories are grouped based on usage (Gerstenberg & Hofmann, 2016) or on UGS cover (Rupprecht & Byrne, 2014).

According to the EPA (2023), open space categories include schoolyards, playgrounds, public seating areas, public plazas, vacant lots and green space, while the green space category covers parks, community gardens and cemeteries, which are considered partly or completely covered with grass land, trees, shrubs, or other vegetation.

Green space may also include buildings and hard surfaced areas, which highlights the need for a more specific definition. It is often described as land that “consists predominantly of unsealed, permeable, soft surfaces, such as soil, grass, shrubs and trees” (Swanwick et al., 2003). Green space is defined as “consisting of any vegetated land or structure, water or geological feature within urban areas”, while grey space refers to “more civic-oriented spaces, such as urban squares, market places and other paved or hard landscaped areas” (Al-Hagla, 2008).

In campus studies, authors use various terms to refer to campus outdoor areas, such as campus green space (CGS) or public green space (Gulwadi et al., 2019; Liu et al., 2022; Li et al., 2019; McFarland et al., 2010; Speake et al., 2013), public open space (Sun et al., 2015), open green space (Y. Wang et al., 2017), boundary space (H. Zhang et al., 2019) or campus landscape (Akhir et al., 2020; Tudorie et al., 2019). Although, more studies have used other similar concepts, such as campus open space (COS), university campus open spaces (UCOS) (Hanan, 2013; Harun et al., 2020; Tourinho et al., 2021; Tudorie et al., 2020) and campus outdoor areas/spaces (Cooper & Wischemann, 1990; Abu-Ghazzeh, 1999).

4.4.2. Classification of UGI elements

The green elements present functional relationships with some other elements which are not always green like paved squares, concrete planters and pedestrian and cycling areas (Bell et al., 2007; Dunnett et al., 2002). Considering the diversity of green elements and their big dependency on scale, various classifications of GI elements were proposed by literature references.

In the context of the Green Surge project (EU, 2013b), an inventory of GI elements was proposed in order to bridge all the scales, from regional to local to supports cross-city comparisons. At a local scale, GI basically encompasses all the vegetation found in the urban environment that is adjacent to green surroundings. UGI is represented by the following components: parks, gardens, green roofs, ponds, streams, forests, hedges, meadows, restored contaminated sites coastal sand dunes, and connecting elements, e.g., green bridges and fish ladders (Taylor and Hochuli, 2017; Tzoulas and James, 2010).

The literature review helps experts to gather empirical evidence about the connection between urban green elements and landscape services classification. The Green Surge project (EU, 2013b) studies the multifunctional linkages between types of GI and the variety of provided ES and their impacts on biodiversity, human health and well-being, social cohesion and green economy.

Swanwick et al. (2003) has developed an inventory of 25 Urban Green Space (UGS) types, which can be classified into 10 sub-groups and four main groups. These main groups are amenity green space, functional green space, semi-natural habitats, and linear green space. Bell et al. (2007) differentiates between parks and gardens; natural and semi-natural spaces; green corridors; allotments, community gardens and urban farms; outdoor sport facilities; amenity green spaces; provision for children and young people; cemeteries, disused churchyards and other burial grounds and public spaces. However, other authors Kondo et al. (2015) and Suppakittpaisarn et al. (2019) classify GI based on its main function. For instance, green stormwater infrastructure (GSI) plays a significant role in stormwater management and reducing water pollution. GSI includes various components such as rain gardens, bioswales, and green roofs, as highlighted by studies conducted the mentioned studies. Since water management is the primary objective of GSI, its appearance and placement are specifically designed to prioritise this goal.

4.5. Green campus excellence

The Green Flag Award scheme recognizes the importance of green space and well-managed parks, and rewards good management and provision. The Green Flag Award is a valuable tool which ensures a proper management and maintenance of green space and of recreational outdoor spaces according to high international standards of excellence (Ellicott, 2016). The Green Flag Award was launched in the UK in 1996 and had a large positive impact against the decline in green spaces' quality. The goals of the Green Flag Award are: to create a pleasant environment for everybody with a sustainable design which could satisfy the needs of community members, to provide space good management, to recognize and reward the hard work of involved staff, and to promote and share good practice amongst the green space sector. The Green Flag Award promotes clean spaces and citizens' safety as they are important issues related to use and value of these spaces. Another aspect which explains preference and use of spaces is the presence of a rich biodiversity.

The Green Flag Award's criteria cover many types of green spaces belonging to different institutions like cemeteries, housing associations, hospitals, and retail and leisure, canals and waterways, nature reserves, traditional Victorian parks, recreational parks, heritage parks, modern parks and country parks, and campus universities. There are more than 1.600 parks and green spaces with Green Flags Awards flying in Britain and across the world. They provide society access to good quality green space since they are perceived as extremely important for people's health and well-being.

University campus green spaces have recently earned a place in the ranking of important urban green areas, receiving more attention than in the past (Hansen & Pauleit, 2014; United Nations, 2017). Universities' efforts to become sustainable are usually reflected in the level of awareness, knowledge, interest in sustainability issues, students' perceptions of sustainability and a green design for campus open spaces. Currently, there are many universities that are endeavouring to design or improve their campus, creating the characteristics and functions of an urban ecosystem to gain a *garden-park l*ook. Some examples of universities with the Green Flag Award are University College Cork, Trinity College Dublin, and the University of York. In Spain, the first university campus that has received the Green Flag Award belongs to Universidad de Navarra in 2018. Since 1997 the Universitat Politècnica de València (UPV) has had an Environmental Policy in place. Furthermore, it was the first Spanish University to implement an Environmental Management System. Now inspired by the Green Flag Award's criteria, UPV has developed outdoor environment guidelines to obtain well-managed open spaces defined by sustainable design.

4.6. Psychosocial variables

Research on landscape perception, preference, and behaviour primarily falls under the domain of environmental psychology, with inputs from sociology and human geography. In the research about human and environment settings and relationships, the psychosocial variables have been the most striking intervening factor. The exchange between mind, behaviour and environment has been extensively examined by environmental psychology. Environmental psychology studies the interplay between people and their environment. These transactions help to understand how the environment impacts individuals, teaches them to use environmental knowledge for their own benefit, and improves their relationships with the environment (Gifford, 2014).

There are many theories developed to predict the preference and people's use of space which are especially relevant for landscape planning, but lately, are also relevant for urban planning. The majority of research is focused on identifying the factors that influence people's preferences for and use of a space, as well as understanding how people perceive and use that space (Abu-Ghazzeh, 1999; Shan, 2014; Speake et al., 2013; R. Wang et al., 2017). Additionally, some studies explore how spaces can be improved to better meet people's needs in terms of management conditions and the potential of UGI to deliver benefits (Aiello et al., 2010; Andrade et al., 2021; Mao et al., 2020). Until recently, most of the research has been focused on physical parameters and has only used objective variables. However, in recent years, more and more studies have started to analyse the potential of the latent variables in preference studies. This approach allows for the inclusion of subjective or unobserved effects, providing a more comprehensive understanding of people's preferences (Gulwadi et al., 2019; Liu et al., 2018, 2022; Tian et al., 2020). Thus, social psychology has been gaining importance in the study of the behaviour and preference of individuals in terms of green and open space design, and the inclusion of variables such as perceptions, satisfaction, use, preference, and ecosystem/landscape services.

4.6.1. Perceptions, preference and behaviour

In the landscape research literature, perceptions and preference are two different concepts that have been associated (Sevenant and Antrop, 2010). Also, the landscape quality, especially the visual quality, plays an important role in the assessment models. The assessment of preferences plays a significant role in researching the perceptual process. Kaplan (1995) considers that perceptions and preferences are closely related.

Perceptions are the subjective interpretation of reality and can be regarded as the design that individuals construct through interactions with their environment. Firstly, perceptions are considered subjective because individuals react differently to the same stimulus based on their needs and experiences. Secondly, perceptions are selective due to the subjective nature of individuals. People cannot perceive everything simultaneously and, therefore, need to selectively focus on certain aspects of their perceptual field based on what they intend or desire to perceive; and, finally, since perceptions are short-term phenomena, they can be considered temporary.

According to the ecological approach of Gibson (1986), perceptions are a simple process where information exists directly in the stimulus without the need for further internal processing. To emphasise the need of studying perceptions in ecological conditions and how test performance predicts behaviours in real-world settings, Gibson (1986) introduced the notion of ecological validity. There are key variables that contribute to understanding how landscapes are perceived, including the texture, density, and colour of surfaces. These variables interact to create patterns in the landscape at different scales (Gibson, 1979). However, Bell (1999) cited in Bell (2012) acknowledges that the experience is part of the internal process of perceptions. The author states that due to the brain activity connections and updating of memory, the frequent use of patterns is catalogued in the memory store and becomes related to sense of place.

Jessor and Jessor (1973) state environmental perception is temporal and the environmental attributes are perceived to evoke different developmental feelings at various stages of life. Over time there is a series of changes between people and landscape and a dynamic set of needs and desires that shape landscape perception and the value individuals attribute to it. According to Burnett (1976), cited in Downs and Meyer (1978), perceptions and cognition are intervening psychological processes and filtering mechanisms that play a role in human actions and interactions with the environment. Perceptions are the act of comprehending through the mind and senses, of observing and of being aware. It is closely connected with events in the immediate surroundings and is linked with immediate behaviour (Kim, 1999). In the early 20th century, Gestalt psychology appeared and sought to understand the brain and social behaviour by focusing on how people think and perceive environmental stimuli. The concept of Gestalt psychology is based on the interdependence relationships between individuals and environment and on the vision of the system as a whole, and not the sum of its parts, which is in line with ecological perspective.

Preference can indicate a comparison, e.g., between different types of open spaces. In fact, people tend to prefer places in which they can function effectively. The drawback of this theory is that people no longer act as hunter-gatherers, but act with more complex emotions, feelings and underlying needs. Such attributes contribute to the expression of preferences for places (Kaplan & Kaplan, 1989). However, perceptions refer to a more subjective understanding and feelings towards an existing entity. Environmental perception is defined by Zube (1999) as “awareness of, or feelings about, the environment, and as the act of apprehending the environment by the senses”. Kaplan & Kaplan (1989) affirm people search and prefer places that are “[easy] to understand" and those that supply people with “relevant information for their existence”.

The reaction to environment aesthetics is the result of environment assessment according to the compatibility between human needs and purposes (Kaplan & Kaplan, 1989). When persons judge the environment, the assigned qualification is a response to their perceptions and preference of landscape (Sevenant & Antrop, 2010), either by considering its features, e.g., psychophysical model (Daniel, 1976), or by applying subjective criteria, e.g., the past experience explained by the psychological model (Daniel, 1976).

The socio-cultural context and the environment influence people's behaviour. For this reason, the open space design and functions are closely associated with people's daily activities. According to Zube (1987), people's needs and desires, along with their personal utility functions for using the landscape, influence their perceived values and responses towards it. The functionality of a preferred or used open place satisfies people's underlying needs (Kaplan & Kaplan, 1989; Ulrich, 1983) and inspires pleasurable feelings and a neurophysiological reaction that influence individuals' reasons for visiting or avoiding a particular open space (Ulrich, 1986). Ultimately, this facilitates the establishment of bonds between users and the space (Li et al., 2019; van Vliet et al., 2021). Studies of people's behaviour in public open spaces contribute to a better understanding of environmental perception and the promotion of people’s well-being (Han et al., 2022).

The psychologist John B. Watson was one of the early proponents who argued for psychology to be considered a natural science. The Behavioural Psychology Theory, also known as behaviourism, is often associated with John B. Watson, although he himself never claimed to be the founder of the theory. According to behaviourism, the environmental and personal context are vital determinants of behaviour. Behaviourists believe that the environment plays a significant role in shaping human behaviour (Malone, 2014). The Behavioural theory suggests only behaviour is worth being studied and rejects the other 9 psychological factors. According to the Field Theory's perspective, which underlies the Gestalt phenomenological perspective, “the field is a whole in which the parts are in immediate relationship and responsive to each other and no part is uninfluenced by what goes on elsewhere in the field” (Yontef, 1999). The involvement of human activity in space and the human spatial experience provide patterns of space usage.

According to Hillier (2007), human-environment relations are defined as indirect rather than direct physical relationships of cause and effect. These relationships are mediated by spatial configuration. According to this theory, there are reciprocal effects between space and people, where patterns emerge from the influence of space on people and vice versa. Human spatial experience appears to be shaped by spatial cognition, spatial configuration and behaviour interacting with the physical built environment (Kim, 1999).

As for the main theoretical perspectives relevant for this research, apart from the theories within the landscape services theme (chapter 2, sub-chapter 2.2.), some theories are selected and summarised below.

Human-Landscape Transactions

According to the transactional concept, which was drawn from environmental psychology (Ittelson, 1978), landscapes are not static systems like a painting or photograph. Instead, they are dynamic and interactive environments that invite participation. They provide information that humans receive from all directions via multi-sensory modalities (Zube, 1987). Within the complex human-landscape relationships or human-landscape transactions, Zube (1987) highlights an active interchange. Humans are considered active participants in the landscape, because they receive information from both observation and participation and this involves thoughts, feelings and changes. In humans or the landscape, changes can occur either as small and imperceptible shifts, that require numerous repetitions to become noticeable, or as significant and obvious changes. The continuing transactional process argues the perceived values and responses of humans are influenced by some mediating variables such as different human experiences, needs and desires, personal utility functions for the use of the landscape, and socio-cultural contexts.

The Environmental Approach: The Attention Restoration Theory (ART)

The environmental psychology approach has become well-known due to Stephen and Rachel Kaplan (1989), who specialise in landscape perception and preference, and whose work is associated with the relationships between humans and nature (Kaplan, 1995). This theory promotes humans' exposure to nature to improve their restoration. Restoration is a concept used in environmental psychology that intertwines with environmental disciplines to explore the relationships between individuals and a closer environment. According to ART, nature has the capacity to renew the attention and improve people's ability to concentrate. Stephen and Rachel Kaplan (1989) propose the following four states of attention: concentration, mental fatigue recovery, soft fascination, and reflection and restoration. This theory derives from the necessity of people to spend more time outdoors and rather than opting for indoor entertainment, a consequence of rapid technological advancement. As society has become further distanced from nature, there is a concern that society's well-being could suffer serious consequences.

Stress Reduction Theory (SRT)

The Stress Reduction Theory (SRT), proposed by Ulrich et al. (1991), states that exposure to nature or to green spaces helps in calming people, leading to involuntary physiological reactions and thereby mitigating stress. The recovery of the subjects who were exposed to the natural environment was faster and more complete compared to those exposed to urban environments. “The restorative influences of nature involve a shift towards a more positively-toned emotional state, positive changes in physiological activity levels, and that these changes are accompanied by sustained attention/intake” (Ulrich et al., 1991).

Topophilia Theory. Place Attachment Theory

The Topophilia Theory (Tuan, 1974) reveals strong affective aspects of the relationships between people and geographic space. Throughout history, three concepts have been used in the context of attachment to the residential environment: quality, identity and territoriality. In environmental psychology, the measures of environmental quality are closely linked to people's needs, enabling a better understanding of the psychological complexity of individual-environment relationships. (Giuliani, 2003). The spatial identity attachment is based on spatial memories, spatial imagery, the spatial framework of current activity, and the implicit spatial components of ideals and assumptions (Fried, 1963). The territorial attachment supposes an “appropriation of space”, a kind of control over a specific physical environment, which can be translated into three elements: attachment, occupancy and defence (Brower, 1980). Territoriality encompasses emotional aspects of human attachment to space, which leads to the personalization of that space through the creation and strengthening of bonds between the occupant and the territory.

Place and Placelessness: Depth of place

According to Relph's theory (1976), there is an intimate conceptual engagement between space and place. Places are separated from spaces through experiences, since “experiences transform a space into a place by”. The author describes a place's identity as a combination of its physical setting, activities, situations, and events, along with the individual and collective meanings that people attribute to that place based on their experiences and intentions related to it.

Spatial configuration, Spatial cognition and Spatial behaviour Framework

Kim (1999) analyses the interrelationships between spatial configuration, spatial cognition and spatial behaviour and how spatial configuration impacts the spatial experience (Figure 5). The understanding of a space's configuration is associated with human's perceptions and covers the spatial understanding, which leads to human spatial experience's comprehension. The behavioural dimension is closely connected to human activities within that space.

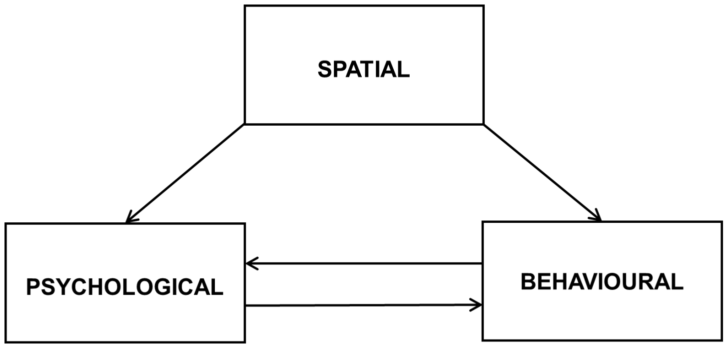


Figure 5. Spatial configuration, spatial cognition and spatial behaviour Framework. Source: Kim (1999)

4.6.2. Perceptions, preferences and use of open space in the literature

In the context of urban landscape dynamics, there is an increasing need to understand the significance of people's preference and use of open space, as well as their participation in evaluating the benefits provided by these spaces. Examples of recent studies that have considered the open space-related psychosocial variables are presented.

Many authors have conducted their research on various aspects of the open space concept, such as preferences, perceptions, usage patterns, satisfaction, and urban space design. Most literature references in landscape perception and preference have focused on aesthetic preference. To test students' preferences, commonly used technique referred to as a visual quality assessment is utilised. For this research, edited images were used, such as indoor photographs containing nature posters or green walls (van den Bogerd et al., 2018) as well as pictures of outdoor spaces where trees and shrubs are added or removed from the original pictures (Polat et al., 2015; van den Bogerd et al., 2018; Wee, 2017). By employing modified images that incorporate built elements alongside natural settings, Wee (2017) discovered that people also prefer places with a combination of grey infrastructure elements and green elements rather than solely green elements. van den Bogerd et al. (2018) identified students' need for greenery in both outdoor and indoor spaces. Polat et al. (2015) showed that students' preference for landscapes increases with the increase of visual quality of taller plants, especially in the springtime. Other past studies (Abu-Ghazzeh, 1999; Speake et al., 2013; Tudorie et al., 2020) proved nature setting and greenery are key factors in positively influencing the participants' preferences.

Beyond the visual quality, there are other factors that are involved in people's preference, which cannot be explained by pictures, for example, the temperature, moisture, smells

(Gyllin & Grahn, 2015), noise (Dzhambov & Dimitrova, 2015; Rey Gozalo et al., 2018) or other sensory stimuli in landscape perception (Preis et al., 2015; Yu & Kang, 2010).

Natural elements, like trees, green space, vivid colour-flowers and water elements (Nordh et al., 2009; R. Wang et al., 2017) are common attractive landscape features that are very appreciated by people and considered as factors influencing the use and preference of a place. Furthermore, several studies have indicated that facilities, amenities or manmade elements such as benches, tables, fountains, are influencing factors in selecting or visiting green spaces (Campagnaro et al., 2020; Madureira et al., 2018; van Vliet et al., 2021).

Recently, researchers have focused on public preferences and valuation of elements of open space, which are important for space design and for high-quality spaces (van Vliet et al., 2021). A high percentage of similarity in people's responses concerning the good quality, cleanliness, maintenance, and high plant species richness, reveals residents' preferences for small parks (Madureira et al., 2018). In particular, cleanliness is one of the six human dimensions, a core and essential set of criteria for evaluating the Chicago River greenway corridor, which alongside naturalness, aesthetics, safety, access, and appropriateness of development, it reflects the depth of people's care for the greenway corridor (Gobster & Westphal, 2004). Lovejoy et al. (2010) examined the preference of people regarding their neighbourhood and determined the attractive appearance and the feeling of living in a safe place represent the most important features of the community. People who prefer sports space better evaluate the quality of the place, as providers of cultural services, such as outdoor recreation, sport activities, and passive enjoyment of green landscapes (Madureira et al., 2018). Shan (2014) suggests fresh air, beautiful scenery and relaxation are often the main reasons for people visiting GI sites. People would appreciate more the naturalistic areas and biodiversity, if they were aware of their significance for the ecosystem (Lindemann-Matthies & Bose, 2008). Therefore, Schebella et al. (2019b) conducted a study to explore how people perceive biodiversity in relation to their well-being in parks. The study reveals that subjective perceptions of biodiversity were better indicators of the benefits to subjective well-being than objective measurements of biodiversity. Additionally, the study has shown that stress reduction and mood improvement are highest in nature parks and lowest in pocket parks.

The environmental perception can affect people's satisfaction and preferences for places. A poor and negative perceived image of sites, could deter the use of sites (Dunnett et al., 2002). Some researchers have established associations among the psychosocial factors such as physical and mental health, optimism, and social support to life satisfaction, ultimately contributing to happiness (Lara et al., 2020). People prefer and need places that improve their well-being and allow them to function effectively (Kaplan & Kaplan, 1989). There is substantial literature about how urban parks encourage physical and social activities, recreation and relaxation and promote people's well-being (Dennis et al., 2020; Tzoulas et al., 2007)

The sociological literature contains a rich amount of studies on the degree to which social contacts are an important factor of livability in neighbourhoods. Relationships within the neighbourhood contribute to a sense of identity and place (Bridge, 2004; P. van Den Berg & Timmermans, 2015). The perceptions regarding the quality of outdoor spaces positively influence residents' satisfaction (Aiello et al., 2010). Environmental preference and restoration are closely related and directly associated (A. E. van den Berg et al., 2003). Ho and Au (2020) conducted a study to validate the influence of specific aspects of environmental perception on preferences for public spaces. Their findings revealed that affective and cognitive factors, including comfort, activity, legibility, enclosure, complexity, crime potential, wildlife, and lighting, are the most significant core attributes for the environmental perception of public spaces.

4.6.3. Campus. Perceptions, preferences and use

There have been limited studies conducted specifically on the campus landscape space. However, in the past decade, there has been an increasing number of studies focused on campus open spaces and campus greens. Among the campus literature references, the most common themes are related to psychosocial factors such as perceptions, preferences, attitudes or behavioural variables (patterns of usage). The campus studies have been associated not only with subjective and qualitative methods, but also with objective and quantitative measurements, e.g., physical parameters or structural characteristics of space as factors which influence the respondents' perceptions and behaviour. Generally, in the campus literature, these main approached themes are interlinked. Research on preferences and perceptions of specific spaces complements pattern-of-use analyses and analyses of the reasons behind preferences and use of space. In terms of open space, between preference and use, there is a slight difference, as people use what they appreciate and prefer what is useful for their well-being.

Regarding preference, Speake et al. (2013) asked about favourite areas and reasons to visit them. They found that students chose areas based on their aesthetic value, relaxing atmosphere, and other attributes and functions such as providing a convenient location for eating, drinking, studying, and engaging in sports, as well as for social reasons. Wang et al. (2017) researched reasons for why people visited the survey site and discovered many of them were related to favourable weather conditions, such as nice weather or sunshine. However, only a few people visit specifically to enjoy the environment itself.

To study patterns of use of space, Hanan (2013) used respondents' favourite place for developing formal or informal activities, and determined those places where social activities like gathering, chatting and having lunch, happen are meaningful places for students. The findings of Wee (2017) denote students would use space to do sports, relax, exercise, study and socialise. Tourinho et al. (2021) revealed elevated numbers of students using space for academic activities and for walking. McFarland et al. (2008) discovered a relationship between the frequency of using CGS and perceived quality of life, while findings of Speake et al. (2013) highlighted a connection between CGS awareness and students' perceptions of CGS quantity.

A great amount of studies has provided valuable information about open space's health (Lau et al., 2014; Mengjia et al., 2020; C. Zhang et al., 2020), psychological restorative potential, stress and well-being (Gulwadi et al., 2019; Hipp et al., 2016; Liu et al., 2018, 2022; van den Bogerd et al., 2018; Yang et al., 2019). Foellmer et al. (2021) propose the Healthy Academic Greenspace Framework (HAGF) to prove academic green space can act as a therapeutic landscape, as it is an important health resource on campus for many students. Almost all these studies are based on Kaplan's Attention Restoration Theory (ART) and Stress Reduction Theory (SRT), which are the most common theories researched in the campus works. Other theories of interest for authors which have helped in researching campus related topics are: study place's attachment (Place Theory) (H. Zhang et al., 2019), preference for landscape (Landscape Assessment Theory) (Abu-Ghazzeh, 1999; Akhir et al., 2017) or Information Processing Theory (Akhir et al., 2017, 2020), and accessibility opportunities (Travel Behavioural Theory) (Sun et al., 2015).

Perception studies related to green spaces encompass various themes. Some of these themes include: people's well-being, green space restoration and measurements of perceived naturalness, restoration, self-rated health and quality of life (Akbar et al., 2015; Gulwadi et al., 2019; Hipp et al., 2016; Liu et al., 2018, 2022). Perception studies have been conducted to explore various aspects of campus landscapes, including their functions in providing outdoor education opportunities (Tezel et al., 2018), visual quality and attractiveness (Akhir et al., 2019; Li et al., 2019; Zaki et al., 2020), place attachment (H. Zhang et al., 2019), and sense of place and natural heritage (Kermath, 2007). Other research focuses on physical parameters, such as greenness (Gulwadi et al., 2019; Li et al., 2019; Sun et al., 2015; Yang et al., 2019), thermal comfort (Y. Wang et al., 2017), accessibility (Li et al., 2019), walkability and pedestrian friendly (Harun et al., 2020). Sustainability issues have also been often approached among the literature references (Erten, 2015; Tezel et al., 2018).

The relationships between open space and people have been studied before, especially preferences and use of open space (Abu-Ghazzeh, 1999; Schipperijn, Stigsdotter, et al., 2010), but few have been approached through assessments of LS. Little evidence is found regarding the perceived supply of benefits in the campus landscape -related work (Gulwadi et al., 2019; Liu et al., 2022). Services are identified in the literature (Vallés-Planells et al., 2012) more often than they are assessed (Tian et al., 2020). However, studies about perceived campus landscape's quality comprising the whole range of LS, in the campus-related work are scarce (Liu et al., 2022). Tian et al. (2020) address regulation and cultural dimensions. Even though the cultural theme includes more classes and groups of benefits (Vallés-Planélls et al., 2014), Tian et al. (2020) combined the perceived supply of cultural benefits into a single survey item. Foellmer et al. (2021) studied the reasons for which students should do a stay in greenspace (which are closely related to services provided by campus landscape), but used only the categories involved in the therapeutic and academic healthy potential (mental, physical activity and well-being), which are equivalent to socio-cultural LS. Gulwadi et al. (2019) The research of Gulwadi et al. (2019) revealed that perceived greenness and objective greenness may differ, likely due to the fact that qualitative and quantitative methods capture different aspects of greenness.

4.7. Socio-demographic and user-related characteristics influencing the perceived LS

In terms of the relationship between socio-demographic variables and perceived ecosystem services (ES) or landscape services (LS), the existing studies primarily focus on identifying the services rather than valuing them. Moreover, these studies are predominantly conducted in rural environments. At the city scale, there is some work done on people's perceptions of the LS/ES provided by outdoor environments (Larson et al., 2016; Schebella et al., 2019a; Tian et al., 2020), and few studies have been conducted at a lower scale, like the neighbourhood scale (Liu et al., 2018, 2022).

Some studies in rural areas conclude socioeconomic status, gender and level of education are determinants of perceptions of services (Allendorf & Yang, 2013; Martín-López et al., 2012). Also, livelihood activities and setting location (Moutouama et al., 2019), language, race and age (Zoeller et al., 2021) influence people's perceptions regarding provided services. In villages, the setting location is an influencing factor of perceptions of cultural ES, like aesthetic values and cultural heritage values (Xu et al., 2020). The culture, social organisation and daily community habits condition services' perceptions. The proximity to Ágora, to surrounding vegetation and the frequency of sightings of bird species, facilitate people's perceptions regarding the cultural functions of a space, for example, the level of recognizing bird traits (Zoeller et al., 2021). People who live in rural areas seem to be more connected with their environment through the livelihood activities than people of urban areas. Rural residents often perceive their homes as the primary source of provisioning services and as secondary providers of other categories of ecosystem services (Moutouama et al., 2019). These authors conclude people in rural areas rely more on natural resources and it is easier for them to physically identify provisioning benefits, e.g., wood, berries, fuel, etc., rather than cultural or supporting services.

In the scientific literature, there seems to be no agreement on the way in which gender influences the perceptions of services at city level (Larson et al., 2016). Although, according to Martín López et al. (2012), females have a more positive perceptions and are more likely to recognize the landscape's capacity to supply environmental benefits, e.g., air quality, temperature and flood protection, than males. Moutouama et al. (2019) determined in rural areas, females perceive the supply of provisioning services, as they are uncharged with the forest resources for domestic use, while males recognize the supporting services, due to their main activities, e.g., grazing and hunting.

Apart from gender, age and economic factors, occupation and education influence people's perceptions and experience of cultural ecosystem services. Living in a rural environment or having links with it, e.g., farming or other rural-related activities, affect the perceived services. Zoeller et al. (2021) stated young people were less likely to perceive supporting services, compared to adults and old people. Xu et al. (2020) indicated that village residents with land-use rights tend to place more importance to cultural services provided by spiritual places where their ancestors are buried than those who do not have right to land use.

There is evidence for how socio-demographic and economic factors influence in the residents' perceptions of services at an urban scale. Tian et al. (2020) confirmed higher socioeconomic status and higher frequency of urban green space visits positively influence in perceiving cultural services, in particular in the willingness-to-pay for the conservation of urban green spaces. Martín López et al. (2012) discovered females, people with a higher level of formal education and environmental behaviour are more likely to recognize the ecosystem's capacity to supply services. Elderly and rural people place more value on provisioning services (e.g., related to agriculture, fishing, forest products and cattle), while younger and urban people place more value on regulating services, such as air purification, microclimate regulation, aesthetic value, tourism activities, environmental education, and the existence value of biodiversity. Overall, this is owed to the difference between urban and rural people's individual needs, cultural traditions and sources of household income, and also to their access to services (Martín-López et al., 2012).

Campus open space-related studies. Profile characteristics influencing the perceived LS

Regarding perceptions, some studies have provided valuable information on the relationship between preference or use of a space and people's socio-demographic characteristics.

In campus-related work, there are studies that highlight the importance of analysing the profile of people as a factor influencing their perceptions and relationships with open and green space.

Recent research (Liu et al., 2022) has focused on examining the differences in perceptions related to naturalness, restoration, and health, considering the influence of gender and socio-cultural background. Liu et al. (2022) discovered males indicate a stronger link between the self-rated health and perceptions of natural attributes, compared to females. Additionally, the authors learned that females tend to use campus green spaces less frequently than males and are often accompanied during their visits. Moreover, male students enrolled in landscape architecture or arts programs express lower satisfaction and rate university green spaces as providing poor restorative services compared to their counterparts in other academic disciplines.

According to Liu et al. (2022), older students tend to utilise campus green spaces more frequently for relaxation purposes. This could be attributed to the greater number of responsibilities that older students typically have compared to younger students.

The profile of the respondents was examined in relation to their perceived quality of life. McFarland et al. (2010) conducted an evaluation of graduate students' perceptions of quality of life and identified several factors related to positive perceptions. These factors included affective and cognitive aspects, such as feelings of self-worth, the extent of being challenged, and intellectual stimulation within the university setting. The study finds no significant differences between the responses of males and females in terms of their perceived quality of life (Mcfarland et al., 2010).

Some literature references confirm or disapprove differences in preference, perceptions and use of space, according to the profile's characteristics. van den Bogerd et al. (2018) observed among students in terms of gender, age, ethnicity, current education level, or study discipline regarding their preference for and perceived likelihood of restoration from greenery. According to Abu-Ghazzeh (1999), freshmen students prefer using open spaces that are located in close proximity to their departments compared to graduate students, senior students, staff, and faculty members. This preference is attributed to the perceptions of safety and security that these spaces inspire, particularly among freshmen females. Abu-Ghazzeh (1999) and Speake et al. (2013) revealed users' preferences for different types of COS, considering their personality. Students who avoid crowded places tend to like remote natural areas, whereas more social students prefer areas with urban aspects, poor ecological awareness and tamed landscapes.

4.8. Structural characteristics influencing the preference and use of open space

Some literature references study the impact of space's characteristics on space's functions and perceived supplied services.

The size of green space is an influencing factor regarding its preference and use (Palliwoda et al., 2020; Schipperijn, Ekholm, et al., 2010). The large size of the park is not necessarily a valued attribute (Madureira et al., 2018). Different active and passive lifestyle activities depend on the size, shape and edge of a green patch (Marušić, 2015). For active recreational activities, such as sports, a minimum activity buffer space of 20 metres radius is recommended. For passive recreational activities like sitting or relaxing, a slightly smaller buffer of 15 metres is considered suitable (Marušić, 2015). A complex shape positively influences on casual encounters and on neighbours' social interactions (Zhu et al., 2017). Size is one of the physical attributes known to be associated with biodiversity, along with the degree of naturalness, structural heterogeneity, habitat diversity, bird species richness, and vegetation cover. Young and Jarvis (2001) discovered that patches larger than 3.5 hectares are not necessarily more diverse in their elements compared to smaller patches. According to Grafius et al. (2018), the optimal size of UGS is around ten hectares, in terms of high carbon storage potential and abundance of pollinators.

Stein et al. (2014) considered greater habitat heterogeneity supports greater species richness. Parameters such as the presence of plants of different heights and in various stages of life, habitat diversity, and vegetation cover can significantly influence people's perceptions of biodiversity (Schebella et al., 2019a). By considering the size of urban green spaces, Brown (2008) hypothesised that larger parks maintain a greater diversity of park values, compared to smaller parks. In relation to the distance between urban green spaces and concentrated human habitats, there appears to be a weak relationship for parks that are located in close proximity to such areas (Brown, 2008).

Palliwoda et al. (2020) conducted an analysis to examine the influence of green parameters on the overall range of LS in both managed (urban parks) and unmanaged (green brownfield) green spaces. The study reveals that urban parks with a high diversity of tree cover, diverse vegetation structure, and the presence of water bodies contribute to increased aesthetic values, utilisation of space, and interactions between visitors and urban nature.vb Furthermore, Palliwoda et al. (2020) identified additional complementary uses of UGI observed in the green brownfield areas such as dog walking or meeting places for individuals who appreciate urban wilderness. In older neighbourhoods, large green spaces and diverse vegetation cover are linked to better people's health (Dennis et al., 2020). Besides the increased level of biodiversity and neighbours' health, a large green space can indicate higher income levels in neighbourhoods. For example, private schools often have large and dominant green spaces compared to widely spread charter and public schools, which are typically located in more compact and less green neighbourhoods (Baró et al., 2021).

Campus open space - related studies. Structural characteristics

In campus-related literature, physical parameters are analysed as influencing factors in people's preference, perceptions and behaviour regarding open space. Abu-Ghazzeh (1999) recorded the relationships between the physical features of students' favourite open spaces and the use of spaces to better understand the well-being of the university community. Cooper and Wischemann (1990) conducted a literature review focusing on outdoor areas and provided design recommendations for different types of campus open spaces. Their recommendations are based on considerations of users' perceptions, preferences, and daily activities carried out in these spaces. Carvalho Tourinho et al. (2021) identified several important aspects of outdoor areas that contribute to students' attraction. These aspects include campus infrastructure, socialisation opportunities, the presence of suitable furniture, feelings of comfort, cleanliness, conservation of green spaces, aesthetic preferences, safety, and opportunities for relaxation. The streetscape elements, especially the presence of amenities and street zoning make campus to be perceived as a pedestrian friendly and attractive place (Harun et al., 2020).

There is little research in campus-related work regarding the open space's characteristics and quality associated to campus attractiveness. Li et al. (2019) suggested increasing attention to the collocation of species, plant layering, and seasonal colour richness in designing and managing outdoor spaces. van den Bogerd et al. (2018) affirmed people prefer indoor and outdoor environments containing some type of greenery, like green wall, interior and colourful plants, nature poster, rather than university environments without greenery (standard design).

Some studies have missed to consider the psychological or behavioural variables, but their contribution is valuable in the campus space-related work, due to their findings regarding the structure and functions of campus landscape. Lau et al. (2014) developed a framework for healthy campus open space including approaches related to spatial and green landscape. The aim of this framework is to provide guidance to urban planners in creating restorative and healthy open spaces on campuses. Hajrasouliha (2015) focused on the design elements of contemporary university campus planning and proposed a framework for a well-designed campus. The framework includes three dimensions of campus form: urbanism, greenness, and campus living. Based on the findings of the study, Hajrasouliha (2015) identified seven common recommendations for master campus planning related to the evaluation of campus form which encompass: land use organisation, compactness, connectivity, configuration, campus living, greenness, and context.

4.9. Methodology used in studies of perceptions, preference and use of open space

Assessing the perceptions through adequate instruments allows developing convincing analysis and models. Interviews and survey questionnaires using or not using photographs, represent common tools to assess perceptions (Akhir et al., 2020; van den Bogerd et al., 2018; Wee, 2017). Objective measurements and observations methods are mentioned as complementary methodology when comes to compare people's preferences and perceptions data (Gulwadi et al., 2019; Li et al., 2019; Mengjia et al., 2020; Sun et al., 2015; Y. Wang et al., 2017; Yang et al., 2019).

While questionnaires and interviews are commonly used in the literature to evaluate the perceived supply of ecosystem services, only a few studies subject their items to rigorous analysis for validation. Within campus space studies, descriptive analyses (Mengjia et al., 2020; Akhir et al., 2020; Tourinho et al., 2021), correlations and regressions, seem to be the most used analyses to study respondents'perceptions, preferences and use of space (Dipeolu et al., 2021; Sun et al., 2015; van den Bogerd et al., 2018). These methods are used to examine the relationships between social concepts, activities and space's elements (Gulwadi et al., 2019; Hanan, 2013; Yang et al., 2019). The second group of tools commonly applied in campus landscape analyses includes exploratory factor analysis (EFA) and principal component analysis (PCA) (Harun et al., 2020; Liu et al., 2018; H. Zhang et al., 2019). In order to test the reliability of the items used to measure perceptions, some studies employ methods such as calculating the Cronbach's alpha coefficient or conducting ANOVA analyses (Liprini & Coetzee, 2017; Mcfarland et al., 2010; Tiyarattanachai & Hollmann, 2016). These analyses establish an initial model and confirm the good fit for the data of the hypothesized model. Few researchers employ a more in-depth analysis to explore how well the assessment predicts these measures, like confirmatory factor analysis (CFA) (Akhir et al., 2019; Liu et al., 2018). Another robust method that has gained interest in the campus outdoor environment-related studies is the use of structural equation models (SEM) (Hajrasouliha, 2017; Hajrasouliha, 2015; Liu et al., 2022; C. Zhang et al., 2020). Liu et al. (2022) perform SEM to study the interrelationships between students'socio-demographic characteristics, perceptions, patterns of use and restorative benefits. Also, Zhang et al. (C. Zhang et al., 2020) conduct SEM to reveal relationships between environmental activities and open space's elements.

In addition to campus landscape studies, there are also research studies that employ structural equation modelling (SEM) to investigate the causal relationships between people's perceptions of the functionality of urban green elements, such as environmental benefits and cultural amenities, and the influencing factors (Tian et al., 2020; C. Young et al., 2020). The Path Analysis, which is a component of SEM analysis, is used to examine direct and indirect relationship between the influencing factors related to livability, physical and mental health-related quality of life, self-efficacy, optimism, social and economic issues (Ansarzadeh et al., 2020; Lara et al., 2020).

To our knowledge, there are few studies focused on the perceived supply of ecosystem services and patterns of open space use that employ path analysis methods. Akhir et al. (2019) use the path coefficient to evaluate the relationships between student's well-being, preference and components of Kaplan's ART Theory (1989). They identify a strong link related to complexity and coherence pattern, but a weak link between preference and legibility. Horacek et al. (2016) use path analysis method to study the influence of different level of physical activity on students' health and that students who engage in moderate walking and biking within the campus outdoor environment tend to have a lower body mass index. Gulwadi et al. (2019) use a serial model linking to explore mediations between objective and perceived measurements of greenery, quality of life, and physical characteristics of space.

Chapter 5. Materials and methods

5.1. Dissertation methodology structure

The thesis methodology is presented in Figure 6 as a flowchart and is further elaborated upon in the following sections.

- Firstly, the scope of the study is described while data information and concepts are provided to achieve a better understanding of the whole study.
- Secondly, the survey tool (Annex 1) is described by focusing on every section of the questionnaire that was designed for the survey. The variables and the analyses conducted in the study are explained. This part has nested *two sections* corresponding with the two-research level, general and specific, of the condition of campus open space in UPV (Figure 6). According to the study's objectives, the analyses performed in these sections use different variables and different samples of population. For each section, almost 93% completed questionnaires were accepted and non-validate answers were deleted.

    - *The first section* (blue area of chart) is focused on:
        (I) the relationships between the profile of university community members and their satisfaction considering the perceived supply of LS delivered by COS
        (II) University community members' needs regarding the current condition of space

The analyses of reliability and consistency (EFA, CFA) performed to validate the scale and the fitted models (SEM), are explained. These analyses are associated with hypothesis H1 and sub hypotheses (H1.1 - H1.3), which are included in the first conceptual framework (Figure 2). The used variables belong to all sections of the survey questionnaire. Only the first section considers the profile of respondents (socio-demographic and user-related characteristics).

- *The second section* (green area of the chart) explores:

(I) the factors involved in finding out which COS typologies can be found in UPV campus in order to better understand (the most used and most preferred open space that university community members had to indicate in the questionnaire survey) and

(II) factors influencing the preference and use of a space (structural characteristics, activities and LS-related reasons)

To identify COS typologies, structural characteristics of open space were used. Regarding use and preference, space's structural features were researched as predictors. Additionally, activities and LS-related reasons which best support the most preferred open space, were analysed. Hierarchical linear regressions used to predict the factors influencing the preference and use of COS, are explained below. The Path Analysis method was carried out to confirm the effect of activities and LS-related reasons on preference for two COS. These analyses are associated with Hypotheses H2 to H5, in line with the second theoretical framework. The used variables are related to section 1 of the questionnaire survey.

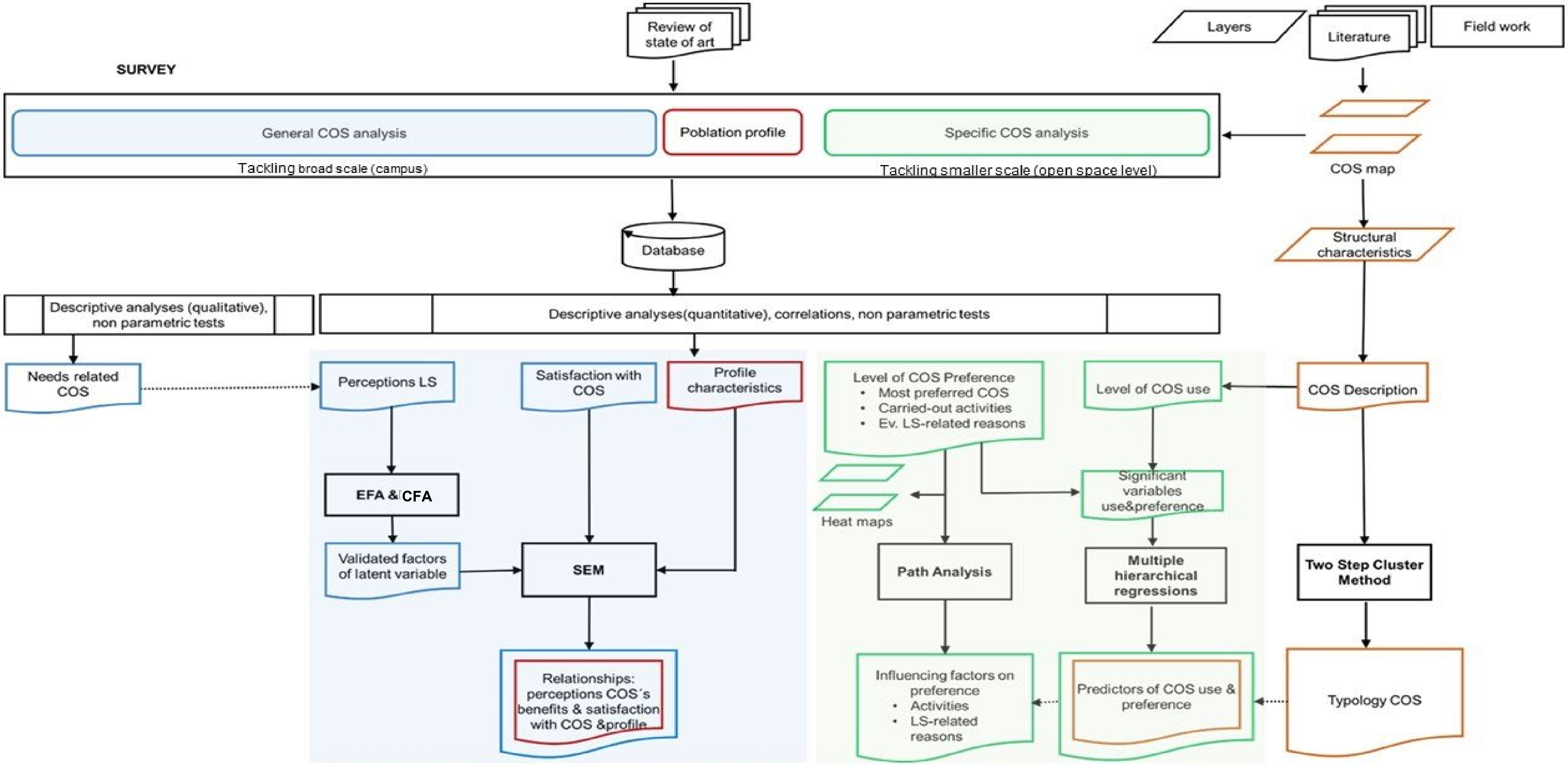


Figure 6. Flowchart of thesis development; EFA, Exploratory Factorial Analysis; CFA, confirmatory Factorial Analysis; and SEM, Structural Equation Model

5.1.1. Scope of research

The campus open space of Universitat Politècnica de València occupies more than 108.000 square metres, 22% of the total surface area (almost 57 hectares), and around 87% is developed (Blasco Sánchez & Martínez Pérez, 2013). The presence of open spaces in central and adjacent areas to buildings, as well as small green spaces between buildings and campus streets, contribute to the overall greenness of the campus. More than eighty buildings are situated around Ágora square, which is considered the heart of the university.

Based on the urban naturalness index (Schebella et al., 2019a), UPV campus achieves a naturalness level of 3 on a scale of 1 to 5. This is attributed to the presence of mixed native and exotic species in the ground layer vegetation, as well as tree and shrub layer vegetation. Based on Calaza Martínez (2019), it is recommended to have a minimum of 25% tree cover of the total area of a city, with over 15% projected tree cover specifically along streets. However, when considering the campus as a district, the tree cover falls short of this minimum requirement, as it accounts for approximately 7% of the total surface area

According to Hajrasouliha (2015), UPV campus can be considered a mixed, dense, connected, structured, livable, green and urban campus. It is seen as a mixed campus because it allows to integrate academic and research activities in shared facilities, and to mix different disciplines and areas; dense campus, as the majority of university functions should be located close to the centre of campus. UPV campus is a connected area that provides clear pedestrian routes and shorten distances between key activities and destinations, due to various entries, paths, walks or passages. Regarding livability, UPV campus has various campus housing including multidisciplinary academic facilities. The main requirements of this urban ecosystem are undoubtedly laboral and formative, but the daily basic and social needs occupy a special place in campus territory and life.

A campus represents an urban territory, where the whole university community coexists and interacts (Blásco Sánchez, 2013). The university community consists of 36.483 members (Universitat Politècnica de València, 2018) distributed over 13 schools, 42 departments, 34 research institutes, and 87 services. There are 28.801 students, 4.971 employees (teachers and administrative staff), and 2.711 external personnel.

5.1.2. Cartography of open space and green infrastructure

The sources for the cartography are those available on the websites of different related map making institutes like:

- National Geographic Institute: autonomous topographic map and hydrographic map (https://www.ign.es/web/ign/portal/cbg-area-cartografia) (Instituto Geográfico Nacional, 2017)
- Cartographic Institute of Valencia: aerial photograph updated to 2018 (25 cm resolution), cadastral map, topographic map, CORINE land cover (2018) map, road infrastructure map, land planning map - urban green infrastructure map, and street trees map (https://visor.gva.es/visor/) (Generalitat Valenciana, 2018) The campus cadastral and vegetation plan maps were supplied by UPV staff.

The generated layers are: campus open space layer, UGI elements layer and tree cover layer.

a. Cartography of open space

Firstly, the COS map was developed with the aid of GIS and fieldwork at neighbourhood scale (Figure 7). The digitalization of COS was based on the following criteria:

1. COS were delineated by existing polygons in the cadastral map. The width of COS considers the edges of buildings and the street limits.
2. COS were mapped according to their distribution and proximity to each faculty and institute. According to Cooper and Wischemann (1990), the closest space delimited by buildings or circulation axis for the faculties and institutes, are qualified as faculties' home base or home turf.
3. According to the definition of open space, COS map includes both green and grey spaces, but not building surfaces.

At the beginning of the survey questionnaire (Annex 1), respondents were provided with a COS map of UPV campus, numbered from 0 to 52 together with COS's definition, study's objectives and data privacy statements. The map was used as a survey tool to find out which COS are the most preferred and used among the community.

Several visits to campus open space were helpful to correct some errors of available cartography, to create a more realistic visual image regarding the distribution of space. The field visits were necessary to ensure that COS limits were according to the present use of space. During each of these checks, the researcher photographed the people and their activities in each space while she was walking in the campus. This was supported by writing notes about the people and their behaviour. Both picture-taking and note-writing were done briefly and unobtrusively, so as not to disturb or change the behaviour of the outdoor space users. Some examples of university community' s daily routine and use of space can be seen in Figure 8 to Figure 16. Some pictures were taken from the office' s window (indoor view) (Figure 11, Figure 14 and Figure 15) or simply by sitting on the lawn.

Figure 7. Map of open space from UPV campus. Zoom map detail of delimitation of campus open and of urban green infrastructure (right)

Figure 8. Lunch break moment at the Ágora square (COS 25 at Figure 7) (May, 2019)

Figure 9. Students spending free time on the lawn next to Library building (COS 28) (June, 2021)

Figure 10. Students relaxing on the lawn next to Rectorate Building (COS 16) (June, 2021)

Figure 11. Different use of space: passing through, gathering with friends and relaxing (COS 16) (January, 2022)

Figure 12. Outdoor class learning about trees measurements techniques (COS 16) (February, 2022)

Figure 13. Researching activities in the garden of Industrial Engineering (COS 29) (May, 2022)

Figure 14. Students' concert during San Isidro labrador, patron of Agronomic Engineering School (indoor view) (COS 16) (May, 2022)

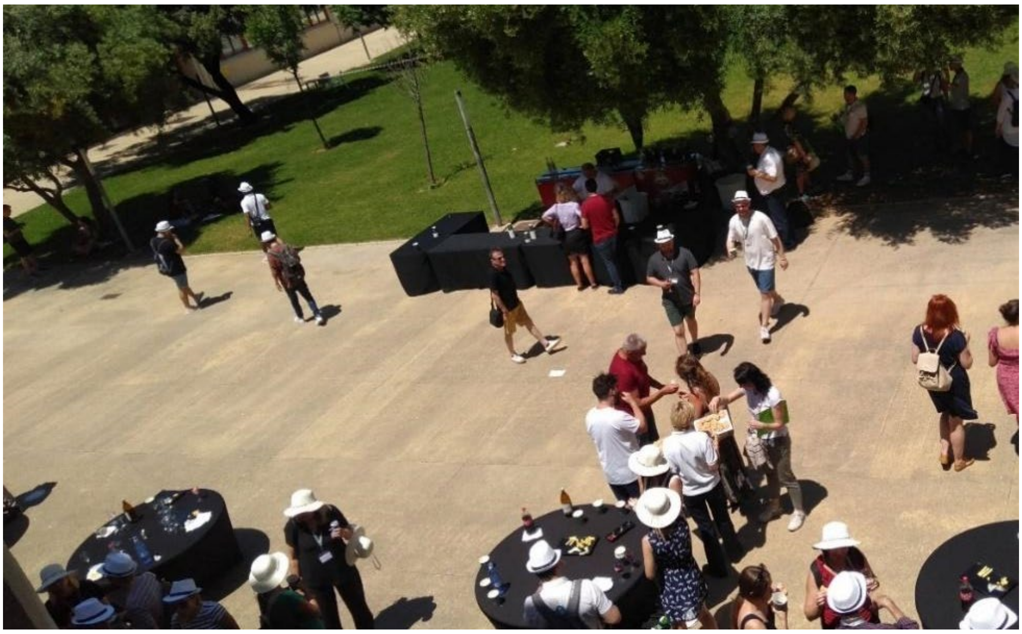


Figure 15. Welcome catering university ex-change visitors in the garden of Agronomic Engineering School (indoor view) (COS 16) (June 2022)

Figure 16. Summer school activities in the garden of Architecture Faculty (July, 2022)

b. Cartography of urban green infrastructure

Secondly, for the development of the UGI elements map (Figure 17), the aerial photograph updated to 2018 (25 cm resolution) and Valencia cadastral map were used, combined with fieldwork at neighbourhood scale. The digitalization follows similar criteria as COS map, along with some new rules:

1. The UGI elements were required to have at least 40% vegetation cover of the total surface to be permeable.
2. Paved tree alleys were not mapped as UGI elements. Just green areas including green verge, street green, green roundabouts and hedges (see Table 1) were considered. Other areas, which were not considered, were paved squares; even if there included some trees, and paved playgrounds. Besides, places with large nude areas and very little vegetation (e.g., parking lots or abandoned construction places, converted into construction material deposits) were not considered, unless they covered 50% of vegetation.
3. As a rule, only green and permeable areas delineated by existent polygons in the cadastral map were considered. However, in cases where the aerial photograph clearly showed the presence of a green space that was not represented in the cadastral map, the green space was digitised.
4. Even the greenhouses did not present outside vegetation, were considered as a green element, and were mapped due to their important role for the campus's sustainability.

c. Cartography of tree cover

Finally, the GIS software was used to create the tree cover layer. The source of information was an aerial photograph updated to 2018. The tree cover layer was used to characterise the campus outdoor environment. Additionally, in regression analyses, the tree cover layer was considered as an influencing factor for the preferences of the respondents regarding open space. The steps followed to generate tree cover layer (Figure 17) are explained in the Annex 3.

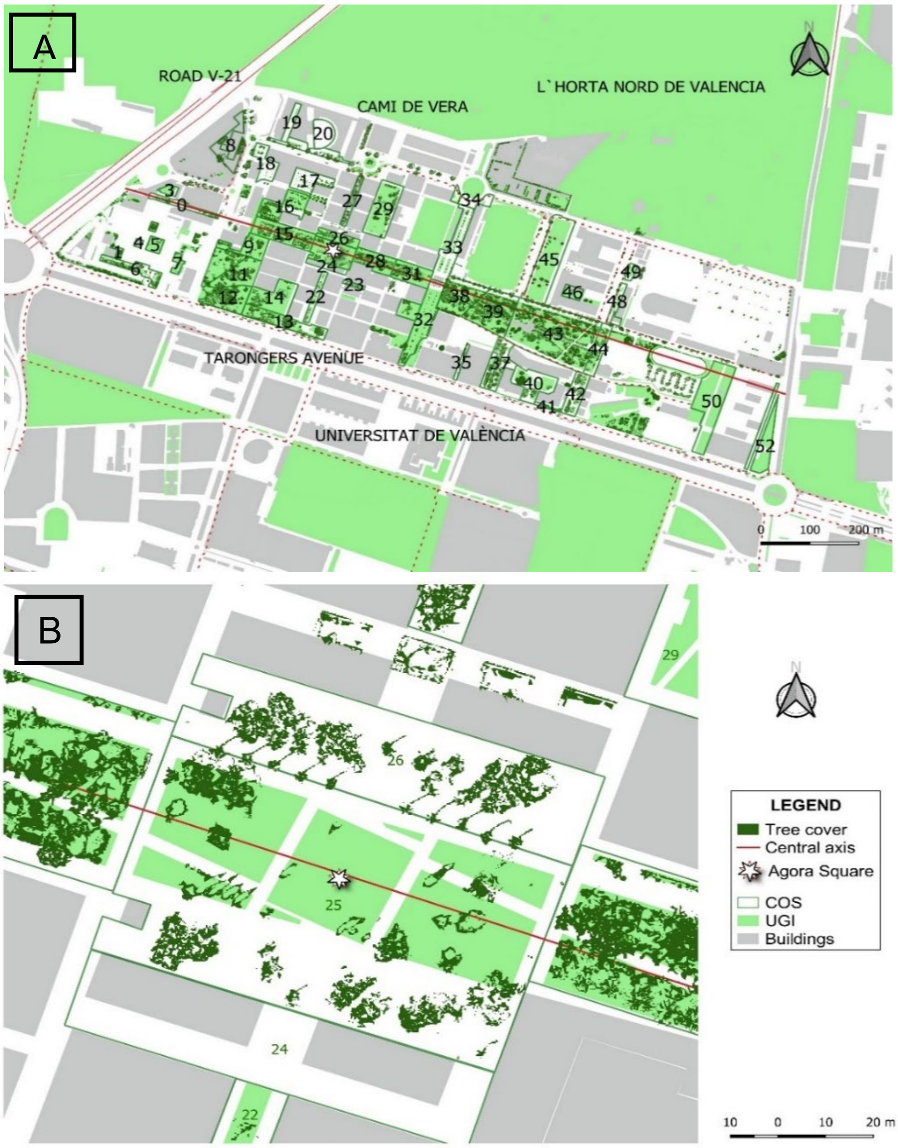


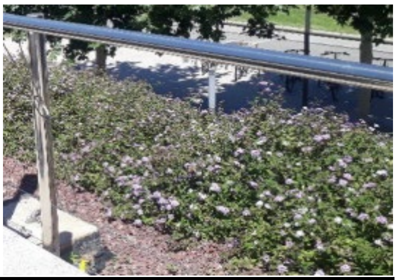
Figure 17. Map of open space from UPV campus including UGI cover and tree cover (A), and zoom map detail of delimitation of UGI and tree cover in the area of Ágora square (B)

<u>5.1.3. Characterization of campus open space</u>

The characterization of COS was conducted with the aid of maps, of vegetation plans, and fieldwork.

The green component of COS spaces was classified in UGI elements through adapting the Green Surge GI classification E.U (EU, 2013b) to UPV campus. The inventory of UPV contains 16 of the total number of GI elements identified by the Green Surge experts (44 types) (Table 1). There are 5 categories which encompass the 16 UGI elements. Some of UGI are located outside of the COS map used for the survey, like experimental farms, Mediterranean garden, ruderal areas, forest and green roundabout (Figure 18). This was attributed to their hardly accessible location and no users or very few users were seen during checks using the space. COS map contains most common spaces, reasonably frequented by members of the university community and adjacent to all faculties. The inventory of UGI is linked to Urban Atlas and Corine land use/ land cover (2018).

Table 1. Classification of campus urban green infrastructure elements adapted to UPV campus based on European Union (2013).

UGI ELEMENT	DESCRIPTION AND LOCATION	UPV COS	EXAMPLES/PICTURES
Building greens			
Balcony green	Plants in balcony and terraces, planted mostly in pots. .	24 and 26	
Institutional UGI and UGI connected to grey infrastructure			
Atrium	Green area surrounded or enclosed in a building planted mostly with ornamental plants.	17 and 18	
Experimental farm	Areas with animals' infrastructure for researching combined with planted trees, ornamental beds and cultivated grass. It is located near Camí de Vera, in the northern part of campus, at the border line with L'Horta de Valencia.		
Greenhouse	A structure with walls and roof made of transparent material, such as glass, in which plants requiring regulated climatic conditions are grown. It is located near the Tarongers Avenue, in the south-eastern part of campus and in the northern part in the nearby of L'Horta de Valencia and experimental farms.		

Mediterranean garden	Educational and ornamental areas planted with Mediterranean plant species. It is located in the south-eastern part of campus, near the greenhouses.		
Green school playground	Areas intended for playing or outdoor learning with street trees.	1	
Tree alley, street trees and hedges	Trees having or not having tree pits, planted along roads and paths either solitary or in rows, trees surrounding hedges along roads or paths. They are distributed all over around the campus.	0, 27 and 35	
Green verge	Stripes of green, e.g., flowers, along a built or natural element. It is often met in campus, mostly in passing areas and in the edge of space.	6, 9, 21, 22, 23, 32-34, 33, 37, 41, 42, 44 and 48	
Street green	Green space covered by lawn, without trees or shrubs. Non-tree, mostly shrubby or grassy road verges, areas between the opposite roadways.	50 and 52	

Green roundabout	Centre insulated lawn, which can contain flowers, shrubs and trees, insulated from car noise. It is a sustainable green roundabout. UPV campus has few green roundabouts.		
Recreational spaces			
Garden (pocket park)	Small park-like areas around and between buildings vegetated by ornamental trees and grass. Surface: >0.1 - 0.2 ha; 40%-50% permeable area.	9 - 14, 16, 29, 30, 40 and 45	
Medium urban park (district park)	Larger green areas within a city intended for recreational use by urban population. They can include different features such as trees, grassy areas, playgrounds, ornamental beds, paths and so on. Surface area: >0.2-0.4 ha; 40%-50% permeable area.	15, 25, 28, 31, 38, 39 and 43	
Yards	Small green spaces vegetated by trees and lawn inside buildings.	2, 3, 5, 7 and 46	
Green sport Facility	Intensively cultivated and fertilized grass turf tolerant to frequent trampling for sport activities (e.g., golf courses, football fiels).		

Woodland			
Small urban forest	Natural or planted areas of dense tree vegetation. It is located in the south-eastern part of campus, near Mediterranean garden and greenhouse.		
Ruderal vegetation			
Abandoned, ruderal areas	Sites with spontaneously occurring pioneer or ruderal vegetation. It is located mostly around some sport facilities or in the peripheral part of campus. Sometimes bare land waiting for new uses.	6, 9, 21, 22, 23, 32-34, 33, 37, 41, 42, 44 and 48	

Figure 18. Map of the distribution of UGI elements in UPV campus

Some physical parameters of open space were evaluated to obtain a characterization of the 53-campus open space used in the survey (Table 2). These parameters were selected considering the context and the content of the landscape. The context parameters are: Area COS, proximity to central axis, proximity to Ágora, and placement. Tree cover and tree species richness, UGI cover and UGI elements, and Indexes of structural diversity are the content parameters.

For the *area* or *the size of space*, the classification of COS was adapted to the classification proposed for the green space in Valencia (Ayuntamiento de Valencia, 1992), which was used in a research case in Benicalap District within the framework of GrowGreen H2020 Project (Table 3). The district of Benicalap has a surface of 222 hectares (ha), which is almost four times bigger than UPV campus (75 ha). The Ciutat Fallera, which is one of two neighbourhoods of District of Benicalap and the location of the pilot projects of NBS, has a similar area compared to UPV campus (50 ha). Considering all these data, a characterization of COS according to their size which better fits for the present study's setting, is proposed. The COS are classified into: very small (<0.1 ha), small (<0.1 ha-0.2 ha), medium (>0.2 ha-0.4 ha), big (>0.4 ha - 0.7 ha) and very big (>0.7 ha), based on Ayuntamiento de Valencia (1992) and EU (EU, 2013b).

For the *proximity to the central axis*, the distance between the centroids and the central Est-West green axis of UPV campus was estimated. The measurement of the distances and the centroids were carried out with GIS geometry tools, e.g., distant matrix, points along geometry by using 1-metre distance between the points, and the distance to the nearest hub.

Regarding the *proximity to Ágora,* it was calculated from Ágora square which is the major square of UPV campus and serves as the popular centre of campus. Almost all universities have some kind of central plaza or a gathering place, which represents the symbolic heart of campus and the places where university community life starts. Sometimes it can be a peaceful pastoral area covered by trees and lawn, like “Harvard Yard” (Lau et al., 2014), the veranda of buildings (Hanan, 2013), or a popular paved square similar to the villages, town or cities' squares, such as Red Square of University of Washington and Sproul Plaza of University of California (Cooper & Wischemann, 1990). Even a large street could be perceived as a campus “core setting”, like Milk Bar Street at the University of Jordan (Abu-Ghazzeh, 1999).

To classify the COS according to proximity to Ágora and central axis, the three ranges distances proposed by EEA (2003, 2023) and WHO (2016), were considered. The classification of COS considering these accessibility parameters can be consulted in Table 4.

Table 2. Definition of descriptive structural variables of campus open space: explanatory (Explan), continuous (Cont) and categorical (Cat) parameters.

STRUCTURAL CHARACTERISTICS	DESCRIPTION	TYPE
Area COS (ACOS)	Surface of COS unit (m^2)	Explan/Cont
Proximity to central axis	Distance between centroid of COS unit and the central axis of UPV campus (m)	Explan/Cont
Proximity to Ágora	Distance between centroid of COS unit and the centre of Ágora square (m)	Explan/Cont
Placement	1=Central; 2=Adjacent to buildings; (Adjacent build.); 3=Between buildings (Between build.)	Explan/Cat
Tree cover	Percentage of tree cover (%)	Explan/Cont
Tree species richness (N. trees sp.)/30x30 m plots	The average number of tree species in different plots of COS of 30x30 metres	Explan/Cont
Urban green infrastructure (UGI)	Percentage of green space (lawn) (%)	Explan/Cont
UGI elements (UGI el.)	1=Asphalt with street trees; 2=Atrium; 3=Garden; 4=Balcony green; 5=Green verge; 6=Medium linear park (park); 7=Asphalt; 8=Playground; 9=Street green; 10=Yard	Explan/Cat
Biotic features, abiotic conditions and infrastructure elements	1=Presence; 0=Absence	Explan/Cat
Index of structural diversity (SID) calculated for biotic features (BioticSID)	Number of existing biotic features (1=presence) in COS divided to the total number of elements per biotic dimension	Explan/Cont
Index of structural diversity (SID) calculated for abiotic site conditions (AbioticSID)	Number of existing abiotic site conditions (1=presence) in COS unit divided to the total number of elements per abiotic dimension	Explan/Cont
Index of structural diversity (SID) calculated for infrastructure elements (Infr.SID)	Number of existing infrastructure elements (1=presence) in COS unit divided to the total number of elements per infrastructure dimension	Explan/Cont
Average SID (Av. SID)	The average SID of abiotic, biotic and infrastructure structural diversity	Explan/Cont

Table 3. The classification of campus open space according to their size and type of green space based on Ayuntamiento de Valencia (1992) and EU (2013b).

GI ELEMENTS (EU, 2013)	GREEN SPACE AREA (Ayunt. Valencia, 1992)	TYPE OF GREEN SPACE (Ayunt.Valencia, 1992)	UGI AREA OF COS	COS
Pocket park	0.1-1 ha	Small	<0.1 ha	Very small
			>0.1-0.2 ha	Small
Medium park	1-5 ha	Médium	>0.2-0.4 ha	Medium
Large park	5-10 ha	Large	>0.4-0.7 ha	Big
			>0.7 ha	Very big

For *Placement*, the classification done by Cooper and Wischemann (1990) was adapted to the types of UPV's campus open space according to their location and functionality in the campus. The adjacent open space refers to a restricted area surrounding the home-base building or faculty department. Typically, it is associated with the front yard. However, the spaces located between buildings often serve as passageways, characterised by street trees and green verges. These areas differ from the front yard, which typically consists of a lawn. Assuming that biotic features dimension affects visitors' evaluation and activities (Voigt et al., 2014), the locations of space could influence as well the use of space.

As for the context of landscape, to determine the *tree cover*, the percentage of tree cover was assessed for each open space by using the tree cover map. Regarding the *tree species richness*, in absence of other actual data, the vegetation plan of Campus Botanic UPV (Esteras Pérez & Sanchis Duato, 2022), the available cartography and several visits were necessary. The number of species was counted in different plots of COS of 30 X 30 metres, in order to obtain a homogenous pattern of tree species and to see if there was a balanced number.

For the assessment of *UGI cover*, the percentage of elements of green infrastructure were used. Tree pits were not considered for the evaluation of UGI. To evaluate the *tree* and *UGI cover*, the percentage values proposed by Schebella et al. (2019a) for the permeability classes of urban parks, which are included in the index of urban naturalness (Machado, 2004) were used (Table 3). The classification of COS according to the number of tree species and greenery (tree cover and UGI) is shown in Table 4.

The GI classification made by EU (2013b) was used for variable *UGI elements* (Table 1). The absence of green infrastructure is marked by asphalt/concrete/cobble surface. Tree pits were not considered as green infrastructure, but in the asphalt areas, such as passing area (COS #0) or restaurants' terraces, COS 35, their presence counts as UGI elements (asphalt with street trees).

Table 4. The classification of campus open space according to their UGI and tree cover, structural biodiversity and accessibility parameters based on EEA (2002); Voigt et al. (2014), WHO (2016) and Schebella et al. (2019a).

UGI COVER	%	TREE COVER	%	TREE SP. RICHNESS	N. SP.
WITHOUT COVER	0 %	Without cover	0 %	No sp. richness	0-1
POOR COVER	1-20 %	Poor cover	1-20 %	Poor	2-3
MEDIUM COVER	>20_50 %	Medium cover	>20_50 %	Medium	4-6
BIG COVER	>50 %	Rich cover	>50 %	Rich	>6
PROXIMITY TO CENTRAL AXIS	**DISTANCE**	**PROXIMITY TO ÁGORA**	**DISTANCE**	**BIOTIC SID**	**VALUES**
IMMEDIATE ACCESSIBILITY	0-50 m	Immediate accessibility	0-50 m	No diversity	0
REACHABLE IN 1-5 MIN	51-300 m	Reachable in 1-5 min	51-300 m	Poor	0.1-0.3
REACHABLE IN 10 MIN	301-500 m	Reachable in 10 min	301-500 m	Medium	>0.3-0.6
REACHABLE IN > 10 MIN	>500 m	Reachable in > 10 min	>500 m	Rich	>0.6-1
ABIOTIC SID	**VALUES**	**INFRASTRUCTURE SID**	**VALUES**	**AVERAGE SID**	**VALUES**
NO DIVERSITY	0	No diversity	0	No diversity	0
POOR	0.1-0.3	Poor	0.1-0.3	Poor	0.1-0.3
MEDIUM	>0.3-0.6	Medium	>0.3-0.6	Medium	>0.3-0.6
RICH	>0.6-1	Rich	>0.6-1	Rich	>0.6-1

To evaluate the *structural diversity of COS*, the method used by Voigt et al. (2014) was considered. It consists in a tool for urban park's multi-dimensional structural diversity, where diversity comprises biotic features, abiotic site conditions, and infrastructure facilities (Table 5). Fieldwork was carried out complementary to the use of aerial photograph, focusing on the presence (1) and absence (0) of the items proposed by Voigt et al. (2014) together with some new infrastructure elements found in UPV campus, like art elements, bicycle parking rack, bike lanes and bins.

The normalised values of the Structural Index of Diversity (SID) were calculated by considering the number of existing elements (assigned a value of 1 for presence) in each dimension within favourite places on campus. These values were then divided by the total number of elements per dimension (Table 5). For example, to calculate the SID of infrastructure (material or man made) elements in COS 43, the next formula is used: 7/9=0.8 (because space number 43, contains 7 of 9 elements). The average structural diversity was calculated with the aid of biotic, abiotic and infrastructure normalised values of SID.

The structural level was approached in order to focus on dominant features at visual level, such as lawns, shrubs, hedge, groups and rows of trees. Some authors (Voigt et al., 2014) considered this concept easily applicable and suitable for comparing different green spaces. It enables people to perceive and evaluate the biotic features at a more structural level. According to biotic features, abiotic site conditions, infrastructure elements and average SID, we propose the following classification for COS: space with no diversity (0), poor diversity (0.1-0.3), medium diversity (>0.3-0.6) and rich diversity (>0.6-1) (Table 4).

Table 5. List of the structural elements of open space based on Voigt (2014).

DIMENSION	CATEGORY	ELEMENT
Biotic features	Vegetation	Flowers
		Hedge (trimmed or untrimmed),
		Lawn (intensive)
		Row of trees/Tree-lined path
		Shrubs
		Isolated trees
		Group of trees
Abiotic site conditions	Water elements	Fountains
	Topography	Mounds
Infrastructure elements	Amenities	Art elements
		Benches & stairs
		Bicycle parking rack
		Bike lanes
		Bins
		Crossing paths
		Drinking fountain
		Lighting (of main paths)
		Tables & chairs

To find out which typologies of open space can be found in campus of Universitat Politècnica de València (UPV), a Two Step clustering method was used (right part of flowchart in Figure 6). The Analysis of Variance (ANOVA) and *post hoc* tests were performed using structural variables (Table 5) as input variables, in order to discover which are the significant variables that participate in grouping the open space in COS typologies. All the variables which were not significant (p>0.05) were eliminated. *Post hoc* analyses were carried out using *Placement* and *UGI elements* as categorical variables in order to detect if there were significant differences between their groups.

5.1.4. Classification of landscape services

This study researches landscape services (LS) provided by campus open spaces (COS). A new classification of benefits was adopted and adapted to the characteristics of the campus. This classification was inspired by the Landscape Services Framework proposed by Vallés-

Planélls et al. (2014), with services as a useful tool for incorporating sustainability principles into decision-making processes. The landscape services considered for this study are presented in Table 6.

The campus open space or campus landscape is related to landscape elements, rather than to ecosystems, as some elements are furniture, infrastructure and other man-made objects. Although these elements provide benefits to the university community, they are not typically regarded as systems.

Furthermore, since the present thesis focuses on the connections between people and the landscape, as well as the values conveyed by the local environment, the concept of perceived supply of landscape services (LS) is more appropriate than the concept of perceived supply of ecosystem services (ES). This is because the perceived supply of services is specifically oriented towards meeting the needs and preferences of people. According to Termorshuizen and Opdam (2009), it is ‘‘the detailed pattern of landscape elements that the locals perceive, evaluate and manage”.

In the provisioning group, only the daily activities class has been used (Table 6). Daily activities class is split into three groups according to the new services required by the setting of the study. These are important requisites for the well-being of the university community, such as a place to live (satisfy basic daily needs), a place to work and a place to move. Pedestrian circulation or sustainable mobility makes part of COS users ‘life. In the regulation and maintenance group, flow regulation, regulation of physical and regulation of biotic elements classes have been partially used, since only LS related to water and atmospheric regulation, and to biodiversity, were researched. As for cultural and social groups, cultural LS is a more complex category, containing the following classes: Health/Enjoyment, Self-fulfilment (personal) and Social fulfilment. There is a thin border between these two pairs of LS: active enjoyment and physical health and passive enjoyment and mental health. We perceive that leisure activities e.g., doing sports, walking, running or playing in open places, are related directly to increasing physical health. The same happens for the other pair. Passive enjoyment can mean stress relief, which is closely linked to mental health and understood as body and mind restorativeness, not illness or disorders. When we compare services offered by other types of public spaces, like parks or playgrounds with campus LS, their range of spare time activities is larger than in COS, such as.g. hiking, climbing, fishing or fitness in the open air.

Table 6. Classification of landscape services adapted to UPV campus based on Vallés-Planélls et al. (2014) and Tudorie et al. (2020).

THEME	CLASS	GROUP	LANDSCAPE SERVICES
Provisioning	Daily activities	Circulation setting	Outdoor place to pass through
		Work/study setting	Outdoor space to work or study
		Basic needs setting	Outdoor space to eat or rest
Regulation and maintenance	Flow regulation	Water flow regulation	Space that contributes to flooding control and reduction
	Regulation of physical environment	Atmospheric regulation	Space that improves air quality Space that helps to provide pleasant climatic conditions (temperature, humidity, solar radiation, ventilation)
	Regulation of biotic environment	Lifecycle maintenance and habitat protection	Space that maintains and increases biodiversity
Cultural and social	Health/enjoyment	Active enjoyment (physical health)	Outdoor space to do sports or walk
		Passive enjoyment (mental health)	Outdoor space to disconnect or relax
	Self-fulfilment	Didactic resources	Outdoor education
		Scientific Resources	Outdoor sites for research
		Source of inspiration	Source of inspiration for art (photography, cinema, painting, sculpture, etc.)
	Social fulfilment	Place identity	Space that contributes to the establishment of psychological and cultural connections between the university community and the campus
		Social interactions	Space that offers meeting places for social interaction

5.2. Description of survey tool, study variables and analyses

5.2.1. Structure of the survey tool

A survey was conducted in October 2019 at Universitat Politècnica de València to examine the benefits of campus open space (COS) (Annex 2). The survey, distributed through email and social media in both Spanish and English, gathered quantitative and qualitative data. COS refers to the outdoor areas university community members use or prefer and encompasses green and grey spaces without buildings or other built structures, as defined by Stanley et al. (2012). It is a diverse and interconnected space that encompasses various functions and is used by a wide range of users. COS includes paved areas with green elements, meeting places like squares (e.g., Ágora square), tree-lined corridors, and other types of open spaces. The map of distribution of COS and a list of examples of open space were supplied to respondents as a guide. Open space encompasses parks, gardens, outdoor terraces, lawns, walking areas, and outdoor play areas. However, sport fields such as football, tennis, volleyball, basketball, and athletic tracks were excluded. The study's objectives and data privacy statements were included to clarify the research goal.

The survey uses a three-part online questionnaire to collect information on the study variables. Open-ended, semi-open-ended, and closed-ended questions were employed. To ensure no sub-optimal responses which could bias the whole research, trap questions were used. Pilot testing was conducted and validated to ensure the study's consistency.

There were no incentives for the participants. A reminder to participate in the survey was published on social media and sent by email.

To ensure an unbiased survey while allowing respondents to freely express their opinions, two additional options were provided: “Do not know/Do not answer" and “Other”. All questions in the survey required respondents to rate their responses on a five-point Likert scale. For example, options ranged from 1 (“I do not like it at all” or “Strongly disagree”) to 5 (“I like it a lot” or “Completely agree”), or from 1 (“Very poor”) to 5 (“Excellent”).

The questionnaire was structured in three sections:

- Section 1 is about the way participants perceive the space in general, the needs and recommendations related to current state and the importance of space (Annex 2, questions 1-5 and 17-18)
- Section 2 researches members' preferences, level of use and evaluation of specific campus open spaces (Annex 2, questions 6-11)
- Section 3 deals with respondents' socio-demographic characteristics (Annex 2, questions 12-16)

Section 1 aims to establish the perceptions of the campus open spaces in general by considering the current state of spaces and their importance for respondents' satisfaction.

Measuring perceptions cannot be done with only one method. So, a more complex instrument for measuring perceptions of all three LS themes (provisioning, regulation and maintenance, and cultural LS) is needed. For this, we develop an instrument of 14 items to assess the perceived supply of LS provided by COS, according to Larson et al.'s questionnaire (2016). The instrument is called Landscape Services Assessment Scale (LSAS). The answers were rated on a five-point Likert scale (1-very poor, 2-poor, 3-neutral, 4-rich, and 5- excellent) (Likert, 1932).

Specifically, the variables considered in section 1 focus on:

- Evaluation of perceived supply of LS

- General satisfaction of university community members with open space's condition
- Perceived needs regarding open space

It also comprises user-related information about: frequency of visiting and respondents'general preference for spending free time in different types of places, such as indoor, outdoor and sport places.

Section 2 focuses on preference. Respondents are asked about their most favourite open spaces, the activities developed in these places and the LS-related reasons that justify their choice. They are also asked about the most used places in the campus. These places were selected with the aid of the COS map.

Section 3 focuses on determining the users' profile by capturing the following socio-demographic characteristics: age, gender, occupation, level of studies, branch of knowledge and time spent at UPV COS (Table 7).

A total number of 828 of respondents participate in the survey. After cleaning the non-validate answers to the questionnaire, 786 and 764 respondents represent the samples of the population.

5.2.2. Description of study variables

The socio-demographic variables and user-related data provide insights into the respondents' profile and their evaluation and preference of COS (Table 7). The socio-demographic data are collected in the third section of the questionnaire and are employed in the study's analyses together with the variables of the first and second section of the questionnaire.

Most of the s*ocio-demographic characteristics* were adjusted to the specific characteristics of the UPV population, like t*he role respondents occupy in the university*, *the time spent* there and the *branch of knowledge* they belong to (Tudorie et al., 2020).

The questions about respondent's role in the university were inspired by some previous studies carried out in campus universities. Most of these studies focus primarily on students (Gulwadi et al., 2019; Mcfarland et al. 2010; Speake et al., 2013), while only few consider other members of the university community (Abu-Ghazzeh, 1999; Tudorie et al., 2020). The branch of knowledge was modelled after similar instruments of literature references (Chirico et al., 2023; Li et al., 2019; Tudorie et al., 2020). *Age* and *gender* were widely used in perceptions and preferences studies (Li et al., 2019; McFarland et al., 2010; Speake et al., 2013; Tudorie et al., 2020)

Table 7. Definition of respondent's profile variables: explanatory (Explan), outcome (Outcom), continuous (Cont), categorical (Cat), and their associated codes.

SOCIO-DEMOGRAPHIC CHARACTERISTICS	DESCRIPTION	TYPE
Age	1=<18–22 years old; 2=>22–30; 3=>30–50; 4=>50	Explan / Cont
Gender	1=female; 2=male; 3=prefer not to answer	Explan / Cat
Occupation	1=student; 2=AdSS (administration and services staff; 3=TRS (teaching and research staff); 4=other	Explan / Cat
Time spent at UPV	1=one year or less; 2=two-five years; 3= six-ten years; 4=over ten years;	Explan / Cat
Level of studies	1=Secondary school/High school; 2=Vocational education; 3=Undergraduate; 4=Master; 5=Doctorate; 6=Other	
Branch of knowledge	1=Art and Humanities (Art&Hum); 2= Health and Food Science (Health&FoodSc); 3=Social and Legal Sciences (Social&LegalSc) ;4=Agrifood and Forest Engineering (Agrifood&ForestE); 5=Architecture and Civil and Building Engineering (Arch&BuildE); 6=Science and Technology for Health Engineering (Sc&TechHealthE); 7=Industrial and Aeronautical Engineering (Industr&AeroE); 8=Information and Communications Technologies Engineering (Inf&CommTechE); 9=Other	Explan / Cat
USER-RELATED CHARACTERISTICS	**DESCRIPTION**	**TYPE**
COS Frequency	1=never or once (low users); 2=twice (medium users); 3= three times and 4= four or more a week (high users)	Explan / Cat
COS Preference	1=open space; 2=indoor space; 3=sport space; 4=go home	Explan / Cat

For the variables *COS Frequency* and *COS Preference* (Table 7), one question was employed for each item ("How many times a week do you use open spaces on campus?" and "Where do you prefer to spend your free time on the university campus? "). A short definition of use of space was provided, meaning spending time in a specific place, such as sitting on the lawn, on a bench, on coffee shops terraces or practising some outdoor sport, etc., or do small walks through open spaces. As a general preference, respondents could choose between open, indoor or sport space. The questions related to the frequency of visits to campus green and open spaces were developed based on previous research (Ibrahim & Fadzil, 2013; Schipperijn, Stigsdotter, et al., 2010; Scholl & Betrabet Gulwadi, 2015; Wee, 2017).

To evaluate *perceptions of open space*, the general and specific conditions of campus open space were used. On one side, in survey section 1, the *perceptions regarding the evaluation of the general level of satisfaction* of the university community were researched. This explains how university community members perceive the current management of campus space (Table 8). On the other side, in survey section 2, the *perceptions of respondents regarding specific open space* were analysed (Table 9).

Regarding the general preference and evaluation, *the level of satisfaction* of the university community was measured with a single item (“Please assess your satisfaction with all open spaces' condition and management”). The respondents had to rate on a five-point Likert scale (from 1, “Very bad”, to 5, “Very good”).

The variable *Evaluation of COS* (Table 8) was evaluated with a general question ("How would you rate the aspects of the current state of the campus open spaces in general?”). The question includes 14 items (A1-A14) and respondents had to rate on a five-point Likert scale each of them (from 1, “Very poor”, to 5, “Excellent”) (Table 8). These statements are relevant in the campus context and consider the whole range of LS, e.g., provisioning, regulating, and cultural services *supplied* by the green elements of the campus landscape. According to Burkhard et al. (2012), *supply* refers to “the capacity of a particular area to provide a specific bundle of ecosystem goods and services within a given time period”.

For the evaluation of the general condition of COS, the *needs* of members of the university community considering the existing management practices and the elements present in the open spaces, were considered. Qualitative and quantitative methods were performed.

For the quantitative method, respondents were asked to mark their needs according to their satisfaction level regarding campus open space. To answer, respondents had to select one or more predeterminate statements or to propose some new needs in the other category. *Don't know* and *don't answer* possibility was offered as well. A binary system (1=yes; 0=no) was used to assess the frequency of selecting needs related to space's management. Three types of needs were researched, such as

- environmental needs, e.g., natural shade, water, trees, native species, less asphalt surface, cleaner air

- functional needs, e.g., tables and benches in order to eat, using COS as natural classrooms, closer outdoor sites to respondents' faculties, more outdoor sites for recreational or sport activities, and
- psychological needs: tranquillity and security.

For the statement's formulation, literature references (Abu-Ghazzeh, 1999; Tudorie et al., 2020; A. E. Van Den Berg et al., 2007; Voigt et al., 2014; L. Zhang et al., 2021) were used completed by several visits to campus outdoor environment to analyse its current situation.

Regarding the *evaluation of specific open spaces*, questions were employed to analyse the favourite places selected by respondents with the aid of COS map. The questions comprised the *activities* developed in their favourite place and the *reasons of their preference*.

Each of the questions included various statements (Table 9). To find out how respondents use their favourite places, a list of activities was provided, in order respondents to select one or more activities in which they were engaged in favourite space 1 and favourite space 2. For the list of activities, the following literature references were used: Cooper and Wischemann (1990), Abu-Ghazzeh (1999), Olbińska (2018), Madureira et al. (2018) and Zhang et al. (2021).

For the same most preferred places, a list of LS-related reasons was used. Respondents had to rate each reason on a five-point Likert scale (from 1, “I strongly disagree”, to 5, “I completely agree”) (Likert, 1932). The list of LS-related reasons was inspired by Arnberger and Eder (2015); Vallés- Planélls et al. (2014), Tian et al. (2020) and van Vliet et al. (2021).

As for favourite and most used places, COS were classified as follows: sites without preference/use, sites with low preference/use (selected by respondents between 1 and 10 times), sites with medium preference/use (selected between 10 and 100 times), and sites with high preference/use (selected more than 100 times) (Table 10)).

Table 8. Definition of variables related to general evaluation of campus open space: explanatory (Explan), continuous (Cont) and categorical (Cat).

PERCEPTIONS OF COS (GENERAL)	DESCRIPTION	TYPE
Satisfaction with COS	1=very bad; 2=rather bad; 3=neutral; 4=rather good; 5=very good	Explan / Cont
Needs	1= selected; 0=not selected	Explan / Cont
	More tables and benches outside in order to eat	
	More outdoor sites for recreational or sport activities	
	More tranquillity	
	More security	
	Water elements (fountain)	
	Less asphalt surfaces	
	Cleaner air	
	More trees	
	More natural shaded areas	
	More native species and higher proportions of each species	
	Use open green spaces as natural classrooms, laboratories or workshops (botany, landscape, ecology, architecture, design, photography etc.).	
	More open space next to my school/my work	
Evaluation of COS	1=very poor; 2=poor, 3=normal; 4=rich; 5=excellent	Explan / Cont
	A1. Pleasant space for short or long walks	
	A2. Space to study / work	
	A3. Space to meet daily basic needs	
	A4. Quiet space to relax	
	A5. Play areas	
	A6. Space to do sports	
	A7. Space for research	
	A8. Space to learn about natural environment	
	A9. Space for art creation	
	A10. Space to gather with friends	
	A11. Protection against floods	
	A12. Air quality	
	A13. Pleasant temperature and light	
	A14. Habitat for native species	

Table 9. Definition of variables related to evaluation of specific campus open space and their associated codes: explanatory (Explan), continuous (Cont) and categorical (Cat).

PERCEPTIONS OF FAVOURITE COS	CODE	DESCRIPTION	TYPE
Favourite place*	**Fav**	Frequency of selecting examples of most preferred or favourite COS	Explan/ Cont
Most used place*	**Use**	Frequency of selecting examples of most used COS	Explan/ Cont
Activities*	Walk	Doing short or long walks	Explan/ Cat
	Work	Working/Studying in campus open spaces	
	Eat	Having breakfast/snack/lunch	
	Relax	Relaxing /Enjoying beautiful views	
	Play	Playing	
	Sport	Doing sports	
	Research	Research	
	Learn	Learning about structure and functions of natural environment	
	Paint	Painting/Drawing/being inspired by natural environment	
	Gather	Gathering with friends and colleagues	
LS-related reasons**	Peaceful	Because of their peaceful location (isolated)	Explan/ Cat
	Concentrate to study	Because I can concentrate more to study	
	Place to do sports	Because I have plenty space to do sports	
	Good condition to eat	Because provide good conditions to eat (there are tables, banks)	
	Beautiful views	Because of beautiful views	
	Safe	Because I feel safe	
	Research setting	Because they are the background of my research	
	Green cover	Because of the green cover	
	Biodiversity	Because of flowers and animals' species	
	Natural aspect	Because of the natural aspect	
	Permeability	Because I prefer permeable spaces	
	Breath clean air	Because I prefer to breath clean air	
	Sunny area	Because I am looking for sunny areas	
	Natural shade areas	Because I prefer shady areas (natural vegetation shade)	
	Proximity to Ágora	Because they are near some of campus interest points: classrooms, library, laboratories, restaurants, sport facilities etc.	

*1=selected; 0=not selected
**1=strongly disagree; 2=do not agree; 3=neutral, 4=agree; 5=completely agree

According to the proposed classification of sites considering the frequency with which respondents selected activities they develop in their favourite places, COS are classified in three classes: less preferred, preferred and most preferred (Table 10).

Table 10. Classification of open spaces according to variables of specific evaluation of open space.

PREFERENCE	TIMES	USE	TIMES
Without preference	0	Without use	0
Low preference	1-10	Low use	1-10
Medium preference	11-100	Medium use	11-100
Big preference	>100	Big use	>100
LS-RELATED REASONS	**NUMBER GOOD EVALUATIONS**	**ACTIVITIES**	**TIMES**
Poor perceived performance	1-10	Less preferred	1-10
Medium perceived performance	11-100	Preferred	11-100
Good perceived performance	>100	Most preferred	>100

The less preferred COS's category involves a small number of activities and the fact that COS was rarely selected as favourite. For example, COS 0, which is a passing through area in the west side of campus in the nearby of Building and Informatics school, was selected as favourite site to spend free time by 5 respondents, who chose it because they could carry out some activities, like: walking and working activities (only 1 time), relaxing and painting (2 times) and eating (3 times). Preferred sites are those which were selected at least 10 times for any types of activities, like restaurant terraces (4, 8, 19, 26 and 47) or more private gardens (30, 40 and 45) (Figure 17A). The last type, which refers to the most preferred COS, aligns with the best-rated areas in terms of the perceived supply of LS-related reasons, e.g., parks (15, 25, 28, 31, 38, 39 and 43) and gardens (10, 11, 12 and 29).

As for evaluation to places considering LS-related reasons, three classes are proposed, considering the total number of good evaluations (4 and 5 on a five-point Likert scale (from 1, “I strongly disagree”, to 5, “I completely agree”) (Likert, 1932). These are the following: sites having a poor perceived performance (with 1 to 10 good evaluations), sites with medium perceived performance (between 11 and 100 good evaluations) and sites with a good perceived performance (overpassing 100 good evaluations) (Table 10).

For the qualitative method, two open-ended questions were utilised to allow respondents to answer freely and prevent potential biases that may arise from providing predetermined answer options. The first question sought the respondents' opinion on the campus open space, while the second question focused on their recommendations for improving the condition and management of the open spaces on the UPV campus. The responses were coded using a predefined set of words capable of encompassing all possible perceptions of the outdoor environment.

5.2.3. Data analysis

The questionnaire was available for one month (October 2019). Data was automatically downloaded as a Microsoft Excel file (.xlsx). Statistics tests were performed with two statistics software solutions: IBM SPSS Statistics 23 and Statgraphics Centurion XVII. Descriptive analyses were carried out. Basic statistics and measures of normality, symmetry, and kurtosis were obtained for the information related to preference for open space, use of space, structural characteristics, level of satisfaction, needs, perceived supply of LS and types of LS. These methods and techniques are the following: non-parametric tests and correlations, Factorial analyses and Structural Equation Model, Two Step cluster method, Hierarchical multiple regression, Path analysis and qualitative analysis.

Non-parametric tests and correlations

For the evaluation of respondent's needs related to COS management, a binary system was used. To identify needs, with 1= yes, when some specific need was marked and with 0=no, when it was absent. As our data was not normally distributed, non-parametric tests were used to find significant differences between the university community's answers.

Significant differences of the perceived number of well-provided LS were calculated with the Kruskal–Wallis test between groups of users according to age, occupation, time spent at UPV, and COS frequency. Significant differences in perceived LS and satisfaction based on socio-demographic and user characteristics were assessed using the Kruskal-Wallis nonparametric test (H). Post hoc analysis among subsets of pairs was conducted using the Dunn non-parametric test to further examine these differences.

The Kruskal–Wallis test is a rank-based nonparametric test that can be used to determine if there are statistically significant differences between two or more groups when the dependent variable is measured at least at an ordinal level or when it is measured at an interval level. It is used when the assumptions of one-way ANOVA are not met (Laake & Fagerland, 2015).

Mann–Whitney U test or Mann–Whitney–Wilcoxon (MWW) test was used for the gender and branch of knowledge. The Mann-Whitney-Wilcoxon test is used to compare the locations of two independent groups when the underlying distributions have an equal shape. However, it is important to note that verifying this assumption in practice can be challenging. In the Mann-Whitney U test, the null hypothesis (H0) is accepted when the observations from the two samples are assumed to be from the same distribution. The alternative hypothesis (H1) states that the observations of the two samples are from two distributions that have the same shape, but there is a shift in location (Anderson, 1962).

Bonferroni's correction was applied to counteract the issue of multiple comparisons between groups of users, ensuring a 95.0% confidence level ($P < 0.05$) (Kent State University, 2020).

Factorial Analyses and Structural Equation Model

In order to gain a deeper understanding of the data and uncover unobserved factors that account for the complexity of the observed data, Exploratory Factor Analysis (EFA) was conducted using the IBM SPSS program, version 23 (Thompson, 2004). The results of the EFA are depicted in Figure 6.

The objective of EFA in this paper was to differentiate latent (unobserved) factors related to the perceived supply of LS provided by COS (observed) defined in the theoretical framework. To confirm the theoretical framework (hypotheses), Confirmatory Factorial Analysis (CFA) was employed. CFA is a multivariate statistical procedure used to test how well the measured variables represent the number of constructs and is used to confirm or reject the measurement theory (Statistics Solutions, 2013).

Structural Equation Model (SEM) was used to explore the relationships between variables of conceptual framework (Figure 2). Confirmatory Factorial Analysis (CFA) and Structural Equation Model (SEM) were conducted using the Mplus program, version 7. Cronbach's alpha was used to measure internal consistency (Cronbach, 1951) and Kaiser-Meyer-Olkin (KMO) was used to indicate sampling adequacy (Kaiser, 1970). The Barlett Test of Sphericity was used to test the strength of the relationships between variables (Barlett, M., 1954). Maximum likelihood with Huber-White covariance adjustment (MLR) was used for parameter estimates (Yuan & Bentler, 2000). The descriptive measures of model fit used for Path analysis were also evaluated with the following cut-off values: 0.9 for the comparative fit index (CFI) (Hu & Bentler, 2009), <0.08 or <0.05 for the root mean square of approximation (RMSEA) (Browne & Cudeck, 1992), and <0.08 for the standardised root mean residual (SRMR) (Bollen, 1989). The closer to 0 values indicate a good fit of indices and test (Vandenberg & Lance, 2000). The adequacy of model fit to data is given by >0.6 values of path analysis coefficients.

Structural equation modelling (SEM) is a strong analysis tool which has been used to great benefit in social and behavioural sciences (Maccallum & Austin, 2000; Shaheen et al., 2017). Lately, it has gained attention in studies related to urban green spaces (C. Young et al., 2020) and campus outdoor environment (Hajrasouliha, 2015). In this study, the SEM technique was employed for the fitted conceptual model to identify the type and the direction of the causal relationships of various latent and observed variables expected to be found in theory (Figure 2). SEM was used to explore the relationships between the perceptions of campus landscape's services, user satisfaction with COS, and respondent profile. SEM's second role was to identify the interactions between the functional dimensions of latent factors (perceptions of LS) at landscape services assessment scale (LSAS) of conceptual framework (Figure 2) and the university community's satisfaction. The LSAS was built with the aid of 14 items (Annex 2, question 3) and is based on Landscape Services Framework (Vallés-Planélls et al., 2014).

For these analyses, socio-demographic (excepting level of studies), user-related information, the variables satisfaction with COS and evaluation of COS in terms of perceptions of COS (general), were used as variables.

Structural equation modelling integrates a number of different multivariate techniques into a model fitting framework, e.g., measurement theory, factor (latent) variable analysis, path analysis, regression and simultaneous equations (National Center for Research Model, 2020). The measurement model for both CFA and SEM is a multivariate regression model that examines the relationships between a set of observed dependent variables and a set of latent variables (unobserved variables). Structural equations are used to capture causation, the weighted influence of exogenous variables on endogenous variables (Hox & Bechger, 1998).

The tests related to *Hypothesis 1* (which states the perceived supply of LS and satisfaction with campus landscape are expected to be mediated by the profile of university community members) are tests used in EFA, CFA and Structural Equation Model, such as Cronbach's alpha, Kaiser-Meyer-Olkin (KMO), the Barlett Test of Sphericity, Maximum likelihood with Huber-White covariance adjustment.

The goodness-of-fit for the CFA model, designed to determine the number of constructs for community members' perceptions, and the SEM model, which explores causal relationships between (a) university community's characteristics and perceptions of services (*Hypothesis 1.1*), (b) community's characteristics and satisfaction (*Hypothesis 1.2*), and (c) perceptions and satisfaction (*Hypothesis 1.3*), were assessed using indices such as RMSEA, SRMR, CFI, TLI, and Chi-square.

Two Step Cluster Method

To test the validity of the cluster solutions obtained regarding COS typology, Two Step clustering method was used (Figure 6). Two-Step Clustering is an exploration tool designed to reveal meaningful subgroups (or clusters) within a data set. The Two Step clustering algorithm, as its name suggests, consists of two main steps. In the first step (pre-clustering), the dataset is divided into a preliminary set of sub-clusters. In the second step, the pre-clusters are merged in a stepwise manner until all clusters are combined into one final cluster. This algorithm is suitable for handling both categorical and continuous variables simultaneously. Additionally, it has the capability to automatically determine the optimal number of clusters. In comparative studies of clustering methods, the Two-Step cluster analysis is often regarded as a robust algorithm. Along with the K-Means and Binary-Positive methods, it is considered reliable for analysing the number of subgroups detected (Gelbard et al., 2007).

To perform this analysis, structural characteristics of space were used. The Kolmogorov-Smirnov Goodness of Fit Test (K-S test) was used for normality tests for continuous variables. Proximity to Ágora, proximity to central axis, green infrastructure cover, mean SID and tree cover were the five input variables for Cluster analysis, while UGI elements and placement represent categorical variables. The Log-likelihood distance and Bayesian information criterion (BIC) were selected for clustering of categorical variables. To indicate how much a variable contributes to clustering, statistics tests were used ranging from 0 to 1, where 1 represents a 100% of contribution and 0 means no contribution. The cluster cohesion ranges between 0 and 1, where values closer to 1 mean good cohesion. The size ratio should be between 1 and 3, where 1 is the ideal value indicating a good clusters' evenness of elements.

The one-way ANOVA analysis was employed to determine whether there were statistically significant differences between groups based on the categorical variable, which in this case is Placement. Post hoc analyses were then conducted to examine the specific differences between groups. For the post hoc analysis, the Tukey test (Driscoll, 1996) was applied assuming equal variances among groups. In cases where unequal variances were assumed, the Games-Howell test (1976) was used. Both the independent samples t-test and ANOVA assume the homogeneity of variance, meaning that all compared groups should have similar variances. These tests use a 95% confidence interval for assessing statistical significance. The Levene test (1997) was used to check the assumption of homogeneity. To test the model fit, Independent samples t-test were conducted to determine whether there were statistically significant differences between the two groups. For robustness to violations of assumptions, *F* and *t* tests were employed. The robust tests of equality of means, Brown-Forsythe test or Brown-Forsythe F-ratio (1983a) are used to confirm the results of ANOVA analysis.

Hierarchical multiple regression

To predict the preference and the use of COS (H2-H3), a hierarchical multiple regression analysis was performed with the aid of SPSS software. For this analysis, variables related to structural characteristics of COS were used (Table 2). GIS software was used to evaluate the physical parameters to describe the open space of campus.

To use variable Placement in regression, dummy variables were created, where central placement was coded with 1 and adjacent-to building placement was coded with 0.

A hierarchical multiple regression is a multiple linear regression analysis in which the independent variables are added to the model in separate steps called “blocks”. The collinearity diagnosis and the coefficient of determination or squared R (R2) were used for testing the regression's assumptions. The R2 statistic helps to explain the variance of the dependent variable. The variance inflation factor (VIF) is used to detect the multicollinearity. In order to meet the non-multicollinearity assumption, the VIF values should range between 1 and 10, and the coefficient values of dependent variables close to 1. The ANOVA indicates if the model built of independent variables predicts the dependent variable in a statistically significant way. Standard residuals and Cook's distance were used to check if there are outliers. In order to see if the residuals are normally distributed, standardised residuals should be between -3 and +3 for small samples, and -2 and +2 for big data sets. Cook's distance uses leverage measures, which are indicators of outliers. These residual values in Cook's distance should ideally be less than 1.

All these tests, such as R2, VIF, Standard residuals, Cook's distance and ANOVA were used to research the impact of structural characteristics of COS on the use (*Hypothesis 2*) and on the preference of space (*Hypothesis 3*).

Path analysis

To see the impact of certain actions and LS-related reasons on the respondents' preference for space (*Hypothesis 4* and *Hypothesis 5*), Path analysis was performed. In some of the studies, path analysis has been used to examine direct and indirect relationship between influencing factors related to liveability, physical and mental health-related quality of life, self-efficacy, optimism, social and economic issues (Ansarzadeh et al., 2020; Lara et al., 2020; Tchouamou Njoya & Nikitas, 2020). Van den Berg et al. (2015) conducted a study on the factors influencing neighbourhood-based social contacts. Through path analysis, the authors discovered that socio-demographic variables such as age, duration of residence in the neighbourhood, family composition, and the number of residents in the neighbourhood are more significant in explaining neighbourhood relationships than neighbourhood characteristics themselves.

To evaluate the use of the favourite specific open space of university community members (COS map in Figure 7), a binary system was used. The presence of carried-out activities within the COS was marked with 1=yes, and the lack of activities with 0=no.

The variables involved in path analysis are Activities and LS-related reasons within the perceptions of COS (specific) (Table 9). Path analysis method is an extension of multiple regression and a precursor to, and a subset of structural equation modelling (SEM). Path analysis and confirmatory factor analysis (CFA) are components of SEM. Unlike SEM, which deals with observed and latent variables, path analysis uses only observed variables (Murti, 2016). The aim of path analysis is to estimate the magnitude and significance of hypothesised causal connections among sets of variables (Stage et al., 2004). The variables can be either exogenous (their variance is not dependent on any other variable in the model) or endogenous (their variance is determined by other variables in the model) (Petersen, 2001). Path analysis estimates both direct and indirect effects acting on a specified outcome via multiple causal pathways. In a path analysis model, the indirect effect of an independent variable on the dependent variable is via a mediating variable (Murti, 2016). In the path diagram, the exogenous or independent variables have straight arrows emerging from them and none pointing to them. The dependent variables, known also as endogenous variables, have at least one straight arrow pointing to them. A single-headed arrow points from cause to effect, while a double-headed curved arrow indicates correlation (see later Figure 25, Figure 33 and Figure 34). A correlated path model is more common and it is equivalent to a multiple regression, where we assume the predictors are correlated with one another to various degrees. Path analysis determines whether the data are consistent with the model, which allows to compare the model and determine which one best fits the data (Streiner, 2005). We also evaluated model fit using the standardised root mean residual (SRMR) (Bollen, 1989), the comparative fit index (CFI), the tucker-lewis index (TLI) (Hu & Bentler, 2009) and the root mean square error of approximation (RMSEA)

(Browne & Cudeck, 1992). The recommended cutoff value for the CFI is 0.9. Regarding the related indices of fit, the cut off values for RMSEA should be <0.08 or <0.05 and for <0.08 for SRMS, as closer to 0 values indicate a good fit of indices and test (Vandenberg & Lance, 2000). The adequacy of model fit to data is given by >0.6 values of path analysis coefficients.

Therefore, similar tests employed in SEM, are used to confirm the influencing factors (activities in *Hypothesis 4* and LS-related reasons in *Hypothesis 5*) of community members' preference as well.

Pearson's correlation

The bivariate Pearson correlation is a parametric measure commonly used to measure correlations between pairs of variables. Pearson's correlation matrix produces a sample correlation coefficient that measures the strength and direction of linear relationships between pairs of continuous variables (Kent State University, 2020). Pearson's correlation matrix was used to observe differences among the following variables: age, occupation, level of studies, branch of knowledge, and time spent at UPV. Pearson's correlation matrix was employed to identify significant correlations between all items of LSAS to evaluate the present perceived condition of COS. Pearson correlation analyses were then conducted to identify the significant variables (with $p < 0.05$ and $p < 0.01$) related to the preference and use of space.

Qualitative analysis

To gain insights into respondents' free answers, the affinity diagram technique (Castilla et al., 2017) was used. This technique synthesises information by grouping similar words and assigning a significant word to represent each group. Focus group sessions were conducted with four participants, including researcher students and professors, to reduce the number of topics. They reviewed the respondents' answers and discussed the topics that best aligned with the answers. The process continued until no new words emerged. After applying this technique, the initial list of 60 items was reduced to 29 topics (nouns). This method has been previously used to describe students' perceptions of their classroom environment (Castilla et al., 2017). The proposed topics are categorised based on the campus open space's functions (purpose), design, and management.

Chapter 6. Results

Some parts of the content of the present chapter are published in "Tudorie, C.A.-M., Vallés- Planélls, M., Gielen, E., Arroyo, R., Galiana, F., 2020. Towards a Greener University: Per-ceptions of Landscape Services in Campus Open Space. Sustainability 12, 6047, (DOI:10.3390/su12156047)"

6.1. Survey results: The perceived supply of LS, level of satisfaction, needs, opinions and recommendations regarding COS' current state and management

6.1.1. University community sample profile description

A total of 828 respondents participated in the survey and completed the 61-question survey. After removing invalid responses, the final sample consisted of 786 participants.

Among them, 49.4% were females, 46.8% were males, and 3.8% chose not to answer. The age range of the respondents varied from 18 to over 50 years, with 35.6% representing university members between 18 and 22 years old (Table 11). The majority of the respondents (60.9%) were students (undergraduate or graduate), followed by administration and services staff (AdSS) at 20.2%, and teaching and research staff (TRS) at 17.7%. Within the AdSS category, the largest proportion consisted of respondents over 30 years old (53.5%) and over 50 years old (45.1%) (Annex 5, Table 5.1). Around 55% of TRS were over 50 years old.

The respondents' relationship with the university varied in terms of length of service, with a significant portion (44.5%) having worked at the UPV campus for over ten years, while first-year students made up 15.8% of the sample. In terms of level of studies, 31.4% completed secondary school or high school, 4.7% attended vocational school, 20.7% had an undergraduate degree, 22.5% pursued a master's degree, and 19.9% were already doctors.

It is important to note that among the student respondents, the majority fell within the age range of 18-30 years. Most of them had spent a maximum of 5 years at UPV, including both freshmen and those who had recently completed high school. On the other hand, the

AdSS and TRS categories generally consisted of staff members older than 30 years, who had been associated with UPV for more than 6 years, as shown in Annex 5, Table 5.1.

Considering the branch of knowledge, 39.1% of respondents were connected to landscape-related disciplines (LRD), such as forestry, agriculture, environmental engineering, architecture, and fine arts, which involve analysis, planning, intervention, or representation in terms of landscape and are expected to have a higher sensitivity towards the environment and open space. The remaining respondents (59.7%) were from other disciplines (OD), such as economics, computer science, civil engineering, etc.

In terms of COS frequency, the majority (60.7%) were classified as high users, using COS three, four, or more than four times a week.

Table 11. Sample distribution considering the percentage (%) of respondent's categories (TRS, teaching and research staff; AdSS administration and services staff). Source: Tudorie et al. (2020).

AGE	%	TIME SPENT AT UPV	%
18–22	35.6	One year and less than one year	15.8
22–30	18.8	Two–five years	23.6
30–50	23.1	Between six and ten years	13.0
>50	18.7	More than ten years	44.5
No data	3.8	No data	3.1
OCCUPATION	**%**	**COS FREQUENCY**	**%**
Student	60.9	Low users	21.9
AdSS	20.2	Medium users	16.3
TRS	17.7	High users	60.7
Other	1.2	No data	1.1
COS PREFERENCE	**%**	**LEVEL OF STUDIES**	**%**
Open space	74.6	Secondary school/High school	31.4
Indoor space	8.0	Vocational education	4.7
Sport space	11.6	Undergraduate	20.7
No data	5.8	Master's	22.5
		Doctorate	19.9
		Other	0.8
BRANCH OF KNOWLEDGE	**%**	**GENDER**	**%**
Landscape related disciplines	39.1	Female	49.4
Other disciplines	59.7	Male	46.8
No data	1.2	I prefer not to answer	3.8

Between variable age, occupation, level of studies, and time spent at UPV, positive significant correlations ($p<0.01$) were detected (bold numbers in Annex 5, Table 5.2).

6.1.2. <u>Level of satisfaction</u>

In terms of satisfaction with the perceived general state and management of COS, the differences between satisfied, unsatisfied or neutral were very small, rounding all three categories 33% (Table 12). Within groups of COS users, only four of them expressed a higher percentage of satisfaction with the COS' current management, eight showed a negative appreciation, and six were neutral. Considering only the good opinion, those who expressed the highest evaluation of outdoor areas were university community members over 50, AdSS staff, females, those who prefer no answer, medium and high users (bold values, Table 12).

Table 12. The degree of satisfaction of university community members with state and management of COS. Significant differences between respondents' satisfaction according to respondents' characteristics. Kruskal–Wallis nonparametric test (H), P-values and significant pairs of groups. Dunn's post hoc comparison (Wi, Wj- Median) based on Tudorie et al. (2020).

	Respondents	Good (%)	Neutral (%)	Bad (%)	H	P	Groups	Wi	Wj
	University community	33.19	33.87	32.92					
Variables	Groups of users								
Age	18–22	32.97	34.43	32.6					
	22–30	27.97	36.36	35.66					
	30–50	33.53	32.37	34.10					
	>50	39.84	29.69	30.47					
Occupation	Student	31.40	33.76	34.84	10.641	0.030*	Stdent&TRS	390.339	330.911
	AdSS	41.89	32.43	25.68			AdSS&TRS	405.295	330.911
	TRS	28.81	35.59	35.59					
Branch of knowledge	LRD	33.79	32.08	34.13					
	OD	32.95	34.77	32.27					
Time spent at UPV	<=1	36.67	37.5	25.83	3.762	0.005*	<=1&6-10	398.163	334.301
	2-5	32.40	34.08	33.52			2-5&6-10	396.795	334.301
	6-10	31.68	29.70	38.61					
	> 10	31.65	35.44	32.91					
Gender	Women	29.03	32.9	38.06	17.350	0.001*	Women& Men	411.524	355.292
	Men	27.64	39.02	33.33					
	Prefer no answer	38.10	28.57	33.33					
COS Frequency	Low users	30.77	29.37	39.86	8.859	0.030*	Low&High	347.278	398.563
	Medium users	28.57	37.82	33.61					
	High users	35.41	33.63	30.96					
COS Preference	Open	34.85	32.48	32.66					
	Indoor	29.31	36.21	34.48					
	Sport	24.36	41.03	34.62					
	Go home	27.27	33.33	39.39					

Bold is used to indicate the highest positive values among respondents' groups

Significant differences (H=18.1; P=0.000*) were observed between first-year students and respondent groups who had been working or studying at UPV for more than six years (Table 12). There is no clear relationship between the time spent at UPV and general satisfaction with COS, but individuals who spend more time on campus and become more familiar with it tend to be more critical compared to other groups. Interestingly, respondents with a relationship of more than 10 years with the UPV campus displayed a higher level of satisfaction compared to other respondents (Table 12).

6.1.3. Perceived supply of LS

University community members perceived eight landscape services (LS) provided by the campus open space (COS) as having good quality, with values over 50%. These services, ranked in descending order of perceived quality, were: get together with friends or meet up (Meeting, 81.3 %), walks, relax, temperature/light, air quality (Air), sports, daily basic needs (Daily needs), and art creation (Art, 52.6 %) (Figure 19).

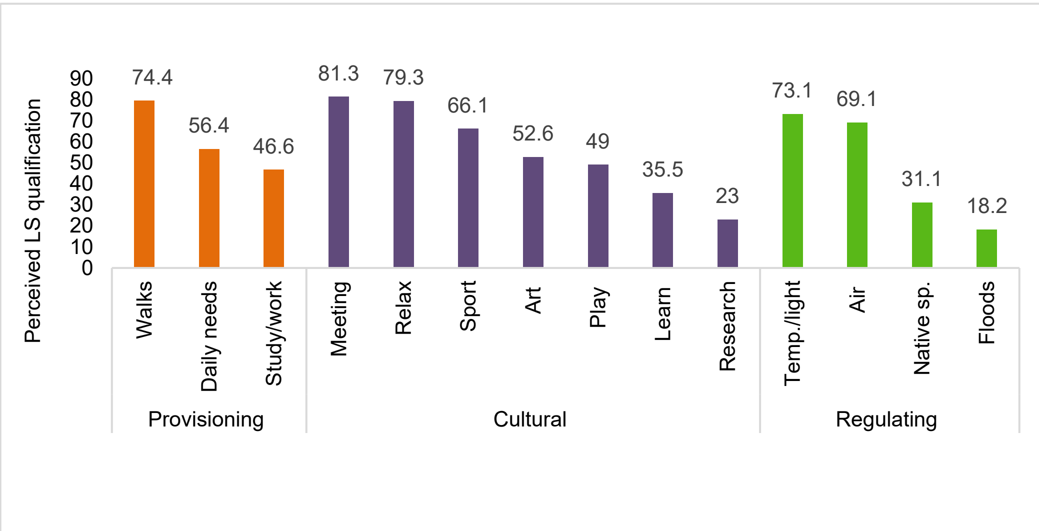


Figure 19. Percentage (%) of supply perceived of LS of good quality LS. Source: Tudorie et al. (2020)

Table 13 presents significant differences (P<0.05) regarding the assessment of the perceived supply of LS, among different groups of users based on their age, occupation, time spent at UPV, and COS frequency. The most frequent pairs of groups that present significant differences belong to: (a) the respondents of 18–22-year-old and over 50, (b) students and teachers, and (c) low and high users of open space (group column, Table 13).

Regarding age, the youngest participants perceived all LS to have the best quality compared to other university community members (Annex 6, Table 6.1). First-year students and high users of COS were the least demanding, rating eleven LS as being of very good quality. On the other hand, respondents who had spent more than ten years at UPV and low users evaluated fewer LS (8 LS) and gave lower ratings to six LS, including floods, research, species, learning, play, and study/work (Annex 6, Table 6.2).

Table 13. Significant differences between respondents' perceptions of LS provided with good quality, according to socio-demographic characteristics. Kruskal–Wallis nonparametric test (H), P-values and significant pairs of groups. Source: Tudorie et al. (2020).

	Perceived LS	H	P	Groups		
Age	Walks	12.6	0.005*	18–22 & 22–30		
	Study/work	16.1	0.001*	18–22 & 22–30	18–22 &> 50	
	Daily needs	19.6	0.000*	18–22 & >50		
	Play	12.7	0.005*	18–22 & >50	,	
	Research	17.7	0.000*	18–22 & >50		
	Art	16.0	0.001*	18–22 & 30–50	18–22 & > 50	
	Temp./light	13.7	0.003*	18–22 & 22–30	18–22 & 30–50	
Occupation	Play	7.7	0.021*	Student & TRS		
	Art	13.7	0.001*	Student & TRS		
Time spent at UPV	Daily needs	11.2	0.010*	<=1 & > 10		
	Play	23.7	0.000*	<=1 & > 10	2-5 & > 10	
	Sports	13.8	0.003*	<=1 & > 10		
	Learn	18.8	0.000*	<=1 & 2-5	<=1 & 6-10	<=1 & >10
	Art	22.5	0.000*	<=1 & > 10		
	Air	12.2	0.006*	<=1 & > 10		
	Temp./light	11.8	0.008*	<=1 & > 10		
COS Frequency	Research	9.8	0.007*	Low & High		
	Learn	6.8	0.031*	Low & High		
	Art	14.8	0.000*	Low & Medium	Low & High	

*significant differences (P<0.05)

Significant differences between females and males regarding perceived LS were calculated with the aid of U Mann–Whitney test (W) (Table 14, Annex 6, Table 6.1). The higher values of Mean Median Range associated with females in the last two columns of Table 14, suggest a higher perceived quality of supplied LS from the part of females.

Table 14. Significant differences of the perceptions regarding the quality with which COS provide LS between females and males. U Mann–Whitney nonparametric test (W), P-values and Mean Median Range. Source: Tudorie et al. (2020).

Perceived LS	W	P	Females	Males
Research	51174.0	0.000*	371.8	320.9
Learn	53328.0	0.000*	380.6	327.4
Art	55144.5	0.001*	378.5	332.7
Meeting	59307.5	0.013*	380.0	345.0
Floods	53414.5	0.040*	356.8	327.4
Native species	57189.0	0.042*	368.9	338.7

*significant differences (P<0.05).

6.1.4. Perceived needs

When considering the number of responses to semi-closed questions, an average of five needs was observed. More than 50% of respondents identified natural shade, water, trees, tables, and benches as the main deficiencies related to COS (Figure 20). The five most commonly mentioned needs by respondents can be categorised into environmental needs (such as natural shade, water, and trees, with an average of 62.6%) and functional needs (including tables and benches, and using COS as natural classrooms, with an average of 50.6%) (Figure 20). Based on the profile of university community members, all groups identified between three and four needs, with a high percentage (>50%) (see Annex 6, Table 6.3)

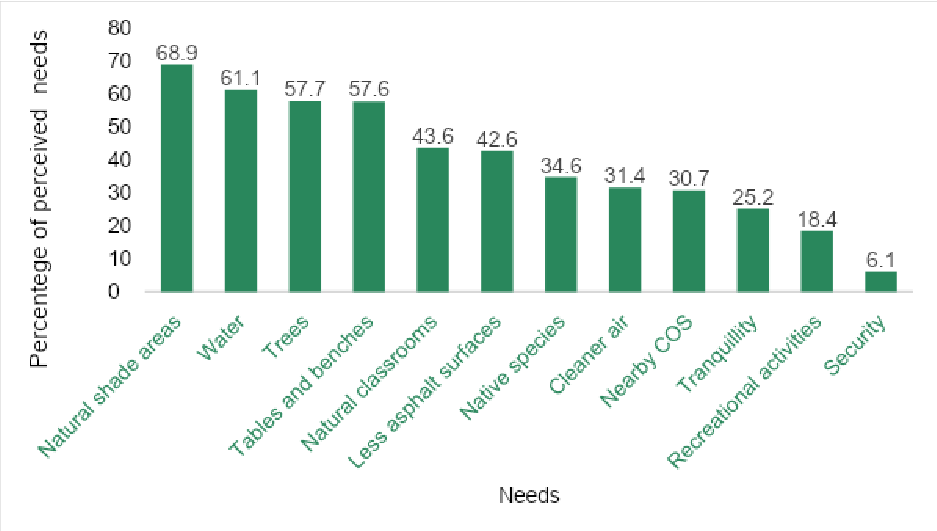


Figure 20. Percentage of perceived needs identified by university community regarding current state and management of COS based on Tudorie et al. (2020)

In terms of socio-demographic characteristics, university community members expressed different priorities. Significant differences were identified between females and males, as well as between users from different branches of knowledge (Table 15). Females expressed a greater desire for an increase in the number of urban facilities compared to males (Mean Median Range: 410.6 (females) and 345.6 (males)). Additionally, females stated a higher need for using COS as natural classrooms compared to males (Mean Median Range: 404.3 (females) and 352.3 (males)). On the other hand, for males, priorities included tranquillity, cleaner air, and more trees (Table 15).

In terms of branch of knowledge, significant differences between users with landscape related disciplines and other disciplines were determined. These are related to the need of introducing more native species on campus and using COS as a learning environment. Respondents with a background in landscape-related disciplines expressed a stronger inclination towards these aspects compared to individuals from other disciplines (Table 15).

Table 15. Significant differences between the needs identified by females and males, and respondents with landscape related (LRD) and other disciplines (OD); U Mann–Whitney nonparametric test (W), P-values and Mean Median Range. Source: Tudorie et al. (2020).

NEEDS	W	P	FEMALES	MALES
Tables and benches	59.298.0	0.000*	410.6	345.6
Tranquility	81.074.0	0.000*	354.6	404.8
Cleaner air	76.784.0	0.030*	365.6	392.2
Trees	77.455.5	0.022*	363.9	395.0
Natural classrooms	61.748.5	0.000*	404.3	352.3
NEEDS	**W**	**P**	**LRD**	**OD**
Native species	67.045.0	0.034*	406.8	378.1
Natural classrooms	62.889.0	0.000*	420.3	369.3

6.1.5. Opinions and recommendations

In terms of the data obtained from open-ended questions, approximately 63% of respondents provided valid responses regarding their opinions and recommendations concerning the open space. These responses were analysed using the Affinity Diagram method (Castilla et al., 2017), resulting in a total of 409 completed and explanatory answers. These answers were categorised into three main themes: *purpose*, *design,* and *management of open space* (Table 16 and Table 17). Within these categories, a total of 35 specific topics emerged, providing a comprehensive understanding of the respondents' perspectives on open space.

The positive opinions about COS, such as *I like them*; *They are good*; and *They are beautiful* were excluded from the descriptive analysis. Similarly, responses such as *I don't know* and *No time for open space* were also not considered. Furthermore, the analysis did not include ambiguous answers that could not be classified into any of the identified topics. These responses were considered to be too broad and had the potential to encompass a wide range of content. Examples of such broad categories could include:

- *They contribute significantly to the well-being of the students and workers.*
- *They make my day-to-day life more pleasant; I value them very much.*
- *They are essential. They cheer me up.*
- *The open spaces of the UPV are very nice and make you feel comfortable.*

To analyse the frequency of categories and topics, the percentage was calculated from the total number of mentions for each topic (TNM) (Table 16 and Table 17). Generally, the answers were complex and one answer of a respondent could contain various codes for topics. The topics' percentage was also estimated considering the total number of respondents with coded answers (TNCA). One person's answers were coded to fit topics only one time in order to detect those respondents with certain interest for purposes and open space design's topics. To avoid confusions, management is considered only a category where the topics are mingled and not defined.

According to the total number of mentions (900), except management, the diversity of green areas (14%), climate comfort (natural shade, cooling effect) (10%) and basic daily needs (9%) were the most mentioned topics. A percentage of 43% of mentioned elements was related to purpose or open's space functionality (Table 16), 45% of topics were about design (dark green colour frame in Figure 21), and 12% reminded of management issues (light green colour frame in Figure 23).

Opinions and recommendations about the functionality of campus open space

The answers comprise present or possible functions of open space perceived by the community that bring benefits and services, which are desirable to be delivered by the open space. Purpose category comprises 14 topics (purposes or functions) revealed by respondents' perceptions (Figure 21). The biggest percentages of mentions are related to basic daily needs (21%) and cooling effect (22%) (dark green in Figure 21 and Table 16). The importance of open space as campus' image was also very often mentioned (14%).

Regarding supplying basic daily needs, participants recognize this function of open space.

- *They are a wonderful place to rest after a busy day, especially those natural places where there are benches and beautiful views.*
- *More open space is mentioned to be properly furnished to achieve the desired purpose: eat, rest, read or sit.*
- *More spaces to eat, like picnic areas, are needed.*

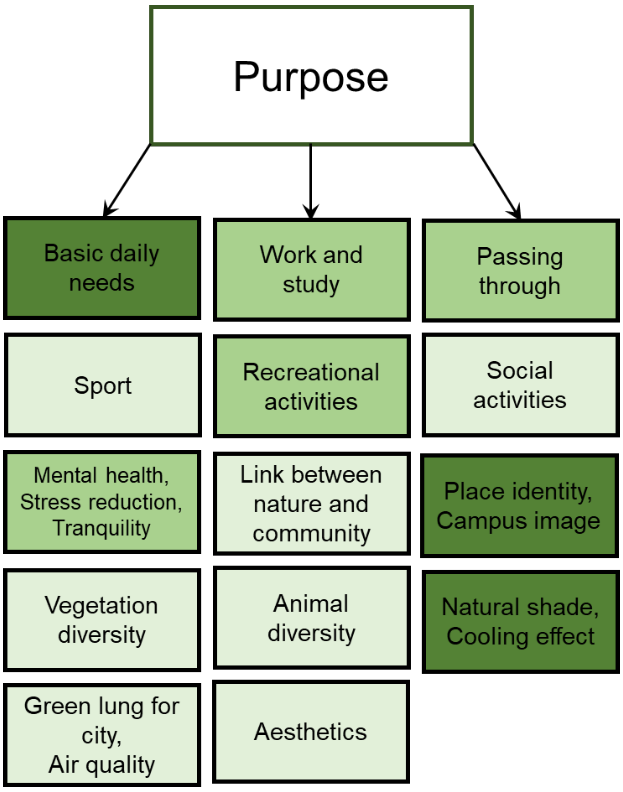


Figure 21. Affinity diagram of perceived COS's functionality (Different shades of green colour indicate the frequency of mentioning topics: darker green for the most mentioned topics and lighter green for the least mentioned topics)

Respondents acknowledged the benefits and functions of open spaces in terms of their cooling effect.

- *They contribute to a better climate.*
- *They bring freshness to campus and help to clear up. Fountains and trees are a good way to regulate the temperature of the environment.*

Respondents identified certain requests regarding the improvement of natural shade.

- *More areas of natural shade. In summer there are almost no shady places for everyone. I would recommend planting more shade trees. A palm tree does not give shade, but an oak or carob tree does.*
- *I prefer more shadows on both sides of the road. Too much pavement, little space for shade, causes discomfort when walking from one centre to another: if there is a lot of sunshine (summer).*

The campus image was associated solely with positive statements.

- *They define the image of the university. It is one of the main assets of the UPV campus.*
- *They give personality to the UPV. It differentiates this university from others and gives it an image of excellence.*
- *Natural spaces, in a certain way, had a great influence when I chose to study at the UPV rather than at other universities.*

Table 16. The main topics and their associated percentage (%) identified among respondents'answers. (%TNCA: % topic from respondents with coded answers; %TNM: % topic from total number of mentions).

PURPOSE (TOPIC)	DESCRIPTION	RECOGNIZE BENEFITS	DEMAND IMPROVEMENTS	% TNCA	% TNM
Basic daily needs	New and properly furnished open space to eat, rest, read and sit and if it is possible under natural shade	X	X	21	9
Work and study	New and properly furnished open space to work or study.		X	7	3
Passing through	Pedestrian circulation in the campus, occasionally under intense sunlight, absence of shade along both sides of the road, absence of unpaved pathways and the dominance of paved areas	X	X	5	2
Recreational Activities	Increase the availability of recreational areas to facilitate a variety of activities and leisure time.	X	X	6	1
Sports	Provide more sport areas to promote physical activity and sport participation.		X	2	3
Mental health, stress reduction, tranquility	Peaceful and relaxing places to escape from the daily routine	X	X	9	4
Social activities	Gathering space. More adequately equipped meeting spaces	X	X	3	1
Place identity, campus image	Element to define the university community. Respondents express their luck to have them, to work in such a green environment and could enjoy them. They do comparations between UPV campus with other campuses in order to highlight their importance for university life.	X		14	6
Link between nature and community	Relationships between community and natural environment	X		1	0
Aesthetics	Indoor and outdoor views	X		1	0
Vegetation diversity	Increase the presence of native vegetation species and remove exotic species to enhance biodiversity and promote the growth of indigenous flora.	X	X	4	2
Animal diversity	Promote the presence of native wildlife by increasing the number of indigenous species and eliminating exotic species to enhance biodiversity. .	X	X	3	1
Air quality, Green lung for city	Good air quality. The importance of campus green infrastructure at neighborhood and city scale	X	X	2	1
Natural shade. Cooling effect	Increased vegetation shade, tree coverage, and temperature reduction to enhance outdoor comfort	X	X	22	10

Opinions and recommendations about the design of campus open space

Many mentions were made to the design aspect of open space (45%) (dark colour frame in Figure 22). This big category is composed of three subcategories, which are: structure (22%), infrastructure and equipment (11%) and vegetation (12%) (Figure 22 and Table 17). Within these subcategories, topics are found. Lack of furniture (56%) and drinking sources/fountains (27%) were some of the most highlighted elements.

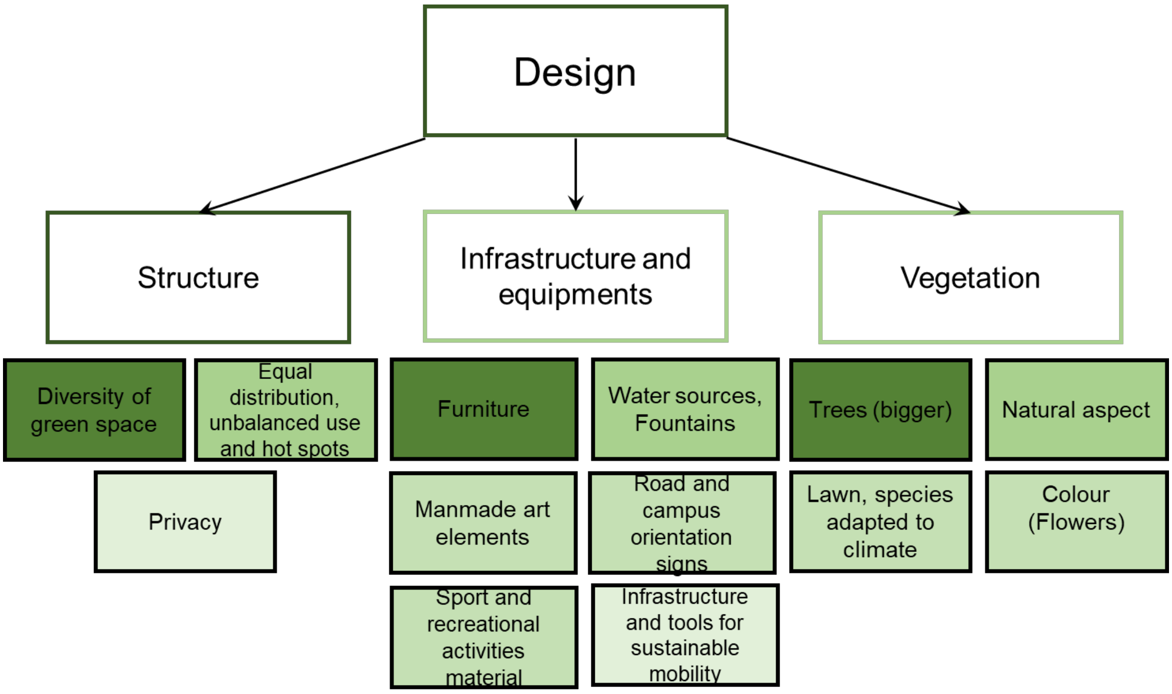


Figure 22. Affinity diagram of perceived COS's design (Different shades of green colour indicate the frequency of mentioning topics: darker green for the most mentioned topics and lighter green for the least mentioned topics)

- *Lack of shaded spaces or benches and tables not linked to cafeterias. More wooden tables are missing in the gardens. More stone or wood seats to sit on would be nice.*
- *The furniture should be improved in quantity, variety and distribution.*
- *More sources of drinking water are needed in the green areas. There could be more fountains around campus for easy drinking.*

Table 17. Percentage of topics related to open space design (%TNCA: % topic from respondents with coded answers; %TNM: % topic from total number of mentions).

DESIGN (SUBCATEGORIES & TOPICS)	DESCRIPTION	RECOGNIZE PRESENCE	DEMAND IMPROVEMENTS	% TNCA	% TNM
	Infrastructure and equipment				
Road and campus orientation signs	Improvements in traffic signalization and enhanced orientation within the campus		X	5	1
Furniture	Lack of urban furniture for satisfying basic daily needs (tables, benches and other sitting features)		X	56	6
Infrastructure and tools for sustainable mobility	Lack of tools and infrastructure for sustainable mobility (bike lanes, bike parking and bike pumps)		X	1	0
Sport and recreational activities material	Lack of sport material (pillars and bars), and game elements (ping-pong tables and chess)		X	4	0
Water sources /Fountains	Lack of drinking water sources		X	27	3
Manmade art Elements	Sculptures and walls for mural paintings	X	X	7	1
	Structure				
Diversity of green areas	Implementation of more green, permeable and extended surfaces, NBS and less paved areas. Blue infrastructure elements. Open space design adapted to local climate conditions	X	X	64	14
Equal distribution, unbalanced use and hot spots	Fair distribution of open areas. The open space's location influences their availability, the proximity to Ágora and their accessibility. An imbalance in the number of users. Examples of open space respondents are complaining about. Difference betweeen green axis, which is considered very beautiful and green, compared to the edges or outskirts, which are perceived poor.	X	X	34	8
Privacy	Lack of private space to develop their activities		X	2	0
	Vegetation (topics)				
Natural aspect	Excessive grey infrastructure and promoting a greener environment. More natural aspect of open space through vegetation to complement the manicured gardens.	X	X	20	2
Trees (bigger)	Implementation of more trees, especially big ones, shade trees and autochtone species.	X		52	6
Lawn, species adapte to climate, autochtones species	Extended ground surface covered with lawn, which supposes waste of water and high costs. Respondents recommend a proper irrigation system and the replacement of lawn with native species that are well-adapted to the Mediterranean climate, requiring less watering.		X	15	2
Colour (Flowers)	Lack of flowers, which have the role to increase the vegetation diversity, to offer color to open space and helps to break the monoton of the lawn landscape.		X	13	2
MANAGEMENT	**DESCRIPTION**	**RECOGNIZE PRESENCE**	**DEMAND IMPROVEMENTS**	**% TNCA**	**% TNM**
Management	Recommendations of maintaining and improving the management of vegetation, of equipment and infrastructure, mobility and traffic issues, sustainable transport, irrigation systems, cleaning, and other management areas.		X	24	12

Respondents mentioned various aspects related to the structure of open space, such as diversity and innovation in design, location, distribution, proximity to Ágora, accessibility, and availability. Privacy was also identified as an attribute that could influence the design of spaces.

- *In general, more aggregated areas are missing, as too many people are concentrating in other lunch areas.*
- *Most of the spaces are completely open to walks, which is intimidating for those who sit and rest.*
-

The need for diversity of green, more permeable and more extended areas, has the biggest percentage (64%). It includes respondents' demand for less paved area and the implementation of green strategies (NBS).

- *Adapting the design to climate change, in terms of mitigation and adaptation, is essential. We should set an example on campus of what a city can be like.*
- *I consider that it still needs to optimise certain areas with respect to the concrete-nature relationship, since sometimes it suffers from excess concrete.*
- *It would be great to start establishing methodologies, such as green roofs, vertical gardens, etc.*
- *Avoid using asphalt or flower pots with an artificial appearance. Expand green areas and increase the number of trees.*

A significant aspect closely related to equal distribution is the presence of hotspots, which are specific locations identified as having deficiencies in terms of their distribution, access, and UGI and tree cover. Only a small portion of responses mentioned the general lack of green and open space.

- *It would be nice to have more trees or vegetation to provide natural shade, as certain parts of the university look "empty".*
- *The gardens are too far away. They are very concentrated.*
- *The number of green areas is very variable depending on the faculty you are in. They are unevenly distributed.*

Within the identified hotspots (34% of mentions), the majority of responses described the current situation of specific places on the campus. These places are presented in order from West to East, corresponding to the sequential development of the campus. It is noteworthy that complaints regarding the lack of green elements were concentrated around the Informatics and Fine Arts faculties.

West side: Inf&CommTechE and Arch&BuildE

- *Space 1 has been covered for many years with pavement without the ability to collect rainwater.*
- *Some areas, especially those close to my work centre (west area), are too paved and would be much more pleasant with grass and trees. It is a space that feels disconnected from the rest of the campus, much greener.*

North side: Art&Hum

- *Remove the asphalt from the semi-circular area of Fine Arts and recover the lawn that existed in the past.*
- *The spaces around the Art&Hum are very bad, without trees and a lot of cement.*

Central-north side: Agrifood&ForestEs

- *Scarce in some areas: between Agronomy and Fine Arts.*
- *There is a lack of shaded areas on the lawns, since practically all the students congregate in those that exist.*
-

Eastside: Polytechnic Research Center (CPI).

- *Green spaces between large new buildings should be increased. Currently large planters are installed, which is only an aesthetic arrangement, but not functional.*
- *In relation to the architecture of the CPI, the open spaces of the UPV are paradisiacal. It would also be more pleasant if the green spaces covered with grass were also planted with trees.*

South side: Inf&CommTechE

- *Scarce in some areas: Telecommunications.*

Central axis: Ágora square; Arch&BuildE; Sport facilities, the path from Nexus to the CPI.

- *The cafeterias around Ágora would be more pleasant if they were in a garden setting.*
- *There are open areas that are largely wasted, such as the terraces on the first floor of Ágora, as there are no shaded or dining areas, becoming only walkways or only can be used on some autumn days to sunbathe.*
- *The campus goes from the Camino de Vera to the Avenida de los Naranjos, that is, it is not only the central axis.*

However, most of the comments regarding the green campus axis were positive.

- *I like the amount of green areas in the central area of the campus.*
- *It is necessary to increase common open spaces that are not only located in the centre of the UPV.*

Some comments are not only directed towards the lack of green elements but also towards the absence of furniture, equipment, and other elements related to the general classification of topics. These comments encompass various aspects such as the availability of furniture, the provision of recreational and sport activities, and various management issues.

- *Some tables there between the CPI and the parking lot in front of 9B would also be ideal for entrepreneurs who work in 9B. I would recommend the incorporation of wooden benches-tables in some of the larger spaces (e.g: 30, 38, 39, and 40).*
- *In the swimming pool area, game elements and greater security would be mainly needed in the pedestrian areas.*
- *In the lawn area of 3G (16) a carob tree rotted due to excessive lawn irrigation. More protection against sun and rain would be needed, especially between areas of buildings, and on long routes such as the route to the Ágora, the Post Office or the Rector's Office.*

Within design-related vegetation topics, tree topic (52%) and natural aspect (20%) were highly mentioned.

- *The fountains and the trees are a good way to give a good appearance, provide clean air and regulate the temperature of the environment.*

However, there were numerous complaints about the implementation of trees and the lack of a more natural aspect in open spaces. Respondents expressed their desire for an increase in vegetation layers and the replacement of asphalt with green areas.

- *There is a general lack of tree density. Isolated gardens need a greater number of larger trees than the current ones.*
- *More natural shade from trees instead of palm trees. Expand the lawn areas and trees.*
- *More types of vegetation are missing, which could add more naturalness.*
- *It would have been nice if the garden wouldn't be to be so perfect so that it would give some feeling that you are not invaded by man space and therefore more natural.*

Opinions and recommendations about the management of campus open space

Along with the identified function and design issues, management issues were also identified (Figure 23). Although there were approximately 100 recommendations and complaints regarding the management of open space, it is worth noting that some members of the university community expressed satisfaction with the current management practices. However, several issues were identified related to vegetation, irrigation, furniture, cleaning, and overall maintenance.

Regarding vegetation, respondents highlighted the need for replacing dead or unhealthy trees, conducting regular pruning actions, and avoiding the use of harmful phytosanitary products. The irrigation system was a point of concern, with participants expressing dissatisfaction with water waste and inadequate protection against floods. Improving the existing furniture and maintaining cleanliness were important concerns raised by the university community. Suggestions included providing more comfortable tables and benches, replacing outdated drinking water sources, protecting sculptures, and installing stronger recycling bins that can withstand windy conditions. Requests were also made for additional recycling bins and ensuring the campus remains clean and tidy.

Some recommendations focused on protecting natural open spaces from encroaching construction, redesigning spaces, and providing appropriate furniture. There were proposals for organising eco-friendly campaigns, creating catalogues of flora and wildlife, establishing an incidence platform, and fostering collaborations between departments to develop green projects. A few respondents also mentioned the dangers posed by fast driving speeds, car accidents, and the lack of management of certain installations within the open space.

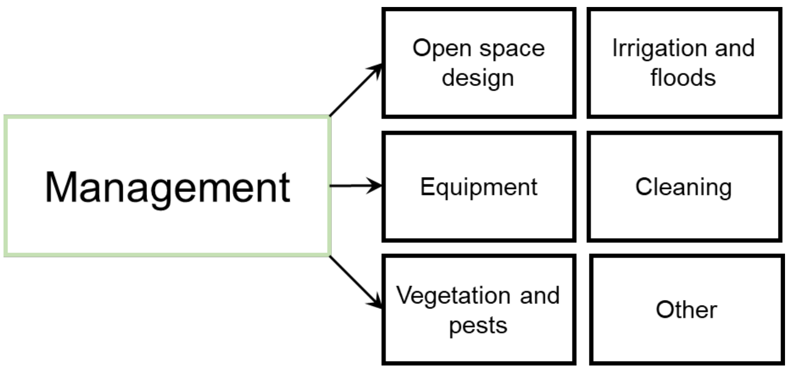


Figure 23. Affinity diagram of management issues of campus landscape

Concerning vegetation:

- *In the last 20 years, the dead trees have not been replaced, and there are multiple holes that have not been replaced. Do not use dangerous phytosanitary products.*

Concerning open space*:*

- *The existing ones must be protected and maintained. They need a better redesign, more care and maintenance.*

Concerning equipment:

- *Furniture needs more care. Fountains (change the old ones). It would be convenient to monitor the condition of the sculptures.*

Concerning floods and irrigation:

- *It would be convenient to supervise the irrigation systems.*

Concerning other issues:

- *Cleanliness is a fundamental aspect. All kinds of recycle bins. Better isolations from the traffic noise of Avenue Tarongers.*

Concerning proposals:

- *A form to make requests or report incidents or queries. Do something similar as a catalogue of birds. I would like to learn gardening. Including libraries for outdoor use.*

6.2. Relationships between respondents' profile, perceived supply of LS and satisfaction with COS

6.2.1. Sample characteristics

This research analysis is based on a sample of 764 members from the university community who provided accurate responses to the specific part of the survey analysed in this study. The sample composition predominantly consists of students, accounting for 61.4% of the participants. Almost 40% of the sample includes Teaching and Research Staff (TRS) and Administrative and Support Staff (AdSS) (Table 18).

Among the student respondents, the majority fall within the age range of 18-30 years, with a higher concentration of younger participants. Additionally, most of the students have spent a maximum of 5 years at UPV. The respondents from the AdSS and TRS categories are generally older, with the TRS group consisting primarily of males who are over 50 years old. The AdSS group, in contrast, comprises mostly females in the age range of 30 to 50 years (Annex 5, Table 5.3).

In terms of age distribution within the survey sample, the largest percentage is found among participants aged 18 to 22 years, accounting for 31.7% of the total. The remaining age groups individually account for approximately 23% of the sample. In terms of gender, respondents are evenly split, with 50% identifying as males, 46.8% as females, and 3.2% choosing not to provide an answer.

Table 18. Survey sample distribution: percentage of respondents according to variable groups (P). Percentage of females (F), males (M), and no answer (N) within each variable subgroup. Landscape-related disciplines (LRD) and rest or other disciplines group (OD).

AGE (YEARS)	P	F	M	N	BRANCH OF KNOWLEDGE	P	F	M	N
<18–22	31.7	50.9	47.0	2.1	Art&Hum (OD)	14.8	72.1	21.6	6.3
>22–30	24.5	57.3	39.9	2.8	Health&FoodSc (LRD)	12.3	53.3	44.6	2.1
>30–50	22.8	52.7	43.1	4.2	Social&LegalSc (OD)	8.3	74.6	23.8	1.6
>50	21.0	38.6	59.5	2.0	Agrifood&ForestEs (LRD)	9.0	50.7	46.3	3.0
					Arch&BuildE (LRD)	13.6	38.8	58.3	2.9
GENDER	**P**				Sc&TechHealthEs (OD)	4.1	77.4	19.4	3.2
Man	50.0	-	-	-	Ind&AeroEs (OD)	19.2	40.7	58.6	0.7
Female	46.8	-	-	-	Inf&CommTechEs (OD)	18.1	30.7	65.7	3.6
No answer	3.2	-	-	-	Other	0.6	66.7	0	33.3
COS FREQUENCY	**P**	**F**	**M**	**N**	**TIME SPENT AT UPV (YEARS)**	**P**	**F**	**M**	**N**
Low users	20.9	44.3	52.5	3.2	≤1	27.5	59.6	38.9	1.5
Medium users	16.5	50	48.4	1.6	2 - 5	26.4	50.0	46.9	3.1
High users	61.6	52	44.4	3.6	6 - 10	9.9	50.7	43.8	5.5
No answer	1.0	50	50	-	>10	36.2	43.6	53	3.4
OCCUPATION	**T**	**F**	**M**	**N**	**COS PREFERENCE**	**T**	**F**	**M**	**N**
Student	61.4	52.8	44.6	2.6	Open space	76.2	55.2	42.2	2.6
AdSS	20.3	59.5	36.6	3.9	Indoor space	7.9	30.0	63.3	6.7
TRS	17.8	28.4	67.9	3.7	Sport space	10.9	41.0	57.8	1.2
Other	0.5	75	0	25	Go home	5.0	23.7	68.4	7.9

When considering the duration of participants' association with UPV, the largest group (36.3%) consists of individuals who have been working or studying at the university for more than ten years, with a majority of them being males. According to users' branches of knowledge, the highest percentage (19%) corresponds to the Industrial and Aeronautical Engineering (Ind&AeroE) discipline, followed by Information and Communications Technologies Engineering (Inf&CommTechE) with 18.1%. Other significant branches include Art and Humanities (Art&Hum) with 14.8%, Health and Food Science (Health&FoodSc) with 12.3%, and Architecture and Civil and Building Engineering (Arch&BuildE) with 13.6% (Table 18).

Regarding the frequency of using the campus landscape, the majority of respondents (61.6%) fall into the category of high users, indicating that they use the campus three, four, or more than four times a week. Furthermore, 76.2% of the participants prefer to spend their free time in open spaces, while 10.9% opt for sport spaces.

6.2.2. Descriptive, Exploratory, and Confirmatory Factor Analyses

Pearson's correlation matrix was employed to identify significant correlations among all items of the Landscape Satisfaction Assessment Scale (LSAS) in order to evaluate the current perceived condition of the COS. Pearson's correlation was performed to select the significant variables for conducting Exploratory and Confirmatory Factor Analyses. The correlation matrix reveals significant positive correlations between 13 items (A1-A13) that assess the variable *Evaluation of the present conditions of COS* (Table 19). However, the last item (A14) related to native species displays a negative correlation that is not statistically significant. These correlations were considered during the model construction process. There are four pairs of variables that exhibit strong correlations (p > 0.60): air quality with temperature and light (A12 & A13), play and sports (A5 & A6), research and learning in the natural environment (A7 & A8), and learning in the natural environment and art creation (A8 & A9).

Table 19. Pearson correlation matrix between items related to LS evaluation.

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14
A1	1	.502**	.432**	.560**	.361**	.362**	.252**	.326**	.368**	.452**	.184**	.447**	.480**	.007
A2		1	.544**	.391**	.425**	.400**	.476**	.406**	.395**	.360**	.225**	.306**	.362**	-.052
A3			1	.422**	.380**	.357**	.387**	.331**	.362**	.425**	.223**	.285**	.356**	-.035
A4				1	.487**	.395**	.245**	.374**	.447**	.494**	.245**	.457**	.488**	.030
A5					1	**.633****	.457**	.394**	.422**	.354**	.254**	.287**	.270**	.025
A6						1	.467**	.401**	.431**	.366**	.217**	.270**	.271**	.011
A7							1	**.618****	.481**	.238**	.368**	.242**	.259**	-.030
A8								1	**.612****	.305**	.396**	.359**	.323**	.010
A9									1	.483**	.296**	.385**	.367**	.012
A10										1	.191**	.437**	.491**	.014
A11											1	.318**	.288**	.023
A12												1	**.660****	.056
A13													1	.051
A14														1

*Note: **Correlation is significant at the 0.01 level (2-tailed); **Bold** numbers indicate strong correlation (p >0.60);*
A1=Pass through; A2=Study/Work; A3=Daily needs; A4=Relax; A5=Play; A6=Sports; A7=Research; A8=Learn natural environmental; A9=Art creation; A10=Gather with friends; A11= Water floods; A12=Air quality; A13=Temperature/light; A14=Native species

Both exploratory and confirmatory factor analyses were conducted. Exploratory Factor Analysis (EFA) was used to assess the scale and determine the latent factors within the conceptual framework, which was developed based on a theoretical construct and consisted of 14 observed items (Table 20). EFA revealed that item A14 had a low correlation with the latent constructs and was subsequently removed from the analysis. The latent factor model (LSAS) (Figure 2) encompasses three latent variables that reflect the university community's perceptions of landscape satisfaction dimensions (Table 20). These latent variables are not directly measured but are estimated within the model using multiple observed variables. The identified dimensions correspond to the different LS categories recognized by the participants, namely provisioning, regulating, and cultural aspects provided by the COS.

The Cronbach's alpha measurements obtained for the three latent constructs (Provisioning LS = 0.740; Cultural LS = 0.844; Regulating LS = 0.670) fall within the range of acceptable values. High KMO values were obtained (> 0.9), which indicate that the factor analysis technique may be appropriate. A null value was obtained for Bartlett's test of sphericity, which supports the use of factor analysis.

The results of EFA using Varimax rotation and a factor loading of 0.40 (Arroyo et al., 2018) as the threshold to maintain items in the factor loading are shown in Table 20.

Table 20. Descriptive, Exploratory, and Confirmatory Factor Analyses. Disaggregated perceptions (percep.) of the whole range of LS and associated item.

		Statistic				EFA	CFA
Variable.	LSAS (Dimensions and items)	Mean	SD	Median	Mode	Factor Loading	STDYX Standardized Loadings (SE.)
	PERCEP. OF PROVISIONING LS						
A1	Pleasant space to pass through	4.11	0.793	4	4	0.686	0.739 (0.028)
A2	Space to study/work	3.44	1.005	3	3	0.380	0.702 (0.027)
A3	Space to meet daily basic needs	3.72	0.869	4	4	0.460	0.683 (0.034)
	PERCEP. OF CULTURAL LS						
A4	Quiet space to relax	4.14	0.835	4	4	0.337	0.701(0.026)
A5	Play areas	3.51	0.979	4	4	0.676	0.596 (0.029)
A6	Space to do sports	3.88	0.948	4	4	0.671	0.602 (0.028)
A7	Space for research	2.96	0.998	3	3	0.821	0.683 (0.032)
A8	Space to learn about natural environment	3.20	1.047	3	3	0.713	0.609 (0.031)
A9	Space for creating art	3.62	0.969	4	4	0.605	0.676 (0.022)
A10	Space to gather with friends	4.29	0.811	4	5	0.703	0.706 (0.029)
	PERCEP. OF REGULATING LS						
A11	Protection against floods	2.72	1.068	3	3	0.728	0.438 (0.038)
A12	Air quality	3.98	0.893	4	4	0.788	0.696 (0.049)
A13	Pleasant temperature and light	4.03	0.892	4	4	0.565	0.739 (0.051)

Note: All CFA factors are statistically significant ($p < 0.01$).
A14 (Native species) did not work and was eliminated from the model

As for CFA, the following goodness of fit indices were obtained: Chi square/degrees of freedom (78) = 3285.339; Comparative Fit Index (CFI) = 0.970; Tucker-Lewis Index (TLI) = 0.970; standardised root mean square residual (SRMR) = 0.039; and root mean square error of approximation (RMSEA) = 0.051. All these indices support the validity of the latent construct. The majority of the coefficients in the factor analysis exceeded 0.60, indicating a strong correlation between the items and the defined latent variables (Figure 24).

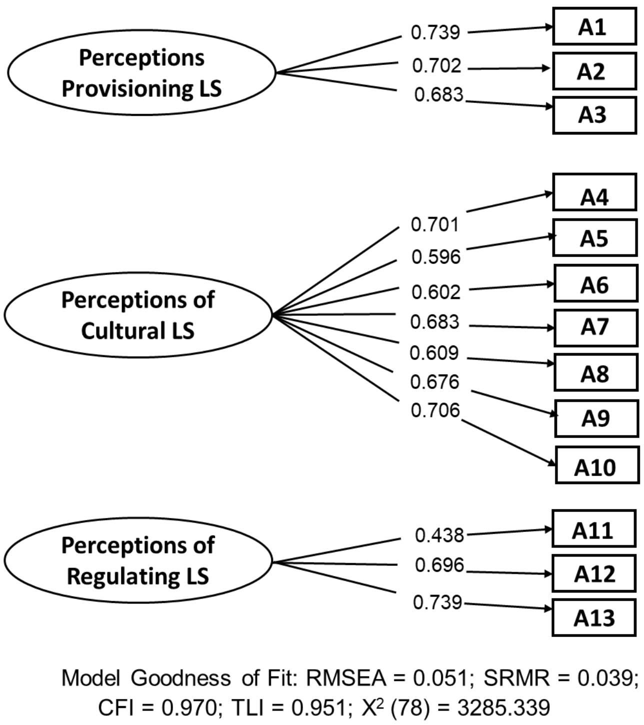


Figure 24. Validated dimensions of the latent construct and the associated items with CFA (A1=Pass through; A2=Study/Work; A3=Daily needs; A4=Relax; A5=Play; A6=Sports; A7=Research; A8=Learn natural environmental; A9=Art creation; A10=Gather with friends; A11= Water floods; A12=Air quality; A13=Temperature/light; A14=Native species)

6.2.3. Characteristics of the university community and perceptions of campus LS

The relationships between perceptions of services and respondents' profiles can be seen in Figure 25. These relationships are based on the values of perceived services associated with different respondent groups (refer to Annex 6, Table 6.1 and Annex 6, Table 6.2).

Significant differences among respondents' groups were analysed for each perceived LS (Table 21). Crosstabs were performed using variables such as age, occupation and time spent in UPV to better understand the profile of respondents (Annex 5, Table 5.3). Age was identified as a determinant factor in understanding the influence of the socio-demographic context on perceptions of LS. Additionally, occupation categories encompass different age classes, except for undergraduate students.

Annex 6, Table 6.4 presents only the significant differences among respondent groups in terms of perceived LS. The median values of Dunn's post hoc comparisons (Wi, Wj) indicate a general pattern (refer to Annex 6, Table 6.4). The first group of respondents tends to have more positive perceptions of LS compared to the second group, except for variables such as COS frequency (high users) and COS preference groups (sport) (bold values in Table 21). Therefore, younger individuals, females, high users of open space, and respondents who prefer to spend their free time in sport and open spaces generally have more positive perceptions of the services.

Table 21. Significant differences between respondents' perception of landscape services according to respondents' characteristics. Kruskal–Wallis nonparametric test (H), P-values and significant pairs of groups.

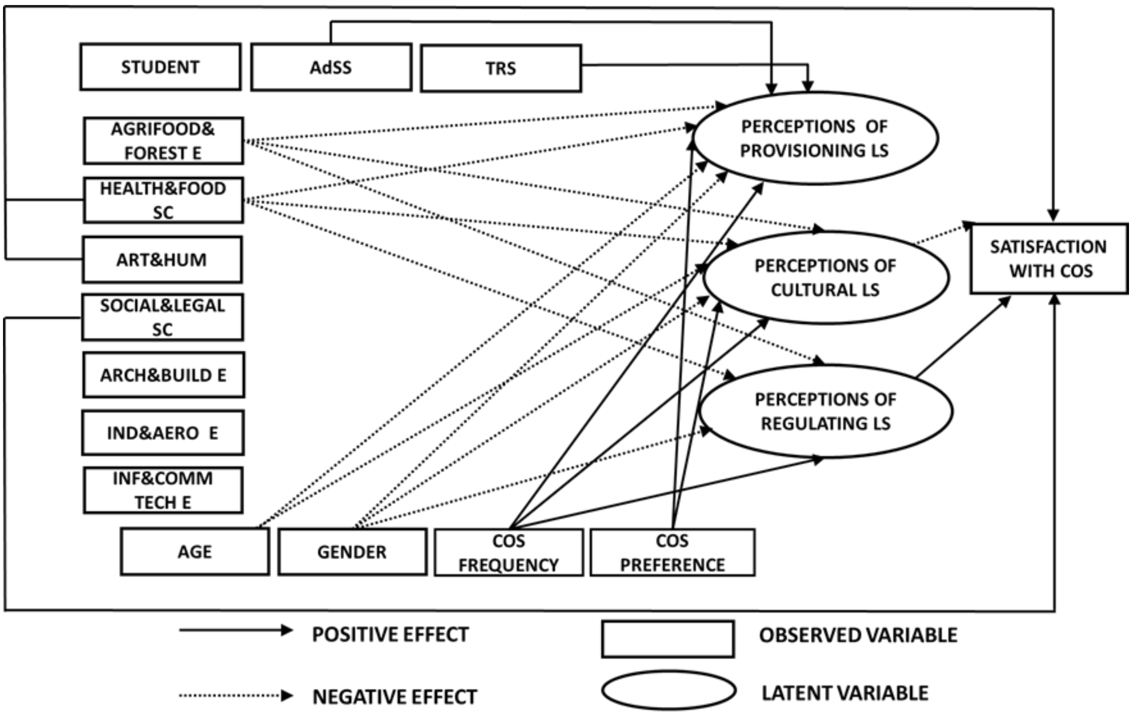
SPACE FOR/ TO PROVIDE	PASS THROUGH	STUDY/WORK	DAILY NEEDS	RELAX	PLAY AREAS	DO SPORTS	RESEARCH	LEARN ABOUT NAT. ENV.	CREATING ART	GATHER	PROTECT.AGAINST FLOODS	AIR QUALITY	PLEASANT T/L	NATIV SP.
AGE														
H		25.351	18.272		21.412	28.689	42.001	14.085	34.753	34.674	27.231		17.785	
P		<0.001*	<0.001*		<0.001*	<0.001*	<0.001*	0.007*	<0.001*	<0.001*	<0.001*		0.001*	
< 18-22 & > 22-30						X								
< 18-22 &> 30-50						X	X		X	X			X	
< 18-22 & > 50		X	X		X	X		X	X	X	X		X	
> 22-30 &> 30-50		X	X				X		X	X	X			
> 22-30 &> 50					X	X	X		X	X	X			
> 30-50 &> 50		X			X									
GENDER														
H	17.783	11.787	26443	16.330	18.899	10.329	14.323	20.985	20.703	23.188			17.546	
P	<0.001*	0.008*	<0.001*	<0.001*	<0.001*	0.016*	0.002*	<0.001*	<0.001*	<0.001*			<0.001*	
Fem & Males	X	X	X	X	X	X	X	X	X	X			X	
Fem &Not Ans	X	X	X	X			X	X	X	X				
Males &Not Ans														
COS FREQUENCY														
H	9.967		16.212	12.565	10.301		16.384	13.407	19.809	8.076			12.120	12.087
P	0.019*		0.001*	0.006*	0.016*		<0.001*	0.004*	<0.001*	0.044*			0.007*	0.007*
Low&Medium							X	X	X					
Low&High			X	X	X		X	X	X	X			X	X
Mdium&High	X												X	
COS PREFERENCE														
H	10.673	21.487	12.905	16.894	17.813	22.749		13.769		23.446		13.885	22.040	
P	0.030	<0.001*	0.012*	0.002*	0.001*	<0.001*		0.008*		<0.001*		0.008*	<0.001*	
Open & Indoor			X											
Open & Sport					X	X								
Open & home		X	X	X		X				X		X	X	
Indoor& Sport		X												
Indoor& home				X	X	X							X	
Sport&home	X	X	X	X	X	X		X		X			X	

6.2.4. Structural Equation Modelling

Based on the conceptual framework and the results of the EFA and CFA, a comprehensive structural equation model (SEM) was estimated to assess the provision of LS by the campus landscape. Figure 25 illustrates the model using SEM graphing conventions, which consist of nodes (representing variables) and edges (representing the connections between variables) (The Comprehensive R Archive Network, 2020). The nodes in the SEM graph consist of observed variables represented by rectangles and latent variables represented by ovals.

The observed variables in the model include demographic and user-related characteristics as well as satisfaction with COS. Additionally, the model incorporates three latent factors representing the dimensions of perceptions of LS: provisioning, cultural, and regulating. The causal path diagram in Figure 25 shows the connections between variables as straight lines with arrowheads indicating the direction of causality.

The goodness-of-fit of the model is supported by the values of indices such as RMSEA (0.036), SRMR (0.032), CFI (0.944), TLI (0.930), and Chi-square (4451.371). All hypothetical causal relationships between the university community's characteristics, satisfaction, and perceptions of the campus landscape in the model were found to be statistically significant ($p < 0.01$).



Model Goodness of Fit: RMSEA = 0.036; SRMR = 0.032; CFI = 0.944; TLI = 0.930; X^2 (315) = 4451.371
** $p < 0.01$

Figure 25. Scheme of the perceptions of campus LS and their satisfaction relationships between the research variable set using SEM

The SEM's scheme presents not only similar relationships between respondents' profile and perceived LS found with the aid of significant differences, but also new relationships (Figure 25). Regarding demographic characteristics, age had a negative effect with the perceptions of benefits. The older one is, the poorer the evaluation of provisioning and cultural LS (Table 21 and Annex 6, Table 6.1). In addition, gender had a negative relationship with the whole range of LS. Females tended to perceive the campus landscape's capacity to provide various types of LS more positively compared to males and others. Occupation (TRS and AdSS) had a positive impact on provisioning LS perceptions, but no significant relationships with cultural or regulating LS. Overall, the respondents related to two knowledge branches, e.g., Health &Food Sc and Agri-food&Forest E, had negative associations with the perceptions of the whole range of LS. As for user-related information, both COS frequency and preference for spending free time in COS were positively associated with LS perceptions.

6.2.5. Characteristics of the university community and satisfaction with COS

The percentage of respondents ‘satisfaction was calculated according to their profile (see Tudorie et al., 2020) and significant differences among respondents' subgroups were performed (last three columns in Annex 6, Table 6.5). Significant differences of respondents' satisfaction were observed according to their occupation, time spent in UPV, gender and frequency. Females, teaching and administration staff, respondents who spent one year or less in UPV, and high users of open space expressed higher satisfaction with the current state and management of COS compared to the other groups. People who spend more time on campus (6-10 years) and get to know it better and generally are more critical than the other groups (Annex 6, Table 6.2) and less satisfied (Annex 6, Table 6.5). Notably, respondents with a longer than 10 year-relationship with UPV campus, displayed a higher satisfaction level, compared to the rest of respondents.

Regarding the relationships between respondents' characteristics and satisfaction, three branches of knowledge (Art&Hum, Health and Food Sc, and Social&Legal Sc) showed positive associations with satisfaction perceptions regarding the present condition of the campus landscape (Figure 25). None of the branches of knowledge related to landscape disciplines, except for Health and Food Sc, exhibited significant associations with satisfaction. No links with satisfaction were detected for the rest of the profile variables.

6.2.6. Perceptions of campus LS and satisfaction with COS

Positive and significant correlations ($p < 0.01$; $p < 0.05$) (bold numbers in Annex 6, Table 6.6) were found between satisfaction and all perceived landscape services, except for the item *Native species*. Among these correlations, ten LS showed strong correlations (> 0.6). Notably, there were significant positive correlations between perceptions of regulating services and respondents' satisfaction with the campus landscape (Figure 25). On the other hand, the evaluation of cultural services by the university community suggested a negative association with their satisfaction with campus outdoor areas. In terms of provisioning LS, there were no significant associations with users' overall satisfaction with the green space.

6.3. Characterization and classification of campus open spaces according to structural characteristics and level of use and preference

6.3.1. Characterization of COS

A total number of 53 COS was analysed (Annex 4, Table 4.1).

Respondents show low *preference* for most of the COS (58% of the total area). Only a small percentage of COS (8%) is assigned to high preference (Table 22). The COS 43 and 39 (Eastern central park) are the best choice (>200 times) (Figure 26 A) (Annex 4, Table 4.1). A percentage of 13% is not mentioned as respondents' favourite.

Unlike for preference, all COS were selected as the most *used* places. Among these, a percentage of 6% represent places highly used, where 25 (Ágora), 43 and 39, collect up to 176 mentions (Figure 26 B and Annex 4, Table 4.1). The majority of COS (62%) are medium used places and a third part are the least used COS (32%) (Table 22).

Regarding *size*, the majority of COS are small spaces (38%), followed by medium spaces (26%). Only 6% are spaces whose area is bigger than 0.7 hectares. From all COS, 43% has more than 50% UGI cover (Table 22) and only 2 areas (COS11 and COS12 southern main entrance park) present more than 90% of green area (Annex 4, Table 4.1). Twenty-five percent of the COS consist of medium UGI cover areas, while 13% of them lack such cover. Regarding tree cover, the biggest percentage of places (around 40%) present poor and medium cover, while in 15% of places there are no trees, and only 4% present tree cover occupying more than 50% of the surface.

Figure 26. Ten most preferred (A) and most used (B) COS by university community members

Table 22. Description of the sample considering preference and use of space and spaces' structural characteristics. SID, Index of structural diversity.

FAVOURITE	COS (%)	USE	COS (%)
Without preference	8	Without use	0
Low preference	58	Low use	32
Medium preference	23	Medium use	62
High preference	11	High use	6
UGI COVER	**COS (%)**	**TREE COVER**	**COS (%)**
Without cover	19	Without cover	15
Poor cover	13	Poor cover	40
Medium cover	25	Medium cover	41
Big cover	43	Rich cover	4
PROXIMITY TO CENTRAL AXIS	**COS (%)**	**PROXIMITY TO ÁGORA**	**COS (%)**
Immediate accessibility	28	Immediate accessibility	6
Reachable in 1-5 min	72	Reachable in 1-5 min	43
Reachable in 10 min	0	Reachable in 10 min	32
Reachable in > 10 min	0	Reachable in > 10 min	19
BIOTIC SID	**COS (%)**	**ABIOTIC SID**	**COS (%)**
No diversity	6	No diversity	51
Poor	41	Poor	45
Medium	34	Medium	0
Rich	19	Rich	4
INFRASTRUCTURE SID	**COS (%)**	**AVERAGE SID**	**COS (%)**
No diversity	0	No diversity	4
Poor	28	Poor	53
Medium	70	Medium	40
Rich	2	Rich	4
AREA COS	**COS %**	**PLACEMENT**	**COS (%)**
Very small	11	Adjacent to build.	66
Small	38	Between build.	15
Medium	26	Central	19
Big	19		
Very big	6		

About *proximity to the central axis*, all COS are located within a 300 metre-buffer, a percentage of 72% is reachable in 1-5 minutes and the rest of COS present immediate accessibility (Figure 27). The furthest COS is the terrace of “Bellas Artes” restaurant (COS 19), which is at 246 m distance (Annex 4, Table 4.1).

Regarding *proximity to Ágora*, a third of COS is placed within a 300 metre-buffer and 80% of COS are located at 500 m distance from Ágora (Figure 28). Among these, the majority of places are reachable in 1-5 and 10 minutes and around 20% of COS are located further than 500 m distance from Ágora

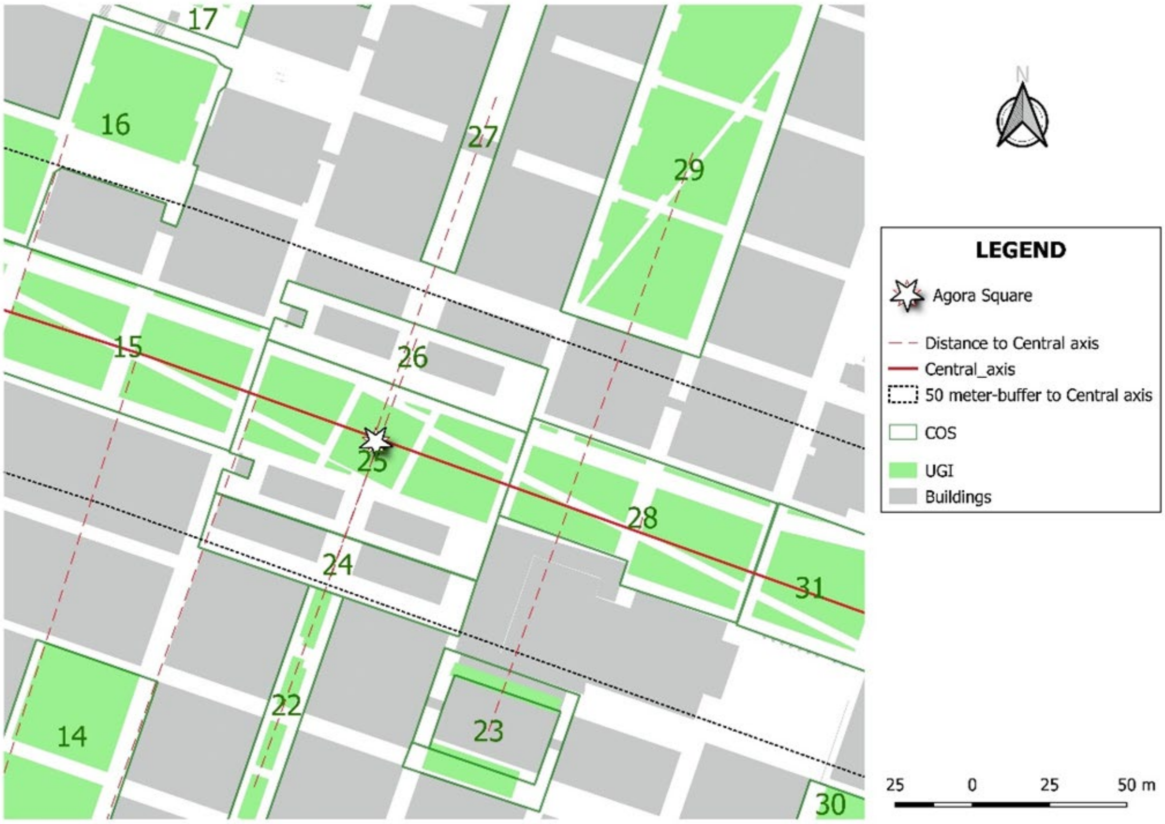


Figure 27. Examples of COS located within a 50 metre-buffer to the central axis (Ágora square and the open spaces which compose the green central axis e.g., COS 15, 25, 28, 31)

Regarding COS's *structural diversity*, more than 30% of open spaces present a medium-poor diversity in biotic elements, while 19 % are spaces with high biotic diversity (Table 22). In terms of abiotic diversity, around half of spaces have poor diversity or lack in abiotic features while a very little percentage (4%) shows high abiotic diversity. As for the infrastructure elements, 70% of places are characterised by medium diversity. Thus, the biggest part (>40%) of COS, are places with poor and medium average diversity. The Annex 4, Table 4.2 informs about COS's values of structural diversity.

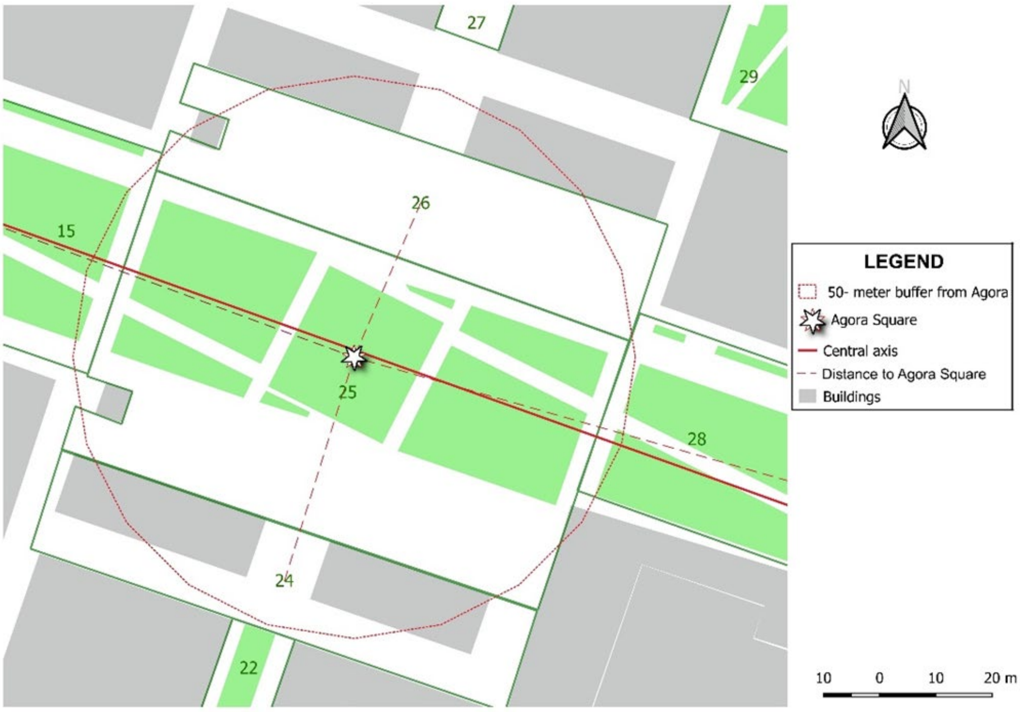


Figure 28. Ágora square (25) example of COS which provides immediate proximity to Ágora

Natural (biotic and abiotic) and material (infrastructure) elements are presented in more than half of COS. These sites are appropriately lighted, present extended lawn surface, with isolated trees or rows of trees, and include sitting features and bins (Table 23).

Over one-third of the COS surface is intersected by 1 to 3 paths, particularly in the areas that form the central green axis from west to east. These areas are also adorned with art elements or equipped with secure bicycle attachment devices. As for the remaining COS, nearly 20% of the surface is furnished, such as restaurant terraces, adorned with groups of trees, or decorated with natural hedges. Less than 10% of outdoor areas include hedges, flower pots and flowerbeds. Only one place, COS 12 (southern main entrance park), is equipped with an artificial pond, and very few are crossed by bike lanes, contain drinking fountains or present different terrain topography (mounds).

Table 23. Percentage (%) of presence of COS's attributes found in COS.

OTHER ATTRIBUTES	% PRESENCE	COS
Lighting (of main paths)	73.4	0; 6; 8-19; 21-25; 27-29; 30a; 31-50; 52
Lawn intensive (open access)	65.6	3; 5-7a; 7c; 9-16; 19; 23; 25; 28-34; 36-41; 44-46a; 47-50; 52
Sitting features: benches, stairs	62.5	0; 2a; 2c; 3a; 5; 6a; 7a; 9; 11; 12; 14-18; 21; 22; 23a; 24; 25; 27-30a; 31-34; 37-40; 42-45; 49-51
Bins	59.4	0; 2a; 5; 6a; 8-12; 14-19; 21; 22; 24-29; 31; 33; 35-40; 42-45; 47; 51
Isolated trees (big/old)	57.8	1; 2; 3a, 7-14; 16-18; 21; 24; 25; 28; 29; 30; 31; 34; 37-40; 43; 45; 46; 49
Row of trees/tree-lined path	56.3	0; 3b; 5; 6; 10-13; 15-17; 22-29; 30b; 31-33; 35-41; 43; 44; 48a
Crossing paths	37.5	9; 10; 13-15; 22; 24-29; 31-33; 37-40; 42-45; 50
Bicycle parking rack	35.9	0; 3b; 6a; 8; 14; 15; 17; 19; 21; 24; 26; 27; 29; 30b; 32; 33; 35; 37; 40; 42; 44; 45; 47
Art elements	31.3	3a; 6a; 9-15; 23; 28; 29; 30a; 31; 38; 39; 43; 46a; 50
Shrub	29.7	3b; 6b; 9-15; 17; 18; 21; 22; 38; 39; 41; 43; 45; 49
Tables, chairs	20.3	1; 4; 8; 9; 17; 19; 20; 26; 35; 36; 40; 43; 47
Group of trees	18.8	3b; 5; 6a; 9; 10; 12; 14; 29; 38; 39; 42; 43
Hedge (trimmed or untrimmed)	15.6	9-13; 22; 37-39; 49
Flowerbed and flowerpots	7.8	5; 17; 18; 30a; 49
Drinking fountains	6.3	10; 12; 16; 43
Mounds/slope	4.7	11; 39; 43
Bike lanes	4.7	37; 45; 47
Water basin or fountains	1.6	12

6.3.2. Classification of campus open space typologies

The classification of COS was useful to assess respondents'preferences for specific places (COS map in Figure 7).

After submitting all continuous variables to normality test (The Kolmogorov-Smirnov Goodness of Fit Test (K-S test)), five variables were used as inputs for Cluster analysis, which are the following: proximity to Ágora, proximity to central axis, UGI cover, average of Index of structural diversity (SID) and tree cover. Placement and UGI elements are the categorical variables. Following an initial clustering analysis, the variable of tree cover was removed from the model due to its minimal contribution to the clustering process (10%) and lack of statistical significance ($p > 0.005$) (Table 24). A follow-up analysis was performed and left out the tree cover variable. Three clusters were identified: C1 represents 45.3%, C2 is 35.8% and the smallest, C3 is 18.9%. The cohesion is 0.4 and the size ratio shows 2.40 (<3). Regarding the proximity to Ágora and proximity to central axis, the first two clusters have similar centroid mean values for Ágora (370 m) and the central axis (100 m), but different from C3, which includes COS that are in close proximity to Ágora with an average distance of 215.4 metres, as well as sites that are situated very near the central axis with an average distance of 16 metres (Figure 29). In terms of Urban Green Infrastructure (UGI) cover and structural diversity, clusters C2 and C3 exhibit higher mean values for UGI cover (>50%) and structural diversity (approximately 0.4) compared to cluster C1. In cluster C1, UGI cover is less than 20%, and the structural diversity is 0.2.

According to the two-step analysis, Placement is the most influential factor contributing 100%, followed by UGI elements with 90% and UGI cover with 80% (Figure 30). Proximity to Ágora was excluded from the analysis due to its insignificant contribution (<10%).

Table 24. Independent Samples Test.

LEVENE'S TEST FOR EQ. VAR			T-TEST FOR EQ. OF MEANS						
STRUCTURE CHARACTER.	F	SIG.	T	DF	SIG. (2-TAILED)	MEAN DIF	STD. ERROR DIF	95% CONFIDENCE INTERVAL OF THE DIFFER	
								Lower	Upper
Proximity to Ágora	.30	.58	2.73	51.00	**.01**	156.36	57.27	41.38	271.34
			2.84	50.18	**.01**	156.36	55.15	45.59	267.12
Proximity to central axis	1.12	.29	2.73	51.00	**.01**	46.20	16.91	12.25	80.16
			2.70	43.67	**.01**	46.20	17.09	11.76	80.65
UGI cover	3.04	.09	-4.08	51.00	**.00**	-31.11	7.62	-46.41	-15.81
			-4.26	50.49	**.00**	-31.11	7.31	-45.78	-16.44
Tree cover	3.96	.05	-1.69	51.00	.10	-7.05	4.18	-15.43	1.33
			-1.80	50.93	.08	-7.05	3.92	-14.91	.82
Average SID	.07	.79	-7.74	51.00	**.00**	-.24	.03	-.31	-.18
			-7.79	46.28	**.00**	-.24	.03	-.31	-.18

Bold is used to highlight statistical significance ($p < 0.05$)

Small variations were observed in the percentages of UGI elements among the different clusters. (Table 25). Cluster C1 predominantly comprises paved areas, with a significant presence of street trees (80%) and a green verge (44%). Atriums and playgrounds in this cluster are typically located adjacent to buildings. Cluster C2 includes a smaller portion of areas with a green verge (7%) and paved surfaces with street trees (20%). Balcony green and parks are also present in this cluster, which is primarily situated in the central area of the campus. Cluster C3 is predominantly composed of areas located between buildings (56%) and includes street greens, yards, and gardens. Considering the current composition regarding UGI element and the current placement the following three names are proposed for the three clusters: C1 Green tints in grey zones; C2 Core greenway and C3 Neighbouring green.

The complete list of COS with associated Placement and UGI elements can be consulted in Annex 4, Table 4.3.

Table 25. Final classification of open space considering structural and green parameters.

		C1 %	C2 %	C3%
UGI elements	Asphalt	100	0	0
	Asphalt with street trees	80	20	0
	Atrium	100	0	0
	Balcony green	0	100	0
	Garden	0	0	100
	Green verge	93	7	0
	Medium linear park	0	100	0
	School playground	100	0	0
	Street green	0	0	100
	Yard	0	0	100
Placement	Adjacent build.	44	0	56
	Central	0	100	0
	Between build.	100	0	0

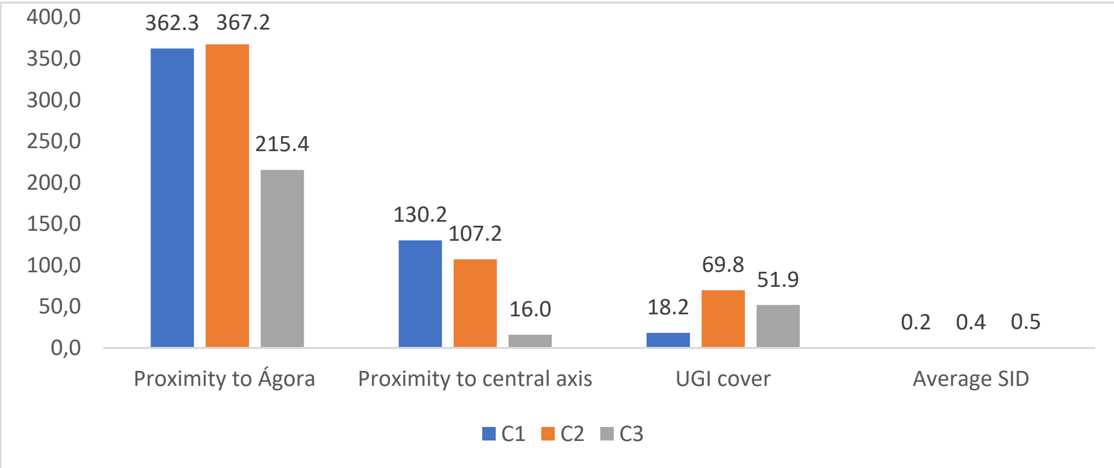


Figure 29. Mean values of structural characteristics for three clusters of open spac

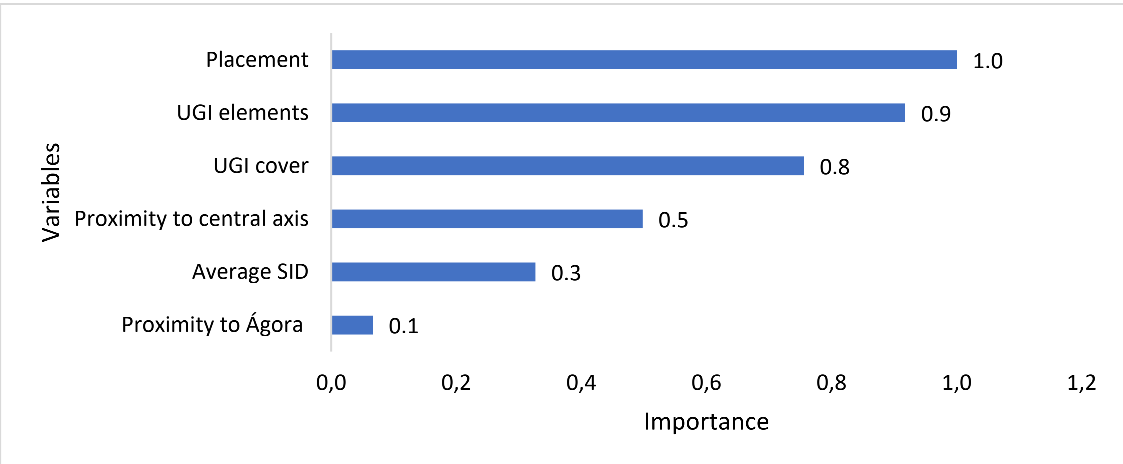


Figure 30. Level of importance of variables to participate at clustering process

After identifying the three clusters, an ANOVA was conducted with a post hoc analysis to determine if significant differences exist between the groups and to identify which groups exhibit these differences. The factor selected for the ANOVA was Placement, while the dependent variables were proximity to the central axis, UGI cover, and average structural diversity (as shown in Table 26)

The independent samples t-test and ANOVA have the assumption of homogeneity of variance, which means all the comparison groups present the same variance. The independent samples t-test and ANOVA utilise the t and F statistics, which are generally robust to violations of the assumption as long as group sizes are equal. In our case, the groups have different sizes (N), such as 10, 34 and 9. The lower and upper values of 95% confidence interval are provided.

Table 26. Independent Samples Test developed using three structural parameters with Placement selected as ANOVA factor.

		N	Mean	Std. dev.	Std. error	95% Confidence Inter. of mean		Min	Max
						Lower	Upper		
Proximity to central axis	Central	10	16.02	13.399	4.237	6.43	25.60	-	35
	Adjacent build.	34	121.59	55.823	9.574	102.12	141.07	23	246
	Between build.	9	114.04	53.162	17.721	73.17	154.90	1	190
	Total	53	100.39	64.332	8.837	82.66	118.12	-	246
UGI Cover	Central	10	51.90	25.362	8.020	33.76	70.04	0	79
	Adjacent build.	34	46.41	33.219	5.697	34.82	58.00	0	99
	Between build.	9	20.67	18.330	6.110	6.58	34.76	0	43
	Total	53	43.08	31.185	4.284	34.48	51.67	0	99
Average SID	Central	10	.4890	.10898	.03446	.4110	.5670	.33	.67
	Adjacent build.	34	.2962	.16809	.02883	.2375	.3548	.04	.61
	Between build.	9	.3100	.10416	.03472	.2299	.3901	.18	.51
	Total	53	.3349	.16526	.02270	.2894	.3805	.04	.67

The Levene test is significant for UGI cover, which means there are significant differences between proximity to central axis's groups ($p<=0.05$) (Table 27). The average SID is not significant, so there is homogeneity ($p>0.05$). There was a statistically significant difference between groups as demonstrated by one-way ANOVA (Table 28). The *F* test for proximity to the central axis is 17.34 and reaches significance with a p-value of 0.00 (less than 0.05 alpha level). Similar results present UGI cover ($F=3.16$; $p=0.05$) and average SID ($F=6.53$; $p=0.00$), meaning there is a statistically significant difference between the means of the different levels of these variables.

The robust tests of equality of means, Welch and Brown-Forsythe (Roth, 1983), show similar results as ANOVA analysis. Therefore, proximity to the central axis, UGI cover, average SID are still reliable variables (p <=0.05) (Table 29).

Table 27. Test of homogeneity of variances.

	Levene Statistic	df1	df2	Sig.
Proximity to central axis	4.44	2	50	0.170
UGI cover	3.84	2	50	0.028
Average SID	2.73	2	50	0.075

Table 28. ANOVA analysis.

		Sum of squares	Df	Mean square	F	Sig.
Proximity to central axis	Between groups	88146.49	2.00	44073.24	17.34	0.00
	Within groups	127060.06	50.00	2541.20		
	Total	215206.55	52.00			
UGI Cover	Between groups	5676.56	2.00	2838.28	3.16	0.05
	Within groups	44893.14	50.00	897.86		
	Total	50569.70	52.00			
Average SID	Between groups	0.29	2.00	0.15	6.53	0.00
	Within groups	1.13	50.00	0.02		
	Total	1.42	52.00			

Table 29. Robust tests of equality of means.

		Statistica	df1	df2	Sig.
Proximity to central axis	Welch	58.69	2.00	19.05	0.00
	Brown-Forsythe	24.42	2.00	17.88	0.00
UGI cover	Welch	6.41	2.00	20.63	0.01
	Brown-Forsythe	4.74	2.00	32.00	0.02
Average SID	Welch	10.15	2.00	20.66	0.00
	Brown-Forsythe	10.22	2.00	35.13	0.00

a. Asymptotically F distributed

Table 30. Comparison multiples using a post hoc analysis.

DEPEND VARIABLE				MEAN DIFF (I-J)	STD. ERROR	SIG.	95% CONFIDENCE INTERVAL	
							LOWER BOUND	UPPER BOUND
Proximity to central axis	HSD Tukey	Central	Adjacent build.	-105.574*	18.135	.000	-149.38	-61.77
			Between build.	-98.020*	23.162	.000	-153.97	-42.07
		Adjacent build.	Central	105.574*	18.135	.000	61.77	149.38
			Between build.	7.554	18.897	.916	-38.09	53.20
	Games-Howell	Central	Adjacent build.	-105.574*	10.469	**.000**	-131.02	-80.12
			Between build.	-98.020*	18.220	**.001**	-148.98	-47.06
		Adjacent build.	Central	105.574*	10.469	**.000**	80.12	131.02
			Between build.	7.554	20.141	.926	-45.59	60.70
UGI cover	HSD Tukey	Central	Adjacent build.	5.488	10.779	.867	-20.55	31.52
			Between build.	31.233	13.768	.070	-2.02	64.49
		Adjacent build.	Central	-5.488	10.779	.867	-31.52	20.55
			Between build.	25.745	11.233	.066	-1.39	52.88
	Games-Howell	Central	Adjacent build.	5.488	9.838	.844	-19.50	30.47
			Between build.	31.233*	10.082	**.018**	5.27	57.20
		Adjacent build.	Central	-5.488	9.838	.844	-30.47	19.50
			Between build.	25.745*	8.354	**.014**	4.86	46.63
Average SID	HSD Tukey	Central	Adjacent build.	.19282*	.05399	**.002**	.0624	.3232
			Between build.	.17900*	.06895	**.033**	.0124	.3456
		Adjacent build.	Central	-.19282*	.05399	.002	-.3232	-.0624
			Between build.	-.01382	.05626	.967	-.1497	.1221
	Games-Howell	Central	Adjacent build.	.19282*	.04493	.001	.0803	.3054
			Between build.	.17900*	.04892	.005	.0534	.3046
		Adjacent build.	Central	-.19282*	.04493	.001	-.3054	-.0803
			Between build.	-.01382	.04513	.950	-.1278	.1001

Bold is used to indicate significant differences (P<0.05)

In the case of proximity to the central axis and UGI cover, the assumption of equal variances (as tested by Levene's test) was violated. Due to the homogeneity of variances between groups, Games-Howell *post hoc* test was used (Table 30). In the opposite case, where there is no homogeneity of variances, which is the case of Average SID, Tukey *post hoc* test was used.

From the point of view of proximity to the central axis, the open spaces located in the central axis are different from the spaces located between buildings (p=0.001), and also differ from the adjacent to buildings spaces (p=0.000) (Table 30). Concerning their placement, it seems the adjacent buildings and between buildings spaces are similar (p=0.926). Significant differences were observed for the average SID (Structural Diversity Index) between the central space and the space adjacent to buildings (p=0.02), as well as between the central space and the space between buildings (p=0.033). These differences indicate variations in biotic, abiotic, and infrastructure elements among these two pairs of spaces. However, no significant differences in structural diversity were discovered between the space adjacent to buildings and the space between buildings (p=0.967), suggesting similar elements in terms of structural diversity (Table 30).

In terms of UGI cover, there is no statistically significant difference (p=0.844) between the spaces adjacent to buildings and the central spaces, indicating similar UGI cover. However, there is a significant difference (p=0.018) in UGI cover between the central spaces and the spaces between buildings (Table 30). Additionally, significant differences were observed between the adjacent to building spaces and the between building spaces (p=0.014), indicating that these two types of spaces have different UGI cover.

To sum up, the landscape of UPV campus includes three different typologies of open spaces based on the parameters type (Table 31).

Table 31. Characterization of campus open space. Percentage of COS (%) according to structural characteristics used in identifying open space typologies.

STRUCT. CHARACT.	CENTRAL	ADJACENT TO BUILDING	BETWEEN BUILDINGS
UGI COVER	**COS %**	**COS %**	**COS %**
Without cover	10	17	38
Poor cover	10	14	12
Medium cover	10	23	50
Rich cover	70	46	0
PROXIMITY TO CENTRAL AXIS	**COS %**	**COS %**	**COS %**
Immediate accessibility	100	11	13
Reachable in 1-5 min	0	89	88
Reachable in 10 min	0	0	0
Reachable in > 10 min	0	0	0
AV SID	**COS %**	**COS %**	**COS %**
No diversity	0	6	0
Poor	10	63	62
Medium	70	31	38
Rich	20	0	0

According to Placement, central spaces are located 100% in the green central axis, while 88% are located adjacent to buildings or between buildings spaces (89%), as are reachable in 1-5 minutes. Regarding the average structural diversity, central places have medium (70%) and rich (20%) average structural diversity (Table 31). This means that central COS includes a good diversity of biotic, abiotic and infrastructure elements, while spaces located adjacent to buildings/between buildings present a poorer structural average diversity (62%-63% of poor average structural diversity and 31-38% of medium one). As for UGI cover, central spaces are dominated (around 70%) by a rich UGI cover, similar to spaces located adjacent to buildings (46%). At the same time, the second ones present also a poorer percentage of medium UGI cover (23%) when comparing with spaces between buildings (50%), but richer cover than central space (10%). Among the spaces between buildings, approximately 38% do not have UGI cover, while in the central space, only around 10% lacks of UGI cover.

6.4. Relationships between structural characteristics, use and preference

To examine the relationships between the use and preference for an open space to spend free time and factors that could help predict space preference and use, hierarchical linear regressions were conducted. The analyses conducted are associated with Hypotheses 2 and 3 within the conceptual framework model (Figure 3). The steps of the hierarchical linear regression analyses are provided in detail in Annex 8.

6.4.1. Predictors of COS use

A hierarchical linear regression was conducted to predict the use of COS. Prior to the regression analysis, a Pearson correlation analysis was performed, and variables that did not show significant relationships were removed (Table 32). The remaining variables that showed significant relationships include: placement, tree and shrub species richness, proximity to Ágora, proximity to central axis, COS area, shrubs, row of trees, mounds, paths, drinking fountain, art elements, bins, biotic features, abiotic site conditions, infrastructure elements, and average SID.

A multiple linear regression analysis was conducted using the variables that showed significant correlations at the 0.01 and 0.05 levels (Table 33). Variables that were not significant or violated the multicollinearity assumption were eliminated from the analysis. The final model revealed that placement (specifically the dummy variable placement (central)), area COS, and proximity to Ágora were significant predictors of COS use. The coefficients of these variables were statistically significant ($p < 0.05$), the tolerance values were above the acceptable threshold (>0.4), and the VIF values indicated no multicollinearity (close to 1) (Table 33).

Table 32. Pearson correlation values (p) between use of space and structural characteristics of COS.

STRUCTURAL CHARACTERISTICS	USE	STRUCTURAL CHARACTERISTICS	USE
Use	1	Infrastructure elements	**0.313***
Abiotic site conditions	**0.526****	Mounds	**0.480****
Area COS	**0.530****	Lawn intensive	0.131
Art elements	**0.277***	Lighting	0.180
Average SID	**0.486****	Placement	**- 0.545***
Benches	0.197	Paths	**0.365****
Bicycle parking rack	- 0.120	Proximity to Ágora	**- 0.344***
Bikelanes	- 0.086	Row of trees	**0.370****
Bins	**0.326***	Shrub	**0.400****
Biotic features	**0.358****	Solitary trees (big/old)	0.172
Proximity to central axis	**- 0.480****	Tables	- 0.013
Drinking fountains	**0.279***	Tree cover	0.187
Flower	- 0.165	Tree species richness	**0.640****
Fountains	0.044	UGI cover	0.216
Group of trees	0.201	UGI elements	0.005
Hedge	0.114		

**The correlation is significant at 0.01 level (bilateral). *The correlation is significant at 0.05 level (bilateral).

Table 33. Regression model including regression coefficients (coeff) (unstandardized coefficient = unstd. and standardised=std.), significance (sig.) and collinearity statistics by considering a confidence Interval of 95%.

MODEL	UNSTD. COEFF		STAND. COEFF	T	SIG.	95% CONFIDENCE INTERVAL FOR B		COLLINEARITY STATISTICS	
	B	SE	B			LOWER BOUND	UPPER BOUND	TOLERANCE	VIF
(Constant)	19.649	6.786		2.896	0.006	6.013	33.285		
Area COS	0.004	0.001	.361	3.775	0.000	.002	0.006	0.857	1.167
Placement (Central)	45.673	8.968	.505	5.093	0.000	27.652	63.694	0.795	1.257
Proximity to Ágora	-0.036	0.015	-.221	-2.378	0.021	-.067	-0.006	0.907	1.103

Student residuals, Cook's distance, and Mahalanobis's distance were used to identify outliers in the data. The Cook's distance indicates no outliers (min 0 and max. 0.6). However, COS 25 and 43 were identified as outliers based on the Student residual and Mahalanobis's distance indices (Table 34).

A Hierarchical Linear Regression was performed with *use* as the dependent variable and *Placement* (central), *area cos* and *proximity to Ágora* as independent variables. The variables were entered in the order they appear in Table 35. The three variables were able to predict around 59% of the variance of use. Model 1, which included only the variable *Placement* (*central*), explained nearly 48% of the variance. As *area COS* and *proximity to Ágora* were added in subsequent models, the adjusted R2 increased to 59% in the final model (Model 3) (Table 36).

Table 34. Residual statistics used to identify outliers.

	MIN	MAX	MEAN	STD. DEVIATION	N
Cook's Distance	0.000	0.644	.032	0.099	53
Mahal Distance	0.267	28.012	2.943	4.297	53
Stud. Residual	-2.240	4.333	-0.005	1.027	53

Dependent variable: Use

Table 35. Summary of multiple regression analysis for prediction of use of space. Pearson correlation coefficient (R), coefficient of determination (R2) and standard error (S.E.).

MODEL	R	R^2	ADJUSTED R^2	S. E.
1	0.692	0.479	0.469	26.039
2	0.757	0.573	0.555	23.815
3	0.785	0.617	0.593	22.778

Dependent variable: Use

Model 1 = Predictors: (Constant), Placement (Central)

Model 2 = Predictors: (Constant), Placement (Central), Area COS

Model 3 = Predictors: (Constant), Placement (Central), Area COS, Proximity to Ágora

The ANOVA results showed three statistically significant models ($p < 0.01$). The third model, which included all three independent variables, significantly improved the prediction of the dependent variable ($F = 26.288$, $p < 0.01$) compared to the previous models (Table 36).

The multicollinearity requirement is satisfied as indicated by the VIF (variance inflation factor) values, which are close to 1 and smaller than 5 (Table 37). Additionally, the tolerance values are close to 1 in all cases. The variable with the lowest collinearity statistics is proximity to the central axis, with VIF and tolerance values of 1. However, since the inclusion of all three independent variables improves the R-square value, the final model (Model 3) was selected (Table 37). The t-scores indicate that all three independent variables significantly contribute ($p < 0.05$) to the prediction model, demonstrating a signifycant relationship between the independent variables and the use of space.

Table 36. ANOVA analysis.

MODEL	ANOVA	SUM SQUARE	DF	MEAN SQUARE	F	SIG.
1	Regression	31763.011	1	31763.011	46.846	0.000
	Residual	34579.291	51	678.025		
	Total	66342.302	52			
2	Regression	37983.484	2	18991.742	33.485	0.000
	Residual	28358.818	50	567.176		
	Total	66342.302	52			
3	Regression	40918.550	3	13639.517	26.288	0.000
	Residual	25423.752	49	518.852		
	Total	66342.302	52			

Dependent variable: Use

Model 1 = Predictors: (Constant), Placement (Central)

Model 2 = Predictors: (Constant), Placement (Central), Area COS

Model 3 = Predictors: (Constant), Placement (Central), Area COS, Proximity to Ágora

Table 37. Regression coefficients (coeff) (unstandardized coefficient = unstandar. and standardised=stand.), significance and collinearity statistics by considering a confidence Interval of 95%.

M	VARIABLES	UNSTANDAR-COEFF.		STANDAR-COEFF.	T	SIG.	COLLINEARITY	
		B	SE	B			TOLER.	VIF
1	(Constant)	16.930	3.971		4.264	0.000		
	Placement (Central)	62.570	9.142	0.692	6.844	0.000	1.000	1.000
2	(Constant)	7.421	4.630		1.603	0.115		
	Placement (Central)	52.138	8.935	0.577	5.835	0.000	0.876	1.142
	Area COS	0.004	0.001	0.327	3.312	0.002	0.876	1.142
3	(Constant)	19.649	6.786		2.896	0.006		
	Placement (Central)	45.673	8.968	0.505	5.093	0.000	0.795	1.257
	Area COS	0.004	0.001	0.361	3.775	0.000	0.857	1.167
	Proximity to Ágora	-0.036	0.015	-0.221	-2.378	0.021	0.907	1.103

Dependent variable: Use

The unstandardized beta coefficients (B) provide information on the magnitude of the influence of the independent variables on the dependent variable. *Placement (central)* and *area COS* have positive B values. A one standard deviation increase in *Placement* (*central*) is associated with a 45.673 standard deviation increase in use. A one standard deviation increase in area COS only results in a very small increase in *use* (0.004), when compared to *Placement* (*central*). This implies that larger and more centrally located spaces are associated with higher use. In the case of proximity to Ágora, there is a negative influence, indicating that an increase of proximity to Ágora with one std. dev., will increase use of space by -0.36 std. dev. This suggests that spaces closer to Ágora square have higher use scores. All of these increases are statistically significant ($p < 0.01$) according to the p-values provided in Table 37.

6.4.2. Predictors of COS preference

To identify the variables that are most suitable for the regression model predicting COS preference, Pearson correlation analyses were performed. In this analysis, almost all variables related to the structural characteristics were tested as independent variables to predict the preference for COS (dependent variable) (Table 38). The independent variables that did not show a linear relationship with the dependent variable were removed from further analysis.

Table 38. Pearson correlation values between favourite COS and structural characteristics of COS.

STRUCTURAL CHARACTERISTICS	FAV	STRUCTURAL CHARACTERISTICS	FAV
Fav	1	Infrastructure elements	**0.376****
Abiotic site conditions	**0.652****	Mounds	**0.822****
Area COS	**0.726****	Lawn intensive	0.081
Art elements	**0.449****	Lighting	0.199
Average SID	**0.621****	Placement	**- 0.489****
Benches	0.240	Paths	**0.298***
Bicycle parking rack	- 0.238	Proximity to Ágora	- 0.154
Bikelanes	- 0.084	Row of trees	**0.344***
Bins	**0.291***	Shrub	**0.442****
Biotic features	**0.488****	Solitary trees (big/old)	**0.289***
Proximity to central axis	**- 0.344***	Tables	- 0.014
Drinking fountains	**0.476****	Tree cover	**0.307***
Flower	- 0.136	Tree species richness	**0.784****
Fountains	0.225	UGI cover	**0.411****
Group of trees	**0.431****	UGI elements	- 0.003
Hedge	**0.309***		

* * The correlation is significant at 0.01 level (bilateral). *The correlation is significant at 0.05 level (bilateral).

The unreliable variables or variables with non-significant coefficients ($p > 0.05$) and violating the multicollinearity assumption were excluded from the analysis. Ultimately, the significant predictors for COS preference were identified as Placement (central), area of COS, mounds, drinking fountains, and tree species richness (Table 39).

Table 39. Regression coefficients (coeff) (unstandardized coefficient = unstd. and standardised=std.), significance and collinearity statistics by considering a confidence Interval of 95%.

Model	Unstand coeff		Stand-coeff	t	Sig.	95% Confidence Interval for B		Collinearity	
	B	SE	B			Lower	Upper	Tolerance	VIF
(Constant)	15.379	14.129		1.088	0.285	-13.401	44.159		
Abiotic site cond.	74.840	329.866	0.258	0.227	0.822	-597.074	746.754	0.001	768.295
Area COS	0.006	.002	0.356	3.559	0.001	0.003	0.010	0.168	5.963
Art el.	-0.006	9.294	0.000	-0.001	0.999	-18.938	18.926	0.255	3.926
Average SID	455.123	910.32	1.356	0.500	.0621	-1399.15	2309.39	0.000	4388.38
Bins	11.068	11.464	0.093	0.966	0.342	-12.283	34.420	0.183	5.474
Biotic features	-128.849	297.78	-0.565	-0.433	.0668	-735.419	477.720	0.001	1017.47
Proximity to central axis	-0.026	0.055	-0.030	-0.479	.635	-0.138	0.085	0.417	2.398
Drinking	12.186	13.116	0.059	0.929	0.360	-14.530	38.901	0.422	2.372
UGI Cover	-0.036	0.135	-0.021	-0.270	0.789	-0.311	0.238	0.292	3.430
Group of trees	6.073	9.739	0.045	0.624	0.537	-13.765	25.911	0.324	3.083
Mounds	49.607	24.275	0.209	2.044	0.049	0.160	99.055	0.161	6.219
Infrastructure el.	-201.655	309.10	-0.625	-0.652	0.519	-831.281	427.970	0.002	547.222
Placement (Central)	41.683	10.145	0.297	4.109	0.000	21.018	62.347	0.321	3.114
Paths	-86.894	21.842	-0.787	-3.978	0.000	-131.384	-42.403	0.043	23.362
Proximity to Ágora	-0.020	0.016	-0.080	-1.270	0.213	-0.053	0.012	0.421	2.376
Row of trees	-6.312	9.699	-0.056	-0.651	0.520	-26.068	13.444	0.225	4.448
Shrub	-6.337	8.191	-0.058	-0.774	0.445	-23.021	10.346	0.303	3.304
Solitary trees	-5.772	9.763	-0.051	-0.591	0.559	-25.658	14.114	0.222	4.506
Tree cover	-0.067	0.220	-0.018	-0.304	0.763	-0.516	0.382	0.457	2.189
Tree sp. Richness	3.570	2.518	0.116	1.418	0.166	-1.559	8.699	0.249	4.024

The Student residual analysis identified two cases, COS 25 (Ágora) and 12 (middle of western park), as outliers based on their maximum values exceeding 3 (Table 40). The Cook's distance analysis did not indicate any outliers. However, the Mahalanobis's distance analysis identified COS 43, 39, and 11 as outliers.

Table 40. Residual statistics used to identify outliers.

	MIN	MAX	MEAN	STD. DEVIATION	N
Cook's Distance	0.000	0.875	0.046	0.134	53
Mahal Distance	0.397	32.515	4.906	6.619	53
Stud. Residual	2.425	3.622	0.008	1.056	53

Dependent variable: Fav

A Hierarchical Linear Regression was performed using *favourite* as dependent variable and *Placement* (central), *area of COS*, *tree species richness*, *mounds* and *drinking fountains* as independent variables. All these five variables were introduced in the software in the order they appear in Table 41. The five variables were able to predict about 89% of the variance of preference. In the prediction model for the preference of COS, Model 1 indicates that Placement (central) accounts for 30% of the variance (R2) in preference for COS (fav). By adding the second independent variable, COS area, the variance explained (R2) increases to 62% in Model 2. In the third regression model, 86% of the variance in preference is explained, and after introducing two additional variables (mounds and drinking fountains), R2 reaches 0.895. This means that the five independent variables in Table 41 are capable of explaining almost 90% of the variance in preference.

Table 41. Summary of regression model to predict preference of space.

MODEL	R	R^2	ADJUSTED R^2	STANDARD ERROR (S.E)
1	0.567	0.322	0.309	46.111
2	0.799	0.638	0.624	34.020
3	0.814	0.662	0.641	33.208
4	0.936	0.875	0.865	20.374
5	0.951	0.905	0.895	17.963

Dependent variable: Fav

Model 1 = Predictors: (Constant), Placement (Central)

Model 2 = Predictors: (Constant), Placement (Central), Area COS

Model 3 = Predictors: (Constant), Placement (Central), Area COS, Tree species richness

Model 4 = Predictors: (Constant), Placement (Central), Area COS, Tree species richness, Mounds

Model 5 = Predictors: (Constant), Placement (Central), Area COS, Tree species richness, Mounds, Drinking fountains

The ANOVA results show that all three models are statistically significant (p<0.01), and the fifth model indicates a significant improvement in predicting the dependent variable (F=89.718, p<0.01) (Table 42).

Table 42. ANOVA Analysis.

MODEL	ANOVA	SUM SQUARE	DF	MEAN SQUARE	F	SIG.
1	Regression	51478.697	1	51478.697	24.212	0.000
	Residual	108436.586	51	2126.208		
	Total	159915.283	52			
2	Regression	102046.611	2	51023.305	44.085	0.000
	Residual	57868.672	50	1157.373		
	Total	159915.283	52			
3	Regression	105880.760	3	35293.587	32.005	0.000
	Residual	54034.523	49	1102.745		
	Total	159915.283	52			
4	Regression	139990.488	4	34997.622	84.311	0.000
	Residual	19924.795	48	415.100		
	Total	159915.283	52			
5	Regression	144749.451	5	28949.890	89.718	0.000
	Residual	15165.832	47	322.677		
	Total	159915.283	52			

Dependent variable: Fav

Model 1 = Predictors: (Constant), Placement (Central)

Model 2 = Predictors: (Constant), Placement (Central), Area COS

Model 3 = Predictors: (Constant), Placement (Central), Area COS, Tree species richness

Model 4 = Predictors: (Constant), Placement (Central), Area COS, Tree species richness, Mounds

Model 5 = Predictors: (Constant), Placement (Central), Area COS, Tree species richness, Mounds, Drinking fountains

The VIF (variance inflation factor) values indicate that there is no multicollinearity issue, as the values are close to 1 (Table 43). Additionally, the tolerance values are close to 1 in all cases. The best scenario is observed for Placement (central), where both collinearity statistics are 1. Due to the improved R-squared value with the inclusion of all five independent variables, the final model (model 5) was selected (Table 43). The t-scores confirm that the independent variables make a significant contribution ($p<0.05$) to the prediction model, indicating a significant relationship between all five independent variables and the preference for a space.

Positive changes were observed in the relationship between all five variables and preference for a space. The standardised beta coefficients indicate the magnitude of influence of the independent variables on the dependent variable. Holding the effect of *mounds* constant, an increase of one standard deviation in mounds is associated with a significant increase in the *preference* score by 133.734 standard deviations, which is the highest among all variables. This is followed by *drinking fountains* (42.822) and *placement* (*central*) (38.465). *Tree species richness* has a positive influence on preference, with an increase of 3.592 standard deviations for every one standard deviation increase in tree species richness. The smallest increase in preference was observed for the *area COS* (B=0.003). The positive values of the beta coefficients indicate that *tree species richness* significantly influences the *preference for COS*, suggesting that an increase in the number.

Table 43. Regression coefficients (coeff) for preference for a space and principal structural variables.

M	Variables	Unstandardized coeff		Standardized coeff	t	Sig.	Collinearity	
		B	SE	B			Tolerance	VIF
1	(Constant)	13.744	7.032		1.955	0.056		
	Placement (Central)	79.656	16.188	0.567	4.921	0.000	1.000	1.000
2	(Constant)	-13.370	6.614		-2.022	0.049		
	Placement (Central)	49.914	12.763	0.356	3.911	0.000	0.876	1.142
	Area COS	0.010	0.002	0.601	6.610	0.000	0.876	1.142
3	(Constant)	-21.694	7.849		-2.764	0.008		
	Placement (Central)	40.581	13.426	0.289	3.023	0.004	0.754	1.326
	Area COS	0.010	0.002	0.557	6.077	0.000	0.819	1.221
	Tree species richness	5.510	2.955	0.180	1.865	0.068	0.742	1.348
4	(Constant)	-11.832	4.937		-2.397	0.020		
	Placement (Central)	31.130	8.303	0.222	3.749	0.000	0.742	1.347
	Area COS	0.005	0.001	0.261	4.019	0.000	0.613	1.631
	Tree species richness	5.713	1.813	0.186	3.151	0.003	0.742	1.348
	Mounds	133.978	14.780	0.564	9.065	0.000	0.671	1.489
5	(Constant)	-7.057	4.527		-1.559	0.126		
	Placement (Central)	38.465	7.566	0.274	5.084	0.000	0.695	1.439
	Area COS	0.003	0.001	0.177	2.887	0.006	0.535	1.869
	Tree species richness	3.592	1.691	0.117	2.123	0.039	0.663	1.509
	Mounds	133.734	13.031	0.563	10.263	0.000	0.671	1.489
	Drinking fountains	42.822	11.151	0.206	3.840	0.000	0.702	1.425

of tree species leads to a higher preference score. The increase in preference associated with area COS is relatively small. All these variable increases are statistically significant ($p<0.05$) according to the p-values (Table 43). For the complete list of COS with data on tree species richness, presence of mounds, and drinking fountains, please refer to Annex 4, Table 4.3.

6.5. The impact of perceived factors influencing the preference for campus open space. Description of COS considering activities and LS-related reasons.

The university community members selected 49 COS of 53 as their favourite (Annex 7, Table 7.1). Two maps were created to illustrate the frequency of activities carried out in the most preferred COS and the perceived performance of COS in relation to LS-related reasons (Figure 31 and Figure 32). In both cases, more overlapping circles of different colours are observed more in central areas, in the green central axis and in the adjacent buildings-gardens, rather than COS that are peripherally located.

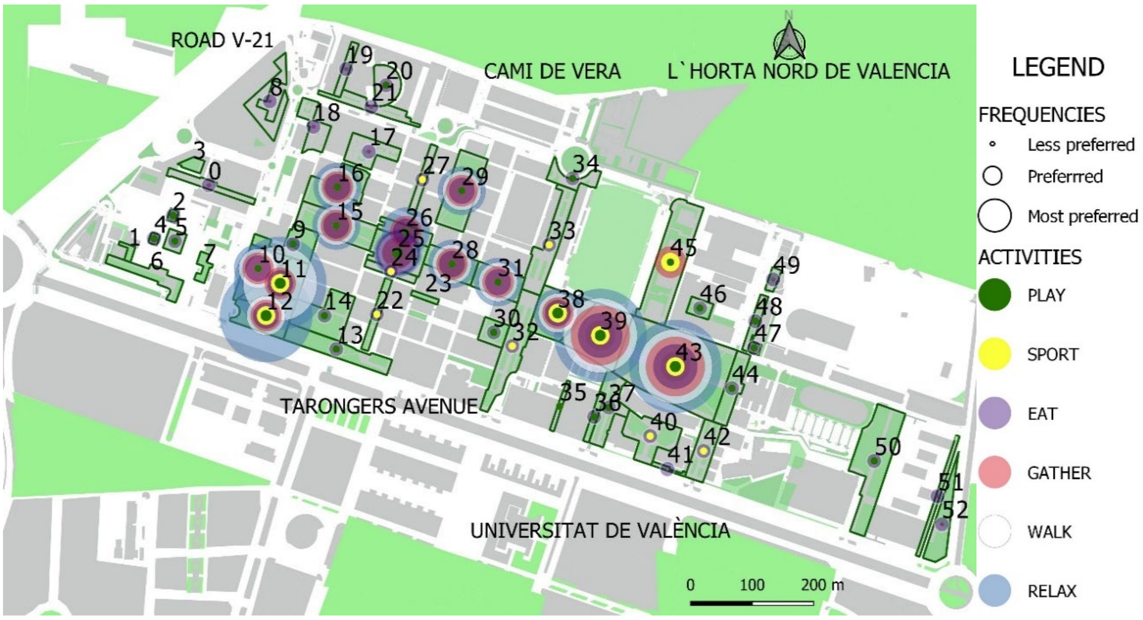


Figure 31. Map of carried-out activities in favourite COS

The preferred spaces, which have a medium perceived performance, primarily consist of restaurant terraces, gardens, and passing through areas. These spaces were highly valued for their ability to provide a wide range of benefits and services, including large gardens and parks. In fact, people tend to evaluate similar places according to activities and LS-related reasons (Table 10). For example, places with big preference are sites with a good perceived performance, like 39 (Central park)) and 43 (Eastern central park).

The COS identified as the best settings for conducting all the proposed activities, as indicated in Figure 31 and Annex 7, Table 7.1, are also perceived to have a good performance, as shown in Figure 32. These spaces have received a significant number of positive evaluations for all LS-related reasons, as outlined in Annex 7, Table 7.3. Among these spaces, COS 11 (southern main entrance park) and 12 (central main entrance park) emerged as the next favourite choices, with slight variations in their specific attributes.

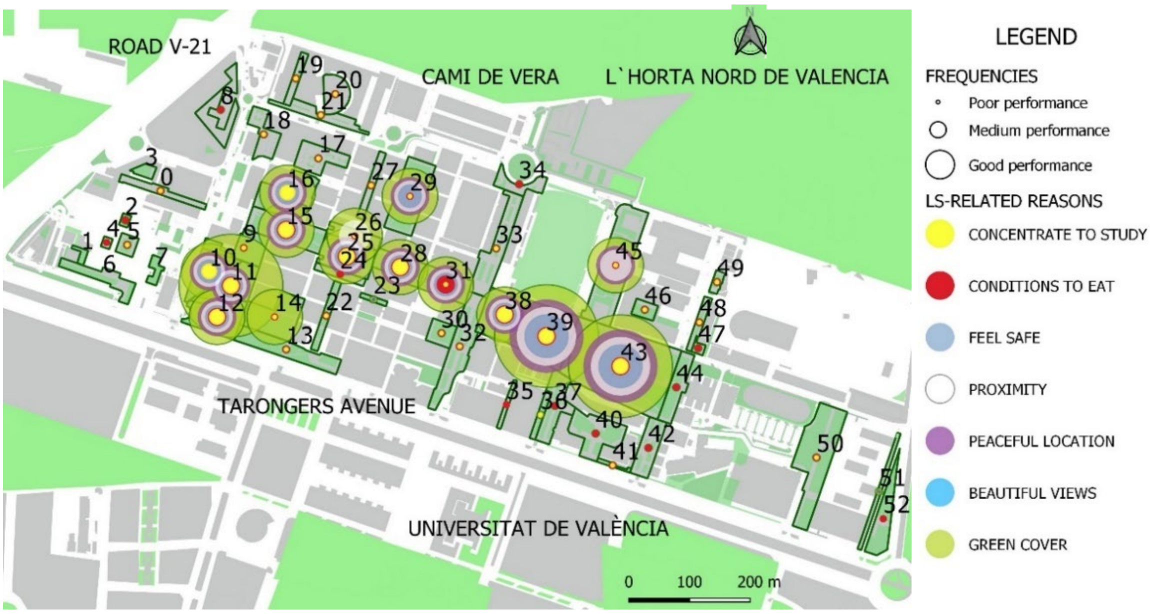


Figure 32. Map of COS's performance regarding perceived LS-related reasons

For example, COS 28 was highlighted for its good conditions for eating, Ágora was preferred for gathering with friends, and COS 15 was recognized as a suitable research setting.

The majority of COS areas are generally perceived as more functional in terms of activities and LS-related reasons.

The preferred COS are commonly used for activities such as relaxation (20.6%), walking (18.5%), eating (17.5%), and gathering with friends and colleagues (16.6%) (Table 44). In terms of LS-related reasons for their choice, respondents prefer these COS mainly due to their green cover and natural appearance (10%), favourable climatic conditions such as clean air (10.1%) and natural shade (9.5%), as well as their proximity to various points of interest such as restaurants, libraries, shops, etc. (8.4%) (Table 45).

The campus outdoor areas were selected as favourites for engaging in an average of 7 activities and were positively evaluated for an average of 13 LS-related reasons. It is important to note that the frequency of respondents' preference for specific COS influences the frequency of activities. Therefore, an analysis was conducted at the specific COS level to identify spaces that are specialised for certain activities. The dominant activity associated with each COS's perceived main function is presented in Annex 7, Table 7.2, highlighted in black. Some of the strongly preferred COS for a single dominant activity include:

Table 44. Percentage (%) of activities developed in favourite COS.

ACTIVITIES	%
Relax	**20.6**
Walk	**18.5**
Eat	**17.5**
Gather	**16.6**
Work	9.5
Play	4.7
Paint	4.7
Sports	4.3
Learn	2.5
Research	1.2

Table 45. Percentage (%) of reasons related to selected favourite COS.

LS-RELATED REASONS	%
Green cover	**10.5**
Clean air	**10.1**
Natural aspect	**9.9**
Beautiful views	**9.7**
Natural shade	**9.5**
Interest points	**8.4**
Quiet location	8.3
Feel safe	7.5
More species	5.4
Condition eat	4.8
Sunny area	4.5
Conc. Work	3.6
Perm. Space	3.6
Space sports	3.4
Research setting	0.9

- COS 13 (O Entrance (Garden) which is UPV principal pedestrian gate area), 31 (Student House green area) and 32 (Santiago Grisolia Av (S.S. Av) or UPV sport pedestrian area) for *walking*;

- COS 16, 17, 25, 26, 29, 30, and 47 (Agro and industrial gardens, Agro atrium, Ágora square and restaurants 'terraces) for *eating*;
- COS 10, 11, 12, 28, 38 (Garden in the Architecture Faculty area and Library and Pool parks) for *relaxing*;
- COS 45 (Administración y dirección de empresas (Garden) next to the stadium) for *doing sports*.

There are some cases, indicated in blue colour in Annex 7, Table 7.4, where sites were perceived as a favourite setting to develop more activities, like: COS 2 (school yard) for eating, walking, gathering with friends, working and relaxing. Other examples of outdoor spaces perceived as multifunctional are: COS 5 (Building school green yard) for relaxing, meeting friends and because it was perceived as an inspirational place to create art; COS 15 (Rectorate building front green walk) for walking and relaxing and COS 36 (restaurant terraces next to principal UPV gate) for walking, relaxing and meeting friends.

It is noteworthy that no space was appreciated for providing opportunities to learn about environmental issues or for conducting research. This observation highlights a significant lack of knowledge among the UPV population regarding the arboretum and the lack of organisation of species based on vegetation groups or communities. It suggests the need for updating the cataloguing of species in the UPV COS to enhance awareness and educational opportunities related to environmental issues and research within the campus outdoor areas.

As for the COS 's dominant LS-related reasons, the *restaurant's terraces* (4, 19, 26, 47) and *popular spots* (*Ágora square, 25*) were well evaluated for their proximity to points of the interest (POIs). No respondent chose any COS specifically for providing a researching setting. Generally, COS were appreciated for their *quiet location*, for *clean air*, *beautiful views*, *green cov*er, *natural aspect* and *natural shade* (Table 45). Other COS were strongly selected as favourites because they provide enough space to do sports (35), *offer good conditions to work* (41), *provide sunny exposition* (40), and because they contain extended *permeable areas* (50), etc. However, there are also examples of COS appreciated for singular reasons, like: COS 0 and COS 46-48 for *proximity to interest points*; COS 12, 28, 34 for *green cover*; COS 49 for *beautiful views*, and so on (black numbers, Annex 7, Table 7.4).

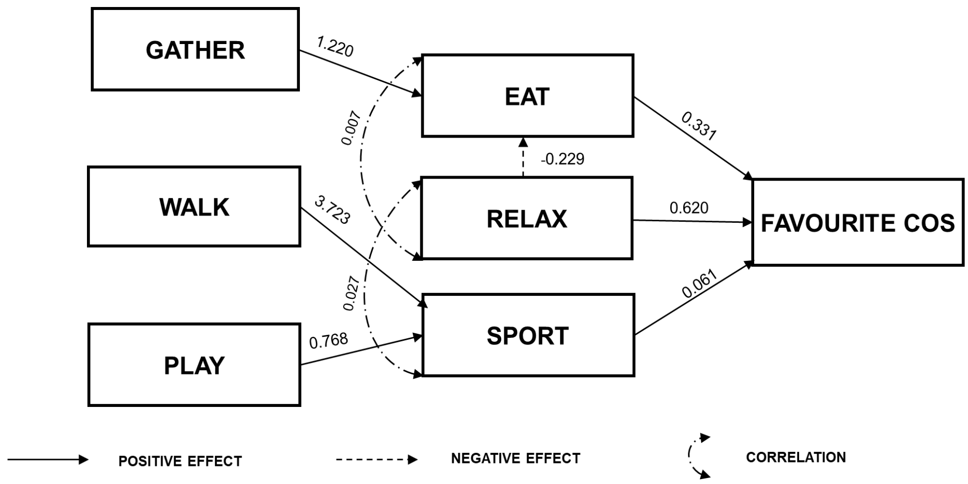
6.6. Relationships between preference and the factors influencing the preference

The preference of university community members for particular COS seems to be influenced by multifunctionality of open space and UGI. To explore the potential synergies among UGI functions and confirm the effects of influencing factors such as activities and LS-related reasons on preference for certain COS, path analysis was employed.

6.6.1. Activities

The analyses conducted are associated with Hypothesis 4 within the conceptual framework model (Figure 3).

The research path analysis model (Figure 33) aims to explore the mediated or indirect effects of activities on the *preference for COS*. In this model, the exogenous variables *gather*, *walk*, and *play* influence the endogenous variable *favourite COS* through their impact on the intermediary endogenous variables *eat*, *relax* and *sport*. All the hypothetical effects between the activities developed in COS and university community's preference for COS, were found to be statistically significant (p<0.01) (Figure 33). After eliminating the variables which were not statistically significant, the final path analysis model contains the three predictor variables: *gather*, *walk* and *play*.



Model Goodness of Fit: RMSEA = 0.0287; SRMR = 0.003; CFI = 0.969; TLI = 0.907; X^2 (15) = 661.206 **p < 0.01

Figure 33. Scheme of the activities influencing the COS preference

Among the *activities, relax* is the most influencing activity in the community's choice (0.620) followed by *eat* (0.331) and in a lesser extent by *sport* (0.061). The presence of a space for gathering and meeting friends or colleagues indirectly influences respondents' preference through intermediary endogenous variables such as *eat* and *sport*. Unlike the activity *eat*, which has a single direct effect from the exogenous variable (*gather*), the variable *sport* has two exogenous influencing variables (*walk* and *play*). *Relax* does not have any predictive variables and directly affects the preference for COS.

The Path analysis model presents cases of covariance between variables. There is one case where an intermediary variable influences another intermediary variable, specifically, *relax* has a negative effect on *eat* (-0.229) (Figure 33).

The goodness of fit indices supports the validity of the path analysis model related to activities (Figure 33). Some of the coefficients exceed 0.60, indicating a good fit of the model to the data.

6.6.2. Landscape services-related reasons

The analyses conducted are associated with Hypothesis 5 within the conceptual framework model (Figure 3).

The research path analysis model of the effect of *LS-related reasons* influencing the *preference for COS* is shown in Figure 34. All the hypothesised effects between the LS-related reasons and the university community's preference for COS in the model were found to be statistically significant ($p<0.01$) (Figure 34). After eliminating the variables which were not statistically significant, the path analysis model contains four predictor variables, such as *beautiful views*, *green cover*, *feel safe* and *concentrate to study*. In this model, similar to the previous one shown in Figure 33, the influence of LS-related reasons on the preference for COS is mediated through three intermediary variables: *good conditions to eat*, *peaceful location*, and *proximity*.

In the path analysis model (Figure 34), the LS-related reasons have different levels of influence on the community's preference for COS. The reason that most strongly influences preference is a *peaceful location* (0.522), followed by *proximity to interest points* (0.334), and *good conditions to eat* (0.154).

Good conditions to eat and *peaceful location* are at the same time intermediary endogenous variables. They mediate the relationship between the LS-related reasons (*beautiful views*, *green cover*, *safety* and a place to *concentrate to study*) and the *preference for COS*. *Proximity to the interest points* has no predictor, but explains space *preference*. Places with *beautiful views* and *tree cover* are considered good places to eat. A *peaceful location*, along with *green cover*, is seen as a place where university community members can *concentrate on studying*.

The effects of independent variables on dependent variables are generally positive, excepting for one case. The feeling of *safety* in relation to a *peaceful location* has a negative effect (-0.394).

Both exogenous and intermediary endogenous variables present correlations. *Beautiful views* are correlated with all three predicted variables, such as *green cover*, *feel safe* and *concentrate to study*. Regarding the intermediary variables, *good conditions to eat* is strongly correlated with *peaceful location*, but a weak correlation with *proximity* (-0.026). Between *proximity* and *peaceful location* there are no correlations. Furthermore, spaces with *good conditions for eating* are not preferred as *quiet places* (-3.507).

The goodness of fit indices supports the validity of the path analysis model related to LS-related reasons (Figure 34). Some of the coefficients exceed 0.60, indicating a good fit of the model to the data.

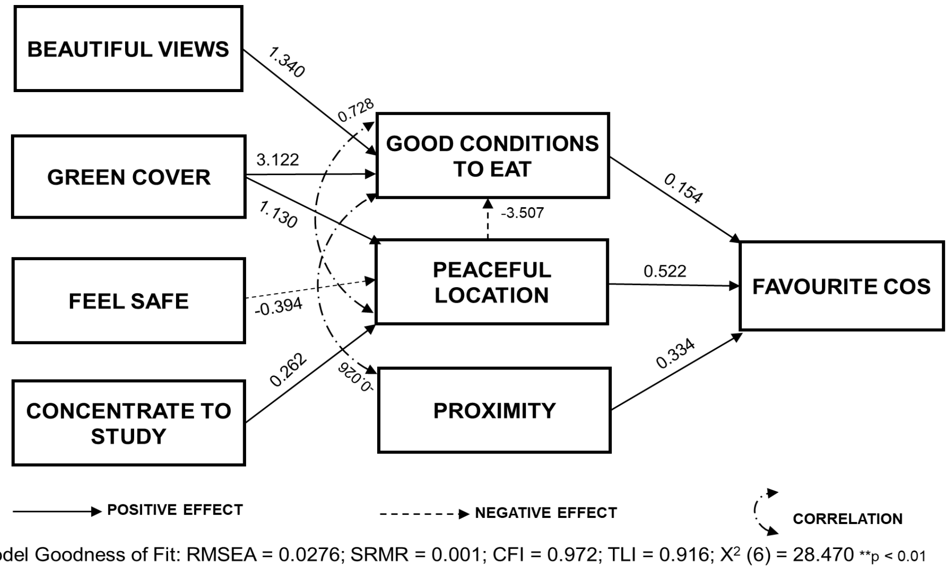


Figure 34. Scheme of the LS-related reasons influencing the COS preference using path analysis

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Chapter 7. Discussion

Some parts of the content of the present chapter are published in “Tudorie, C.A.-M., Vallés-Planélls, M., Gielen, E., Arroyo, R., Galiana, F., 2020. Towards a Greener University: Perceptions of Landscape Services in Campus Open Space. *Sustainability* 12, 6047, (DOI:10.3390/su12156047)”

7.1. General evaluation of UPV's campus open space state and management according to level of satisfaction and needs of university community members

The members of the university community may perceive the campus landscape in various ways, recognizing its abundance of information. However, individuals tend to be particularly attuned to landscape services that are relevant to their needs or desires, and which encourages them to actively engage and participate in the landscape (Zube, 1987).

7.1.1. Landscape services

The results indicate that UPV's COS are perceived as offering a wide range of high-quality landscape services (Figure 19, chapter 6.2.2). However, there is no consensus regarding the level of satisfaction with the current state and management of the COS, as shown in (bold numbers in Annex 6, Table 6.5). As expected, the majority of respondents (around 80%) perceive the following functions of COS as being of good quality: *meeting with friends*, *relaxation*, and providing a space *for passing through*. It is worth noting that the function of *pass through* is a benefit that was not included in any existing category of ecosystem service classifications (Haines-Young & Potschin, 2018).

The activities carried out in open spaces during the pandemic are comparable to those that took place in pre-pandemic times (Arafat et al., 2021). However, open spaces have gained increased appreciation after the crisis due to the health benefits and overall well-being they provide (Poortinga et al., 2021). As a result of the restrictions on indoor dining during the

COVID-19 pandemic, students and UPV staff members have come to appreciate the importance of open spaces in fulfilling their daily basic needs. Consequently, they now gather in open spaces. Indeed, consistent with the findings of previous researchers (Cooper & Wischemann, 1990; Abu-Ghazzeh, 1999), it is common to observe students sitting on the grass, eating, resting, or even taking a nap during lunchtime. Open spaces contribute to increasing social relationships and reducing stress, highlighting their significant social benefits (Ulrich et al., 1991). All these principal functions perceived by the university community members are associated with *provisioning* and *cultural landscape services*.

Regarding the *environmental benefits*, around 70% of participants rated the *provision of adequate temperature* and *light* highly. The qualitative results indicate that *diversity of green areas* (14%) and *climate comfort* (*natural shade*, *cooling effect*) (10%) are the most important concerns of university community's members regarding COS's management (Table 16 and Table 17). This landscape service is especially important in the Mediterranean context, characterised by high temperatures, insolation, and scarce precipitation. The pleasant weather in the Mediterranean region has a notable influence on the use of outdoor areas (Abu-Ghazzeh, 1999; Nikolopoulou & Lykoudis, 2007). At the UPV, sunny and warm days have a major impact, especially on foreign exchange students, who intensively enjoy the outdoors and spending hours sitting on the lawn, listening to music, talking on the phone, resting, reading, studying, or hanging out with friends.

7.1.2. Needs

The statements proposed for the quantitative method, which encompass environmental, functional, and psychological aspects, are in line with the categories and topics identified from the free opinions and recommendations about the current condition and management of the COS (Table 16 and Table 17). Not only do they reflect how respondents perceive the amenities offered by the open space, but they also provide insights into their demands for greater satisfaction with the campus open space.

The answers to *open questions* have revealed many associations between *space's perceived functions* (*purpose*), *structural characteristics* (*design*), and *needs related to space's management* (Table 16 and Table 17). By adopting a fresh approach and seeking respondents' personal opinions regarding the condition of campus outdoor areas, as well as demanding their help to find solutions for the improvement of campus landscape, numerous responses reflecting concern for the well-being of the university community have emerged.

On one side, respondents perceive value in relation to the *current opportunities provided by the space*. Accordingly, university community members express *lower demands* related to those LS they are *more satisfied* with, e.g., *passing through*, *recreational and social activities*. On the other side, they associate value with *potential future opportunities*. For example, respondents propose potential functions for the campus open space such as using it as a *space for work or study*. In addition, new issues related to COS's functions like *aesthetics*, *pedestrian*, *research*, or *psychosocial purposes* have arisen.

Two major groups of respondents are identified based on their *needs*. The first *group* consists of *individuals who desire to be in close proximity to nature*. They appreciate and prioritise the functions of the campus landscape that provide spaces for *relaxation* and support *leisure outdoor activities* such as *walking and enjoying nature*. This group agrees with those users expressing an *environmental view* (Figure 20). Additionally, users whose *needs* emphasise *safety, tranquillity* and *public visits* can be considered as a subgroup within the environmental *view* group, because green elements significantly impact their *well-being* in various aspects. Moreover, respondents emphasise the psychological links between the campus landscape and the community, acknowledging the importance of the *campus landscape's image* in shaping *place identity*.

The second *group* includes respondents expressing a *utilitarian view*, as they are asking for *more green space furniture* like *tables* and *benches*. They also suggest *using open space as outdoor classrooms* which can be associated to *infrastructure and equipment topic* (Table 17) and management's issues (Figure 23).

Environmental view

Environmental needs are also connected with vegetation topics such as *natural aspect*, *trees* (*bigger*), l*awn, species adapted to climate and autochthone species*, and *colour* (*flowers*). The most frequently mentioned topics (64%) centre on respondents' desire for a more expansive green surface and the implementation of NBS. Over 40% of users express their opposition to *asphalted surfaces*, and nearly 35% of respondents specifically request the inclusion of *more native species* (Figure 20), especially *trees*, due to their significant role in providing landscape services (Table 16 and 18). *More water features* such as fountains could refer to the *provision of drinking water sources* or be seen as a design element that contributes to the *structural aesthetics*. Additionally, water elements like *ponds*, *streams* and *fountains* are part of the *blue infrastructure* that when combined with green infrastructure play a role in ensuring the sustainability of the campus. According to Suppakittpaisarn et al., (2019), any kind of green-blue space will be more preferred than a barren landscape.

The UPV is provided with a pond (COS 11), a fountain (nearby COS 9 and 10), that are placed relatively close to each other in the western point of campus and few sparsely drinking water-sources. Unfortunately, these are the only elements of blue infrastructure and its deficiency is perceived by a high percentage of people in the campus (61%) (Figure 20) and 27% of total answers (Table 16).

Although around 70% of participants rated the *provision of adequate temperature* and *light highly*, the analysis of user needs suggests that this service should be improved, since *natural shade* and *trees* are among the most requested *needs*. For instance, *walking by* or *passing through* a more *natural setting* is not the same as walking under full sun and experiencing conditions generated by the asphalt surfaces. As well, *doing sports* or playing games surrounded by green elements is totally different than indoors or in a grey infrastructure setting.

Trees are essentially green elements that contribute to various services and play a crucial role in fostering healthy urban communities by providing environmental, social, and economic benefits (Mullaney et al., 2015). Aesthetics, cooling effects, reduction of contamination, and mental health benefits are frequently mentioned reasons in the literature when discussing preferences for space (Arnberger & Eder, 2015; Mullaney et al., 2015; Leff, 2016; Palliwoda et al., 2020), and all involve vegetation's presence. The trees with big crowns contribute to the design of open spaces and fulfil ecological and social functions (Cooper & Wischemann, 1990).

Furthermore, the qualitative method emphasises needs that go beyond trees and are interconnected with the existing or potential functions of green infrastructure elements and open spaces. The study covers new topics including *lawns*, the need of a *more diverse and layered vegetation* consisting of *shrubs*, *bushes* and *flowers*. These features would add colour, diversity and a more natural and vibrant aspect to the landscape, contrasting with the monotonous lawn-dominated scenery (Table 17).

Psychological view

Moreover, *lawn* and *trees* are green elements which can totally change the environment and influence persons' well-being. The presence of nearest green elements is positively associated with the overall quality of life, in particular with the social quality of life which addresses social support (Speake et al., 2013). It is also linked to the environmental quality of life, which focuses on the quality of the physical environment and the associated opportunities. Our findings align with the research conducted by Berg et al. (2007), which indicates that respondents emphasise ecological-oriented reasons associated with stress reduction and the beneficial effects of natural views on emotional stress recovery and mental fatigue (Kaplan & Kaplan, 1989; Ulrich et al., 1991). Indeed, the type of vegetation structure plays an important role in the positive or negative perceptions. Rahnema et al. (2019) discovered participants report feeling of tranquillity and love when they see flowers, and the flower-bearing plant species are perceived more appealing than leafy ornamental plants.

In terms of *safety* and *tranquillity*, the respondents have expressed satisfaction with the ability of the COS to provide these services. In line with our results, Voigt (2014) determined accessibility and tranquillity are important requirements for people to visit a public space. Curiously, the found mobility and safety topics are related to motorised means of transport and speed rather than green space security, which in literature is understood as crime potential inspired by naturalness and places with dense vegetation (Ho & Au, 2020). However, according to Gobster and Westphal (2004), safety is more commonly associated with concerns about getting lost or experiencing accidents rather than fears related to criminal youth gangs or the hazards of toxic dumping.

Regarding *place identity*, campus open space is perceived as *campus's image*, *identity* and *trademark*. According to Relph (1976), places' identity is given by place's physical setting, its activities, situations, and events, and the meanings of place are revealed by people's experiences and intentions in regard to a place. Therefore, these components are those that allow a place to be differentiated from other, and structural and psychological attributes can mark the beginning of people's preference. For Bastian et al. (2014), landscape conveys identity. Campus is the local environment of university community members and the place where they live and work, and for which they are responsible. The opinions and requests of respondents reveal their care, preoccupation and involvement in the present management of campus landscape.

University community members feel comfortable in the *home turf*, which are small territories belonging to certain departments and faculties (Cooper & Wischemann, 1990). In addition, Van den Berg et al. (2015) discovered people who feel *completely at home* in their neighbourhood are more likely to interact with local alters than people who do not feel such kind of a place attachment. In this case, COS meets the condition as it supplies high quality of perceived *meeting with friends-service*. The strengthening of the students' attachment to the campus is greatly influenced by the presence of vegetation and outdoor furniture, as indicated by Zhang et al. (2019). Unfortunately, urban furniture still remains poor in the UPV campus.

Utilitarian view

In addition to people's well-being and the selection of vegetation types, the inclusion of features related to human uses are crucial factors in the planning and design of urban green spaces (Campagnaro et al., 2020).

The demands expressed by users indicate that the *utilitarian and ornamental* perspectives of green spaces are more prominent than the ecological view. For example, *daily basic needs* emerge as the third most frequently mentioned purpose topic, accounting for 9% of the discussions (Table 16). Furthermore, almost half of the topics related to campus landscape design and management specifically addresses the inclusion of *urban furniture*. Respondents also expressed a desire for *sport* or *recreational equipment*, *drinking fountains*, *tools for sustainable mobility*, *road and campus orientation signs*, and *artistic elements*. These results align with the findings of Zhang et al. (2021), who confirmed that individuals emphasise the importance of improving auxiliary facilities such as playgrounds, sports facilities, and urban furniture when considering their intention to visit green spaces.

Opinions and recommendations about the design of campus open space

The analysis of respondents' opinions, recommendations, and needs regarding the current state and management of the UPV's outdoor areas contributes to a better understanding of the benefits provided by the space. This analysis helps to create a comprehensive view of the multifunctionality of the campus outdoor space. In order to define the functions for which the campus open space was designed, a scheme related to a conceptual map was created. This scheme was developed using the Affinity Diagram method (Castilla et al., 2017) (Figure 35). It was designed to be inclusive, allowing it to be read from the inside to the outside

The relationships between the university community members and nature can be visualised as a hierarchical structure. At the top layer (represented by a black rectangle), these relationships encompass and surround the other layers. The second layer, known as campus identity (represented by a red rectangle), is closely connected to aesthetic quality. This quality is derived from artistic elements such as sculptures, mural paintings, architecture, and green spaces.

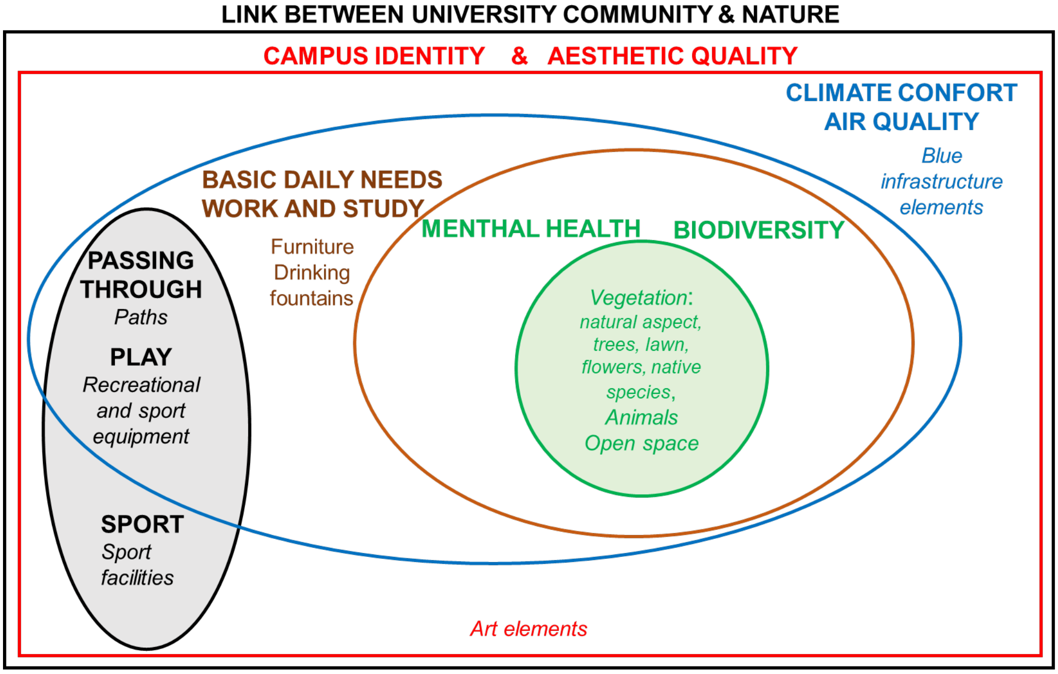

Figure 35. Inclusive relationships between purpose (capital letter) and the components (lowercase letter) related to open space design based on respondents'perceptions (Table 16 and Table 17)

The campus outdoor environment, shown in the fourth layer (illustrated with a brown ellipse-fourth layer), serves as a space where university community members fulfil their daily basic needs (eat, sit and rest), work, study, and engage in leisure activities. This includes activities like doing sports, playing, walking, or simply passing through. The environmental factors (represented by a blue ellipse-third layer) and the biotic features (represented by a green circle) influence these activities.

Certain purposes may be found within the same layer, for example, biodiversity and mental health. Many respondents perceive the presence of greenery as having a relaxing effect, which aids them in coping with various tasks. The abiotic conditions, air quality and climate comfort are supplied by the green and blue infrastructure elements, such as trees, lawn, fountains and ponds contribute to these perceptions and are situated in the same layer.

There are also some isolated purposes, like sport, which can be practised in full sun and does not require shade. On the other hand, passing through is incorporated in the fourth layer, as respondents emphasised the importance of shade when crossing the campus, particularly during hot summer months. The central palm tree-lined path does not provide adequate comfort conditions, necessitating additional shade. The availability of shade also impacts recreational activities and the placement of recreational and sports equipment, which should ideally be located under trees. Neither play, sport, nor passing through activities are affected by the absence of tables, chairs, benches, or other seating features, nor are they dependent on biodiversity elements.

In contrast, fulfilling basic daily needs, as well as work and study purposes, are influenced by the presence of various types of open spaces. These spaces should have an extensive urban green infrastructure (UGI) and tree cover, be well-furnished, and conveniently located nearby to ensure easy accessibility. Numerous studies in the literature have highlighted the stress-reducing effects of walking or engaging in recreational activities. Additionally, green spaces are often associated with improved mental health. Therefore, mental health was placed in the fifth layer, adjacent to green elements, based on respondents' perceptions of peace and relaxation associated with green cover. Passing through and playing, however, are possible without the presence of vegetation.

7.2. Relationships between respondents' profile, perceived supply of LS and satisfaction

The results obtained by analysing the profile of respondents and their perceptions of landscape services (LS) allow us to examine the variations in LS perceptions based on socio-demographic factors and user-related groups within the campus open space (COS). Specifically, we focus on the perceived functionality of the open space to identify differences in LS perceptions among different groups.

7.2.1. The influence of the respondents'profile in the perceived supply of LS

Most of the respondents agree with the open space's landscape services. However, there are significant differences among the user profiles concerning the number of good-quality landscape services identified. Results indicate that respondents' *perceptions of provisioning* and *cultural services* are conditioned by *age*, *gender*, *branch of knowledge*, *COS frequency* and *COS preferences* (Figure 25). *Regulating LS* present mostly *negative* relationships with users according to *gender* and *branch of knowledge*, but *positive* associations according to *COS frequency*.

All services presented significant differences between age groups, except *the passing through*, *relaxation* and *air quality LS* (Table 21). Finding a place with *clean air* to unwind is important for everybody and *age* does not influence people's perceptions and needs in this case. Indeed, stress mitigation from exposure to nature and green spaces (Ulrich et al., 1991) is valued by all age groups. According to Kaplan and Kaplan (1989), nature has the capacity to renew attention and improve people's ability to concentrate.

However, there are other services that are appreciated differently by respondents as their evaluation depends on personal needs. According to Zube (1987), values are clearly tied to the individual's personal experiences and purposes. We speculated that, on one hand, *age* is connected to a longer relationship with the university and more experience. Respondents over 50 tend to rate the landscape services provided by UPV's COS lower than the youngest respondents. Probably because users over 50 are perceived as being more thorough than younger people and also as having another vision of UPV values. People who have spent a third part of their life at UPV rate half of LS poorly and, surprisingly, indicate the smallest number of needs (3 of 12). Older people may also be more aware of and demand more from the use of the outdoor environment (Arroyo et al., 2018). It is normally that with the overtime changes of the social and cultural context, people begin to perceive and value differently the landscapes' functions, priorities change, and they start to give more importance to some functions than others (Ittelson, 1973 as cited in Stokols, 1995).

On the other hand, the way human beings see and value landscapes depends on what they do in them (Ittelson, 1973 as cited in Stokols, 1995). Design elements in outdoor areas, such as benches, tables, lawns, and natural shade, can influence how members of the university community use the space and capture their interest by offering opportunities for short-term activities or uses.

In addition, there are some factors, such as schedules, different daily concerns, and urban furniture, which may influence the respondents' decision on how to use campus open spaces. Our results are in line with the findings of Abu-Ghazzeh (1999), according to which *age* greatly influences how the same space is used. Respondents of 18–22 years old evaluate COS more positively as a *space to study/work*, *to meet their basic daily needs*, as *play areas* and as a *space for research* than people over 50 (Annex 6, Table 6.1). They also rate *space to pass through*, *to study* and *to create art* as services higher than respondents who are 22–30 or 30–50. Regarding the relationship with UPV, the majority of young users have recently come into contact with COS (34.1%) or have spent between two and five years there (49.1%), and are students. Therefore, young people spend more time on campus and use space in a different way than the other groups.

A young person's life is also closely connected to the campus space not only as their place of work or study, but as also compatible with their personal life space. They develop stronger personal lives by meeting up with their friends and classmates every day. The daily campus experience has a significant impact on students, leading them to personalise spaces and develop strong emotional connections. This, in turn, fosters solid bonds between students and the surrounding territory (Tuan, 1974). This is reflected in the students' high rate of positive responses about the general quality of LS provided by COS. Older people perceive campus mostly as a place of work and not a place of leisure. Generally, teaching and administration staff, but also older students, conduct their personal lives outside of the campus.

In contrast to our findings, Liu et al. (2022) argue there is a correlation between age and the frequency of visits to campus green spaces. Older students tend to utilise these spaces more often for relaxation purposes, likely due to facing more problems and responsibilities compared to younger students.

In the scientific literature, there seems to be no agreement on the way in which *gender* influences the perceptions of regulating services (Larson et al., 2016), but, surprisingly, this study identifies significant relationships between the perceived supply of services and gender (Figure 25). Females assess the provisioning, regulating and cultural services more positively than males and others (Figure 25). The significant relationships determined between females and males show females have better perceptions or are more likely to recognize the landscape's capacity to supply services (Table 21) than males. For example, females evaluate the environmental benefits more favourably, like *air quality* (75.1%), *temperature* (78.3%) and *native species* (37.4%) (Annex 6, Table 6.1). Contrary to our findings, Liu et al. (2022) examined the influence of gender in the differences in perceptions regarding naturalness, and they found males indicate a stronger link between self-rated health and perceptions of natural attributes than females, influenced by more visits (alone) to green spaces than females, who are usually with others when they visit.

A more positive assessment of perceived LS, such as *space for research*, *to learn about the natural environment*, for *creating art* or to *get together with friends* (Annex 6, Table 6.1) seems to also be reflected in females' higher degree of satisfaction with the condition and management of COS (29%) compared to males' (27%) (Annex 6, Table 6.5). Males perceived the campus has less potential to offer cultural services than females did, probably influenced by the campus' special TRS distribution in terms of demographics, because there are more older males than older females. In the particular case of the *cultural LS* called *space to do sports*, this can be explained by the fact that males usually use open spaces for sports more than females do, which is in line with the results of Speake et al. (2013).

These results seem to hold for females' higher broad ranging *satisfaction with COS* (Annex 6, Table 6.5). Our results confirm the findings of Panday and Chowdhury (2021), according to whom females are more likely to give more positive overall ratings when responding to surveys than males.

Branches of knowledge influence respondents' perceptions of campus LS quality. Respondents whose interest is in Agrifood&ForestE or Health&FoodSc have negative perceptions of all three dimensions of LSAS. It seems that landscape and environmental knowledge play an important role in how demanding the university community is about LS. The foresters have higher expectations for a more naturalised and diversified arboretum, with consistent species combinations, especially with a dominant presence of native species, which give more coherency to the green space. According to Naussauer (1995), the language expressed through landscapes, specifically conveying the intention to nurture and care for the environment, provides a potent vocabulary for designing to enhance ecological quality, However, the recognition of ecological function is more apparent to those who are educated to seek it. Concerning the architects, their assumption is probably related to more formal gardening. In the last design phase of UPV, a number of non-native exotic species were scattered throughout to increase the diversity of tree species (Esteras Pérez et al., 2014) which can explain the lack of respondent's satisfaction regarding the last item (A14) *native species*. As shown by Tudorie et al. (2020), respondents related to landscape disciplines demand a higher level of naturalness in the spaces and species and the use of open spaces to hold classes in a natural environment than other disciplines. Instead, Gao et al. (2019) discovered students evaluate a campus' exotic nature positively, as the colours of some of the species, e.g., *Styphnolobium japonicum (L.) Schott (Sophora japonica L.) and Ginkgo biloba L.*, inspire feelings of warmth and vitality, positively reducing student stress. Partially in line with our findings, Liu et al. (2018) stated that students enrolled in landscape architecture or arts programs assess university green space as providing poor restorative services and were unsatisfied. These researchers suggest academic training influences students' high demand for quality green space if they majored in landscape design or the arts.

COS frequency presents positive associations according to the whole range of perceived LS (Figure 25). High frequency users (respondents who use COSs more times per week), evaluate all cultural services more positively (Annex 6, Table 6.2) and express a greater and more significant satisfaction with COSs than low and medium users of open space. These results are also confirmed by the significant differences found in perceived cultural LS among frequency groups (Table 21). Respondents use and assign higher value to places based on needs and preferences, leading to a greater appreciation. The motivation of using a space is strongly related to people's perceptions and satisfaction with the benefits offered by that space. According to Zube (1987), people's needs and desires, and the utility of using the landscape influence the perceived values and responses of humans. In the same line with the research results, Tian et al. (2020) discovered high visit frequency enhances residents' perceptions regarding LS delivered by green infrastructure that reveals a higher disposition of people to preserve urban green spaces.

Regarding the *COS preference*, respondents who prefer spending their free time on campus rather than going home, either outdoors or in sports facilities, are likely to perceive provisioning and cultural LS more positively –except for *relax* and *play* (Table 21)– than respondents who prefer to go home (Figure 25). Even those respondents who prefer indoor spaces have more positive perceptions regarding some perceived LS. Doing exercise in open spaces is highly appreciated, and users are looking for any facility and opportunity to enjoy those cultural LS. Spending free time outside and having leisure activities offline positively influences students' well-being (Chirico et al., 2023). As society becomes further estranged from nature, society's well-being could suffer serious consequences. Considering how challenging university studies are, and with the detrimental effects they have on the mental health of students (Iqbal et al., 2022), open spaces play a fundamental role in improving their resilience, as people need to spend more time outdoors (Kaplan & Kaplan, 1989).

Despite our initial expectations, we do not find any significant relationships between the occupation groups of students and their perceptions of cultural landscape services. This is surprising, considering the campus's provision of excellent sports facilities and a wide variety of secluded and common open spaces, which should facilitate social interactions, meetups, and shared meals. However, it appears that the occupation groups of the students do not influence their perceptions of the cultural landscape services provided on campus.

Only TRS and AdSS groups perceive the good quality of provisioning services. These perceptions can be attributed to the fact that these occupation groups use the space less intensively compared to students, as their priorities, daily concerns, and work schedules differ.

7.2.2. Satisfaction with COS

A generally more negative-neutral than positive satisfaction of respondent's groups with COS (Annex 6, Table 6.5) can be explained by their desire to achieve well-being of university community.

Bad feedback is known to attract more attention (Baumeister et al., 2001) and negative stimuli are more informative and thoroughly processed. If the goal of university community members is to enhance COS's facilities, a strategy that focuses on gathering feedback from dissatisfied evaluations may yield more precise and targeted results (Marín & Taberner, 2009). *Satisfaction with COS's condition* is directly linked with *cultural* and *regulating LS*, as evidenced by the way respondents' groups rate individual services (Figure 25). Furthermore, there is a significant correlation between respondents' satisfaction and provided services, except for *native species* (A14) (Annex 6, Table 6.6)

As we expected, there is a *positive* relationship between *regulating services* and general *satisfaction with COS' condition and management*, probably because the *pleasant climatic conditions* and *good air quality* were perceived as high-quality *LS* (Annex 6, Table 6.1 and Annex 6, Table 6.4). In an urban context, people agree air purification and micro-climate regulation contribute directly to their quality of life and environmental sustainability (Martín-López et al., 2012). Other studies determined survey sites are visited because respondents value places which provide nice weather/sunshine (Y. Wang et al., 2017), which might explain the positive relationships between regulating services and respondents 'satisfaction. Moreover, several studies have pointed out the influence of motivation for use on perceptions of benefits and valuation of LS/ES (Shan, 2014; Speake et al., 2013). The perceptions regarding the quality of outdoor spaces positively influences the satisfaction of residents (Aiello et al., 2010).

However, the shortfall in the *perceived cultural LS negatively* influences the university community's *satisfaction with the campus landscape*. Those respondents who value negatively most of cultural LS in campus, like males and people who use very little open space (Table 21), tend to be less satisfied with COS's condition (Annex 6, Table 6.5). Cultural LS connected to studying, reading, eating, painting, and playing board games need physical support. The lack or limited number of tables and benches are COS' main deficiencies, which could provoke users' poor assessment of cultural services and general low satisfaction (Tudorie et al., 2020).

Regarding the profile, *satisfaction* is directly related to the branch of *knowledge groups*. However, only three *branches of knowledge* which are related to *social and health food* *science*, and *humanities and arts*, show positive relationships with satisfaction. Curiously, neither of these knowledge branches belong to the engineering discipline. Besides, no relationships of satisfaction between respondents studying engineering and satisfaction with COS is found. In line with our results, Chirico Kożybka et al. (2023) discovered technical students tend to spend more hours in front of a computer indoors than students of humanities/social science which influence their overall life satisfaction.

7.3. Relationships between structural characteristics, use and preference

Results show that a set of structural characteristics of open space influences and predicts the general use of open space (Table 32) and respondents' preference for spending free time in campus landscape (Table 38). Preference and use of space are more or less influenced by common variables, like the size of area and the central location of open space in the campus, although they mutually exercise a positive influence on one another. People use not only places that meet their needs, but places they really like or appreciate. With the exception of two spaces (12 and 19), favourite spaces are also the most used and vice versa (Annex 4, Table 4.1). The UPV's COS include common areas or common turfs, which are generally located centrally and used or preferred by everyone (e.g., the green central axis of UPV).

Additionally, there are adjacent building spaces such as front yards or backyards, which serve as more private areas for each faculty or institution. These spaces facilitate the development of certain actions that university community members may prefer to engage in away from other public spaces, such as sunbathing, meditating, relaxing, or having private chats (Cooper & Wischemann, 1990).

7.3.1. Structural characteristics influencing the higher level of use of COS

The significant contribution of the three structural variables such as *central placement, proximity to Ágora* and *area* to predict the *use of space* (Table 26), was expected as *distance* and *size* have been found to be very important prerequisites for the use of space in the literature. Considering the research's small scale and the high homogeneity of interconnected campus open spaces (Annex 4, Table 4.1 and Table 4.2.), research results seem to be partially consistent with the findings of Abu-Ghazzeh (1999), who exposed students prefer and use more the central square and the gran pedestrian street than other campus places. Studies regarding the relationships between the community attachment and the distribution of green open space reveal that centralised spaces have a higher impact on community's attachment than the dispersed ones (Zhu et al., 2017). The only space in the top ten most used spaces, which is located slightly further from the central axis, is the terrace of the Fine Art Faculty's restaurant (e.g., 19) (Annex 3). The high percentage of its selection is likely attributed to respondents belonging to the Art & Humanities branch of knowledge (14.8%) (Table 18). However, it should be noted that space 19 is still within a recommended 300-metre buffer from Ágora square and the campus central green axis (EEA, 2003; WHO, 2016).

A decrease of *proximity* to Ágora indicates a shorter distance from space to Ágora square and predicts a higher level of use of space. A walk longer than 10 minutes can be perceived as a barrier for the use of any element of campus. Those COS that are located further from the Ágora square, e.g., 52, 44 (Annex 4, Table 4.1), are less frequently used compared to spaces along the central axis, which are easily reachable within a 10-minute walk.

The Ágora square is a reference point for the UPV campus and a familiar place, where all *campus citizens* feel equal. It is located *centrally* (Figure 17) and connects with one of the main pedestrian entry points and with a green central axis. It is always alive by many students, professors and the rest of UPV's staff, and it can never give the impression of an intimidating place or the feeling that university community's members are alone. This tree-lined plaza and well-equipped spot with urban furniture, was expected to be mentioned as one of the most used and preferred places, because of its good size (0.5 ha) (Annex 4, Table 4.1) and its proximity to many points of interests, such as cafeterias, pharmacy, banks, Central Library and reprography. In line with our results, Speake et al. (2013) find out, when comes to use the greenspace around building, proximity and access to nearby nature are more important for students than the size of space, as it has the ability to provide a setting for social support, especially for students after spending very long time indoors.

Regarding *size*, some researchers state, people are more likely to choose spaces of a bigger size, if the distance does not exceed 600 m (Schipperijn, Ekholm, et al., 2010; Kaczynski et al., 2014). In our case, larger spaces tend to be more complex in terms of activities. In line with our results, Schipperijn et al. (2010) determined that larger parks are more used by residents than smaller parks. The *size* of a space and the *structural diversity* influence the development of different activities and enjoyment alternatives (Voigt et al., 2014).

Regarding the parameters that are not found to be significant for the use of a space such as *UGI cover*, *tree species cover*/*richness*, and other *biotic*, *abiotic*, and *infrastructure* *elements*, it was expected that they would not influence the use of a space, as the campus landscape is relatively homogeneous (Annex 8, Table 8.1). Some of the smallest spaces, measuring 0.1 ha (36, 5, 49), are also the least used spaces (Annex 4, Table 4.1). These spaces tend to have repeated or limited elements such as urban furniture, decoration objects, and vegetation, resulting in poorer *structural diversity* (Annex 4, Table 4.2). Additionally, they exhibit poorer *UGI cover* and *tree cover* compared to larger and more frequently used areas, such as parks (38, 39, 43) and gardens (11, 12, 16, 29) (Annex 4, Table 4.1). For example, spaces like restaurants' terraces (19, 24, 35), the schoolyard (1), the green verge (22, 48), or the atrium (18) have poorer *UGI cover* and *tree cover*. Voigt et al. (2014) discovered there are differences between parks of different sizes and people use and highly appreciate smaller parks (1-2 ha) for their *biotic* and *abiotic features*, such as large and old trees for providing shade and climate change mitigation, proximity to water elements, and manicured flower beds and hedges which offer attractiveness. The same authors revealed visitors highly value bigger parks (5-7 ha) for more or less the same features as smaller parks, but also for more recreational activities which involve developed infrastructure, like: walking, jogging and biking.

7.3.2. Structural characteristics influencing the higher level of preference for COS

As expected, all COS are among the least frequently used spaces, but that doesn't necessarily mean they are the least favourite ones (Annex 4, Table 4.1). People can use spaces of all kinds of size, including totally asphalted spaces and without green elements, like (20, 4, 8) (Annex 4, Table 4.1). However, when it comes to preference, people prefer spaces with certain characteristics that are capable of satisfying their needs.

The significant contribution of number of *tree species*, *central placement* and presence of *mounds* and *drinking fountains*, is justified by space's design, especially the creation of a central green axis and the biotic diversity. In the last building phase of campus landscape, native and non-native species (e.g., cockspur coral tree - *Erythrina crista-galli L.*, blue jacaranda - *Jacaranda mimosifolia D. Don*, queen palm - *Syagrus romanzoffiana (Cham.) Glassman*, rosewood - *Tipuana tipu (Benth.) O. Kuntze*, Chinese windmill palm - *Trachycarpus fortunei* (Hook.) Wendl. and Mexican fan palm - *Washingtonia robusta H. Wendl.*) were planted to increase the diversity of *tree species* (Esteras Pérez et al., 2014). For example, the most preferred spaces (43, 39), have an average of 4.5 species within a 30 metre-grid (Annex 4, Table 4.3). Some examples of the native tree species of Medierranean region, which can be found in the Eastern part of central green axis, are: Mediterranean hackberry - *Celtis australis L.*, olive - *Olea europaea L.*, Italian stone pine -

Pinus pinea L., scarlet oak - *Quercus rubra var coccinea (Münchh.) Aiton*, Portuguese oak- *Q. faginea Lamk.*, holly oak - *Quercus ilex subsp. ilex*, Canary Island date palm - *Phoenix canariensis Hort. ex Chabaud.*, etc., (Esteras Pérez et al., 2014).

When considering the impact of vegetation species diversity on the preference of the university community, several studies have indicated that landscapes dominated by trees, flowerbeds, flowers, and water are significant (Campagnaro et al., 2020; Suppakittpaisarn et al., 2019; van Vliet et al., 2021). The presence of flowers adds diversity in terms of shapes and colours to the surroundings, thereby enhancing the restorative potential of a place (Wang et al., 2019). Other studies claim grass and trees are preferred over bushes and flowers (Nordh et al., 2009, 2011).

The size of a space is associated with the perceived availability of landscape services and the functionality of the space. According to Relph (1976), the characteristics of open space play a crucial role in determining the functionality of the space. Large spaces, especially those with attractive attributes, promote higher levels of walking, as advocated by Giles-Corti (2005). Respondents'perceptions of same-sized open spaces are influenced by the type of space and its functions. Most of the larger campus spaces are perceived as attractive places. For example, spaces 38, 29, and 15, which are among the ten largest spaces (Annex 4, Table 4.1), are perceived to offer a quieter environment, better working conditions, more beautiful views, and proximity to points of interest (Annex 7, Table 7.3). In comparison, spaces 32 or 50, despite having a similar size, are perceived to have lower service provision and a limited range of activities (Annex 7, Table 7.1).

According to Ittelson (1973) as cited in Stokols (1995), landscapes can be valued for their ambiance, their aesthetic qualities and for the meaning users attribute to them, as people are influenced by their past landscape experiences, and by the social context. On contrary, the small sized spaces in UPV's campus, are less attractive than the biggest ones, but they may be appreciated for some small uses and for perceived supply of particular LS (Schipperijn, Ekholm, et al., 2010). According to the outcome of Krajter Ostoic et al. (2017), small green spaces are suitable for dog walkers, but present a limited role regarding other services, like habitat for urban biodiversity or for rain management. In dense campus areas, the small places could play a quick role in daily use such as gathering with friends, eating, resting or studying.

In addition to larger spaces with a greater variety of *tree species* and a *central location*, *topography*, such as *mounds*, and the presence of urban furniture such as *drinking fountains*, play a role in predicting the *preference* of a place. It is worth noting that the only spaces with distinct terrain relief are those located near the Architecture and Topography Faculty (11, 39, and 43) (Table 23). This result partially supports the findings of Halik and Kent (2021), who stated there is a slight overall preference of users for 3D visualisation models in a simulated urban environment than for 2D models. Regarding the preference for *mounds*, Purcell (1994) discovered that individuals residing in rural areas tend to appreciate landscapes with fields and hills less than urban landscapes. This difference in preference can be attributed to the fact that the urban environment often evokes work expectations or vacation destinations, which contrast with the familiar image associated with rural areas.

As for the *drinking fountains*, water is an elemental point in most of the campus recommendations (Lau et al., 2014). The importance of having green spaces with recreation infrastructures, such as benches and *drinking fountains*, is confirmed by the general preferences of university community's members. This is further reinforced by the fact that these elements of urban furniture were consistently mentioned as essential open space-related needs, along with tables and benches, sports or recreational equipment, road and campus orientation signs, and artistic elements (Table 17).

As anticipated, variables such as *UGI cover*, *tree cover*, and other *biotic*, *abiotic*, and *infrastructure elements* (Annex 8, Table 8.6) were not found to be significant factors influencing the preference of a space. This was expected due to the relatively homogeneous nature of the campus landscape (Table 23). The spaces with lower preference tend to have repeated or limited elements, such as urban furniture, decoration objects, and vegetation, as well as poorer *UGI, tree cover* and *structural diversity* (e.g., restaurants' terraces, school yards, green verge, or atrium), when compared to preferred places like parks and gardens (Annex 4, Table 4.1). Interestingly, the *proximity to Ágora* square did not show significant influence on the preference of COS. This could be attributed to the perception that reaching the central axis is less burdensome than reaching Ágora square from the campus edges, thus making proximity to the central axis more desirable.

7.4. Relationships between preference, activities, and LS-related reasons

People's underlying personal and collective needs, emotions and feelings play a role in shaping their preferences for different places (Kaplan and Kaplan, 1989).

The university campus can be thought of as being very similar to a district, where people have access to various facilities such as restaurants, coffee shops, sports fields, libraries, and more. However, the activities that can be developed on a campus are more limited compared to those in a district. Hence, the causal relationships and synergies that are identified can be applicable at the district level.

As expected the causal relationships shown in the path models (Figure 33 and Figure 34) are quite similar since the activities that respondents are engaged in their preferred spaces are included within some typologies of landscape services. In other words, respondents are asked in two different ways what motivates their preference for spending their free time in specific places. Furthermore, there are three activities that they engage in, which influence their preferences: *good conditions to eat*, *peaceful location* and *proximity to interest points*. Additionally, there are three carried-out activities that drive their preferences: *eating*, *relaxing* and *doing sports*. Among these activities, *eating* and *relaxing* are especially closely associated with the reasons for their *preferences*.

In this context, several analogous situations of *preference* were identified between activities and *LS-related reasons*.

The positive relationships between activities such as *eating* and *gathering* demonstrate the synergy between these two activities. Picnics are considered by Plieninger et al. (2013) a form of social relation. Daily meals such as breakfast, lunch, or brunch, enjoyed outdoors, hold great social significance. The favourable Mediterranean climate conditions positively influence people to gather and eat together. It is quite common to observe groups of friends sitting on the lawn and having lunch together in UPV campus. The most used spaces for eating are not only the central ones, as Abu-Ghazzeh (1999) stated, but also many other spaces located adjacent to buildings.

Social interactions are important for a healthy social ecology (Stokols et al., 1996). Therefore, it is essential to promote and encourage people to enjoy more services provided by urban green open spaces in order to foster such interactions. In fact, recent literature references (Dipeolu et al., 2021), highlight social interactions as a main reason for visiting UGI sites. Moreover, due to their attractiveness for passerby users, green streets can increase socialisation, by offering the opportunity to watch and talk with people who are using the nearby open space. In the context of the university campus, the central pedestrian street is described as a flowing river, where pedestrian movements easily complement the stationary behaviour, such as sitting, eating, watching, learning, studying and reading (Cooper & Wischemann, 1990)

The map of activities (Figure 31) reveals that the frequency of preference is distributed differently across campus areas. This distribution aligns with the identified typologies of campus open spaces, as determined through cluster analysis (Table 25). Specifically, central and adjacent building spaces are *preferred* and *most preferred* (e.g., gardens (11, 12) and the green axis space (43, 39, 38)) for more types of activities, like *eating, gathering, relaxing,* and *walking*. (Annex 7, Table 7.1). On the contrary, spaces between buildings are *less preferred* for engaging in these activities. This observation highlights a correlation between the identified *typologies of campus open spaces* and the *preferences for COS* for developing specific *activities*. The findings suggest that the proximity to common areas influences the functionality, and the desirability for these places and their suitability for developing various activities.

The *positive relationships* observed in the path model (Figure 33) between activities such as *walking*, *playing*, *relaxing*, *doing sports* and the *preference for open spaces* were expected. This aligns with the notion that stress reduction and increased physical activities are key objectives in open space design (Ulrich et al., 1991). Thus, synergies between mental and physical health are displayed. Arafat et al. (2021) also reported similar findings, noting that *eating*, *relaxing*, and *participating in sports* were the most common leisure activities on the campus (Figure 31). Outdoor areas play a crucial role in promoting the well-being of the community, as engaging in sports and play activities can enhance both mental and physical health. Furthermore, *walking* is encouraged and supported by the European Union as a sustainable form of mobility (EU, 2019). In the UPV campus, the university community values open spaces for their opportunities for *walking*, *passing through*, and *gathering*, particularly in the central part of the campus (Figure 31). Pedestrian circulation is an integral part of the lives of the university community members, facilitated by the well-designed, organised streets within the UPV campus. The main pedestrian flow passes through Ágora square, allowing people to become more acquainted with this place over time and fostering a sense of closeness and familiarity. In addition to its functional purpose as a directional hub, Ágora square serves as a gathering spot where friends can meet, walk, have lunch, and observe or participate in various school recreational activities.

Walkability is not just a matter of *sport* and *health*; it also plays a crucial role in facilitating chance encounters (Cooper & Wischemann, 1990), providing opportunities for socialisation and a sense of inclusion (Banning & Bartels, 1997). In fact, walkability represents one the most common objectives in the campus university plans (Hajrasouliha, 2015). Consistent with our findings, Zhang et al. (2021) observed a higher preference for walking, enjoying nature, and socialising in open spaces. Cycling is also highly valued in many parks and on the campus (Horacek et al., 2016; Olbińska, 2018). In UPV campus, there are few open areas which are crossed by the bike lanes. A significant number of students uses bicycles as their mode of transportation to reach the university, which explains why a large number of bicycle parking racks are installed in over a third of the spaces near the faculties (Table 23). Therefore, *synergies* between *physical activity*, *relaxation* and *social relationships* are distinguished in the model (Figure 33).

The restoration of attention, as demonstrated in Baró et al. (2021), and the positive energy individuals experience when exposed to nature, represent important interactions between individuals and their environment. Respondents generally *prefer* places with natural elements, rich *green cover*, and *beautiful views* (Figure 34). Some previous studies have shown that a low or moderate number of people increases the perceived restorativeness of urban parks (Arnberger & Eder, 2015; Nordh et al., 2011). In line with our result, Wang and Jiang (2021) argued that students who prefer the refuge-places that are hidden by water, trees, shrubs, edges, because they enhance the *visual quality*. In agreement with findings of Arnberger and Haider (2005), people who prefer *quiet places*, use to avoid crowded areas. Therefore, spaces *with good conditions for eating*, like restaurants ‘terraces, squares, or other sites where the community prefers to eat are not preferred as *peaceful location* (Figure 34. This indicates the need to adapt the UGI according to the priority activities that are developed in each COS. Probably because popular places are perceived as incompatible with a relief or calm atmosphere. These results are in line with the findings of Abu-Ghazzeh (1999), who reveals some respondents preferred to get away from the crowded outdoor area, while others preferred the popular areas.

This observation could explain the high level of appreciation for green spaces that are located further away, as they offer a *peaceful environment* and are well-suited for *relaxation activities* (Figure 31 and Figure 32). For example, perceptions of *good and medium good performance* regarding *green cover, peaceful location*, and *conditions for eating* and *studying* are associated with the west side of *central* (39, 43) and the adjacent building COS within the common areas (10-12). Conversely, places with a *poor perceived performance* are associated with *spaces between buildings* (Figure 32). This observation further underscores the relationship between the identified typologies of campus open spaces and the preferences for COS based on specific *LS-related reasons*. The findings imply that the distance to common areas plays a significant role in determining the quality of these spaces.

The presence of green spaces contributes to creating a *soothing* environment. A *peaceful location* is perceived as promoting a sense of *tranquillity*, enabling university community members to *relax* and better concentrate on their *study* or *work* (Figure 34). In contrast, noisy sites are viewed unfavourably for these purposes.

The detailed responses cover a wide range of topics, providing comprehensive information about the background and context for carrying out different activities, as well as highlighting the *synergies* between various *landscape services*. For example, when it comes to the need for an ideal environment for *studying*, respondents expressed a preference for *locations with vegetation* such as spots under large mature trees. The sociological literature contains a rich number of studies on the degree to which greenery has a positive impact on the well-being and quality of life of citizens (Tzoulas et al., 2007). Our findings are in line with results of Wang and Jiang (2021), who declared open space with a big *natural vegetation* surface is *more preferred* than open hardscape, because it is associated with a relaxing environment, which invites its users to meditate and read. The places which are *quiet*, sheltered, separated from the central area and with urban furniture, facilitate intimacy sensation and offer pleasant time for carrying out activities, like *studying*, sitting, and reading (Figure 31). Our study's results are consistent with the research of Koohsari et al. (2013), who determined learning activities in outdoor spaces require enclosed furnished places which should be located in shaded spaces. As a consequence, green vegetation and trees influence intellectual activities, so, a restorative environment suitable for reading and meditation or enjoying the scenery, is created. Besides, some green space elements have a stronger effect on stress relief than on general preferences. Consistent with our findings, Smardon (1988) stated that the presence of trees is positively associated with reading activities. Similarly, Hodson and Sander (2017) suggested that an increase in tree cover is linked to improved reading performance.

The literature widely documents cases of significant appreciation and preference for natural elements due to their positive, albeit indirect, effects on preferences. *Beautiful views*, *green cover* and *a* sense of *safety* have been found to have a considerable impact on individuals' *preferences* (Shan, 2014).

Regarding the *negative relationships* of path models (Figure 33), the negative effect between *relax* and *eat* is similar to the negative relationship between its analog reasons-related LS (*good condition to eat* and *peaceful location*) (Figure 34). The negative impact that safety has on peaceful location (Figure 34), can be explained by the fact that, even though a peaceful location is preferred for offering a relaxing environment and privacy, a quiet and private location with vegetation could inspire unsafety as well. This result is consistent with research related to wild-looking landscapes (including parks) (Schroeder & Anderson, 1984), which are often perceived as less safe than landscapes with a visible people intervention. The influence of vegetation on preferences can be partially explained by the attributes of naturalness and legibility proposed by Kaplan and Kaplan (1989). A significant amount of greenery is associated with stronger perceptions of the landscape's naturalness. Generally, people prefer landscapes that are both natural and legible because a lack of legibility can evoke feelings of fear (Schroeder & Anderson, 1984). In the case of UPV's campus landscape, only manicured spaces are present, which are far from being perceived as wild-looking landscapes. Manicured spaces are seen as legible and safe, which is why urban residents tend to prefer visiting parks with moderate to low levels of tree cover (Shanahan et al., 2015), as they convey a sense of openness and order (Yang et al., 2021).

The big tree diversity and large trees shade generators are undoubtedly the most preferred and desired attributes of green space (Jim & Chen, 2006; Arnberger & Eder, 2015; Nordh et al., 2011; van Vliet et al., 2021). A suitable and sustainable design of urban open space should consider the vegetation structure, density and diversity. In places without vegetation or with a small percentage of vegetation, a remote increase of vegetation density succeeds in improving users' preferences, but for places with a moderate-high density vegetation, a slight increase, only provokes the opposite effect in open space preference (Suppakittpaisarn et al., 2019). There should be a limited tree density for public open space, as these areas can offer more opportunities and more functions (Bjerke et al., 2006; Gao et al., 2019; Jorgensen et al., 2002; Campagnaro et al., 2020).

7.5. Design outcomes for designing and planning open space

Based on the research results, several recommendations for open space design have been proposed, which are complemented with other design proposals identified in the relevant literature (Cooper & Wischemann, 1990; Lau et al., 2014). We hope the design outcomes will assist urban planners and managers in creating well-managed, sustainable and accessible urban environments.

When designing and planning open spaces in urban areas, it is important to consider multiple scales of use, including a general or broad use at the district or neighbourhood level, as well as more specific uses at a smaller scale, such as individual open spaces and urban green infrastructure elements (e.g., squares, parks, gardens, yards, playgrounds, and street vegetation). Therefore, it is important to design open spaces that cater to a variety of functions, providing multiple benefits to address the community's specific needs, interests, demands, and preferences. Urban planners should also consider subjective factors such as age, gender, personal experiences, lifestyle, and daily activities when designing open spaces. Here are some design strategies that urban planners should consider at both a broad and smaller scale.

7.5.1. Availability, distribution, proximity and accessibility

Respondents have demonstrated a stronger preference for and utilisation of the common areas, which encompass the green central axis and the spaces adjacent to buildings, compared to the peripheral areas. The limited UGI cover in certain faculties, particularly those situated at the outskirts of the campus, has been addressed within campus' hotspots areas. This is due to lack of an initial campus landscape's design and to multiple building phases which have resulted in inequalities in accessibility to open spaces and inconsistencies in the presence of green elements. This highlights the importance of thoughtful planning and organisation to ensure cohesive and functional urban spaces. At the city level, the necessity for a comprehensive and hierarchical space design becomes apparent when incorporating districts and neighbourhoods into the urban fabric.

People tend to prefer places that are close to points of interest like shops, restaurants, and other daily facilities that meet their needs and interests. Therefore, it is recommended to supply and link open space with all these elements.

In relation to proximity and accessibility to open spaces, the issue of space connectivity arises, as it becomes challenging to establish connections between the common areas and the edges of the space once the building stage is completed. In addition, it is important to note that a walk longer than 10 minutes can be seen as a barrier to accessing various elements of the campus. Therefore, it is crucial to consider the distance to open spaces and ensure that it aligns with this guideline. To ensure an equitable distribution, open spaces should be adequately distributed throughout both central and peripheral areas of a neighbourhood or district. For example, following the rule 3/30/300 proposed by Konijnendijk, C. (2021), the inhabitants should have access to a green space 300 metres from home, study or work place.

7.5.2. Connectivity

Urban planners encourage strong relationships between the neighbourhood and the open space. It is important to provide a physical and an ecological connectivity between outdoor areas, which attracts other complex processes.

Respondents prefer places which facilitate spontaneous interactions and chance encounters. In addition, walkability and pedestrian circulation are essential aspects of the university community members' daily lives. To enhance connectivity at a broader level, on one side efforts are made to improve the physical connectivity and establish appropriate infrastructure, which includes the implementation of bike paths, spacious walkways, and outdoor seating areas, all of which prioritise pedestrian and bicycle access to open spaces. This infrastructure encourages residents to explore the area, interact with one another, and promotes social cohesion. According to Cooper and Wischemann (1990), places located near the significant pedestrian flow, openly invite human participation. These authors advise designing the central plaza as an orienting device and planning the streets and pathways to lead to the central plaza.

On the other side, future connectivity improvement actions should go beyond functional criteria. Planting vegetation along streets can function as green corridors, connecting different areas both structurally and functionally. However, when street vegetation is incorporated into the urban green infrastructure to facilitate connectivity, the plant structure along these corridors should intentionally differ from that of a typical road or boulevard. Emphasising a continuous tree-lined canopy and prioritising green elements over the road surface can effectively complement the overall design. In this regard, the Green Flag recommends the role of green spaces in enhancing ecological networks of habitats and species populations.

Criteria for a greater proportion of green spaces have been incorporated in the green infrastructure of UPV campus. The Environmental organisation of UPV, has already integrated these principles into green campus guidelines (Unidad de Medio Ambiente, 2022), by encompassing green strategies to increase native species and promote campus biodiversity. The update of UPV species inventories is necessary for future actions. In present a research-inventory of campus landscape is developing, as it is one of the concerns of the vice-rectorate of the sustainable development of campus.

7.5.3. Area and functions

Open spaces have similar functions within the neighbourhoods and districts of a city. A fair distribution of space and a hierarchical approach can be implemented across various scales to effectively differentiate and segregate the common space (the central axis) from the accessory spaces (spaces located between and adjacent to buildings). This approach enables the effective fulfilment of uses for urban green infrastructure.

Regarding the space's area, it is generally observed that people prefer larger open spaces, as spacious places are more attractive and provide room for a variety of activities. For instance, Agora Square (COS 25) is preferred by students and its proximity contributes to its status as one of the most frequently utilised spaces on campus. Due to the absence of an initial and functional campus design, the focal point that was originally intended for the central plaza has extended throughout the entire common area of the central green axis. Notable examples of COS along the central axis (parks) exhibit this attractive condition. The small-sized spaces in UPV's campus should be designed to become more attractive and offer a wider range of services and uses.

Spaces located adjacent to buildings or between buildings should be designed to fulfil different functions. For example, on campus, these areas are the front or back yards that are more private spaces for each faculty or institution. In these spaces, respondents are involved in activities different than in common areas. At district scale, accessory spaces can be designed according to specific age groups or activities, such as toddler play areas for families with children, basketball courts for teenagers and adults, or seating areas and walking paths for seniors. Small parks or gardens with landscaping elements throughout the area enhance the space's visual appeal and create a sense of place.

Each open space should be designed to allow people to enjoy them, not just for the mere use of space. Based on the synergies identified among activities and UGI's functions, respondents tend to prefer three types of places. Firstly, they prefer sites that satisfy their social and basic daily needs, such as eating, resting, having a place to sit and read, and places to meet with their friends or colleagues. Secondly, they prefer peaceful and relaxing places where they can better study, enjoy nature's cooling effect and escape from the daily routine. Thirdly, they prefer places that provide more dynamic use, such as walking, doing sports, and playing.

7.5.4. Landscape design strategies

In addition to context attributes, content attributes should be considered when designing open spaces. The landscape design strategies based on biotic, abiotic, and material elements can increase space's structural and functional diversity. All these attributes contribute to designing an open space that promotes either social interactions or privacy, both of which are important objectives in open space design. Social interactions are a powerful means of bringing people together and cultivating a sense of community. However, designing open spaces that offer privacy can be a challenging task. According to Lau

(2014), well-designed campus open spaces should express coherence, clarity, and comprehensibility and give the chance to passerby to observe nature and people and to establish connections with other citizens, with the natural environment and sometimes inner connections. Here are some design strategies to consider at open space level.

Biotic features

Respondents prefer spaces with good vegetation cover and diversity of tree species. Open space and greenery are essential for the district's image, and their benefits increase the community well-being. When designing urban open spaces, it is important to consider the vegetation structure, density, and diversity. Greenery and variety are associated with a more natural aspect than lawn areas and provide beautiful views. Street trees and green verges can be planted to mitigate the effects of urban heat island, provide shade, and improve air quality making the space more comfortable and healthier for everyone who uses it.

Lawn

Planting lawn areas is recommended as it provides a lot of green to develop different activities. Open lawn areas that are visible to the public can encourage social interactions. Within the university community, especially among students, the lawn is a popular spot for spending leisure time due to its versatile uses. On one side, law provides an informal use for activities like passing through, gathering with friends, relaxation, and having meals. On the other side, the lawn is also utilised formally for outdoor classes and research activities. To optimise its use, it is essential to maintain a well-watered lawn. Cooper and Wischemann (1990) advised watering the vegetation at night or outside the community's schedule.

According to Lau et al. (2014), lawn areas are versatile playing surfaces suitable for individuals of all ages. Respondents perceive green spaces as peaceful, relaxing and suitable for studying. Likewise, Wang and Jiang (2021) emphasised the significance of green areas for students to engage in passive activities such as reading, meditating, or simply appreciating the scenery, while hardscape areas are suitable for activities like walking. Additionally, apart from its practicality, the lawn enhances the aesthetic quality (Wang et al., 2021). Hence, it is advisable to incorporate other vegetation elements such as flowers, shrubs, or trees to avoid creating a monotonous landscape.

Trees, shrubs, bushes, creepers and flowers

Campus exhibits a high diversity of spaces, particularly in areas with botanical features. However, other spaces have been created for specific purposes, though without an established design or connectivity plan in place. According to Abu-Ghazzeh (1999) and Hanan (2013), the central area of the campus was envisioned as a river-like space with green elements. This includes the presence of trees along the axial route, as well as shrubs and grass, which contribute to the provision of shade and thermal comfort. This design concept is similar to the green axis of UPV.

To increase *diversity*, more aged trees, shrubs, bushes creepers and flowers could be integrated into the existing habitats, especially big, shade trees, to ensure natural breezeways and an effective cooling effect. Such landscape elements offer a more natural aspect of open space, complementing the manicured gardens, enhancing the space's visual appeal and creating a sense of place. To support climate comfort, especially in a Mediterranean climate, planting autochtone species adapted to climate conditions is recommended. The local ecology, including native plant and animal species, should be considered when designing urban GI. Planting native species can help to support the local wildlife and increase the biodiversity in the area.

To enhance social relationships, one effective strategy is to plant groups of trees that provide shaded areas, particularly for large groups of people who require ample shade, as well as complementary sunny areas. This strategy helps to create different zones which allow to satisfy diverse preferences and needs.

The participants of the survey emphasise the importance of shade and trees for their overall well-being and show interest in planting flowers, as they are rare on campus and primarily associated with trees, with few shrub species. Introducing flowers on campus not only enhances biodiversity, but also adds vibrant colours to the landscape, breaking away from the monotonous lawn setting. The diverse and dynamic compositions of colours, textures, and patterns of flowers can delight people's sense of sight (e.g., a garden with flowers or a densely planted flower border) (Lau et al., 2014). University community members, even propose to *carry out tree planting programs with the students, or other species such as flowers, and encourage gardening and landscaping programs*.

Respondents express the desire for more private spaces to engage in activities. To provide privacy, trees, shrubs, and hedges can be used to create natural barriers and boundaries that help to develop a sense of enclosure. Trees and rich green cover and trees are associated with reading activities (Hodson & Sander, 2017; Smardon, 1988). Planting taller trees or shrubs can create a natural wall that separates the open space from the surrounding area. Isolated trees with large crowns or rows of trees can also be effective strategies. Cooper and Wischemann (1990) suggested using screen spaces with natural vegetation or a wall at their back, semi-enclosed patios or terraces surrounded by walls, glass, and planting on three sides. Lau et al. (2014) proposed design strategies that engage all senses, including smell, sight, touch, and sound, to create a peaceful, healing, and mysterious place that evokes a relaxed ambiance, calmness, and complexity. Plants that provide diverse scents, ranging from acrid to sweet and fruity to musky, can delight users and make them experience enjoyment unconsciously. Vegetation with different textures such as pubescent plants and flowers, plants with waxy leaves, and coarse, rough, or wispy foliage, can draw people's attention and encourage them to interact with natural elements, while increasing the visual quality and creating the impression of changes in plant design and space enlargement (Lau et al., 2014).

Abiotic features

Mounds

Terrain level changes can break the monotony of the landscape and the topography of a space can increase people's preference. It is not recommended to build only uniform and flat open areas. Mounds can provide opportunities for social interaction, as they can be used for group activities such as picnics and meeting points. People prefer places with good conditions to eat and beautiful views. Therefore, mounds offer a physical location for individuals to appreciate the surrounding scenery, thus making them attractive spots, such as restaurant terraces. It is advised to design these terraces in a manner that allows for views of the plaza (Cooper & Wischemann, 1990).

Open spaces with varying terrain can also be preferred by people, especially those seeking a secluded atmosphere. Mounds can also provide a sense of privacy when designed to create intimate spaces or used as natural barriers to screen off certain areas from view. Lau et al. (2014) suggested that hills, ponds, and groves of trees are attractive natural features that provide variety to the landscape and help design peaceful and relaxing locations.

The hills are not part of the plain of Valencia and L'Horta de Valencia. However, implementing some earth movement to better divide different spaces could be considered.

Water bodies

The presence of water, including fountains and ponds, is emphasised by the respondents for its role in regulating the temperature of the environment, especially in close proximity to vegetation. The desire for more water bodies in the green areas reflects the preferences expressed by the respondents. In addition to their cooling function, fountains also serve aesthetic purposes, as noted by Cooper and Wischemann (1990) and Wang and Jiang (2021), and create a calming and intimate atmosphere (Lau et al., 2014). A structure of small drainage ditches or streams can give character to the campus landscape allowing to connect the different open spaces and facilitate water management.

Locations in proximity to water features, like lakes, streams, canals, ponds or fountains are often preferred by individuals seeking relaxation and tranquillity. Implementing small fountains or water features can promote private environments. People who choose spaces containing fountains indicate their preference for more contemplative places, especially the graduate students, and mature and older university staff, who prefer quieter places than the chaotic central plaza (Cooper & Wischemann, 1990). Effective strategies proposed by Lau et al. (2014) to generate serenity and provide relief for individuals include the use of fountains with the soothing sound of running water, which can help to mask the outside noise. Other elements such as the sounds of birds, insects, and plants, harmonising with the rhythm of wind and rain, as well as water columns, water drops, and fish swimming in a pond, further enhance the calming effect. In contrast, open space with natural waterscape can inspire gathering activities (Wang et al., 2021), as they provide people with a space to gather, eat, play, or study together (Cooper & Wischemann, 1990).

Infrastructure elements

Common, inclusive and accessible spaces should be designed to generate high use throughout the day and to meet the needs of different groups of people.

Furniture

Based on the results, the lack of or need for improvement in the utilitarian function of open spaces has been frequently highlighted by the respondents, specifically in terms of providing tables to satisfy their basic daily needs, including eating and studying. A mix of furniture elements and seating options such as tables, benches, or chairs, can satisfy people's basic daily and social needs and facilitate the development of related activities involving physical support, e.g., having lunch, resting, reading, or gathering with friends.

The design of seating features should be flexible enough to accommodate different preferences and create a variety of meeting and private spaces. Rollins (2009) suggests sociopetal elements such as circular seating, tables, and arrangements, or picnic-type tables, can create a comfortable atmosphere for users. These elements accommodate different persons or groups and encourage movement and interaction. It is recommended to provide movable seating and tables where appropriate, so that users can arrange them as they wish (Cooper & Wischemann, 1990). Central seats and lawns are prominent elements and are suitable for people who like to be in the spotlight (Cooper & Wischemann, 1990). Benches are spots from which it is possible to see or be seen by people. More noticeable benches attract the users who like to be in the spot of the light (popular) (Abu-Ghazzeh, 1999)

Outdoor furniture can be arranged to create smaller and more intimate spaces. Long and narrow sitting features are socio-fugal elements that discourage people from gathering. Users who are looking for some privacy, usually shy, introverted, or indifferent persons prefer more hidden spots (Abu-Ghazzeh, 1999). Seating areas placed in corners or against walls and columns also create a sense of enclosure and could be associated with people who look for secluded spots. In addition to green screens, screens or panels made of different materials can create physical barriers between different areas of the open space and provide a sense of separation between different zones or create a backdrop for a seating area. All these strategies can create a more intimate and enclosed atmosphere for users.

Drinking fountains

There are numerous complaints regarding the lack of drinking water sources. Their implementation could significantly enhance people's preference for a place and fulfil their daily basic needs. Drinking fountains serve as gathering points where people can interact and engage in conversations while quenching their thirst. At the same time, they provide individuals with a sense of privacy in terms of convenience and accessibility, as respondents can avoid the external sources. According to literature and people's needs (Cooper & Wischemann, 1990), water fountains and ample litter containers should be placed close to seating areas.

Lighting

Respondents perceive that safety can sometimes be a concern in peaceful locations. Lighting can play a crucial role in addressing this concern by encouraging social interaction and creating a sense of safety or privacy depending on the design. Therefore, spaces need adequate lighting, especially during the night (Cooper & Wischemann, 1990).

Chapter 8. Conclusions

8.1. Background and relevance of research

Applying design criteria for high-quality open spaces and effectively implementing urban green infrastructure can contribute to climate change adaptation and urban resilience. Urban green infrastructure elements not only aid in mitigating the effects of climate change but also foster a stronger sense of community, encourage cooperation, and combat social exclusion and isolation. Urban green space management aims to provide natural and man-made features, facilities, and amenities that allow users to enjoy recreational, emotional, social, and educational experiences.

However, restoring the functions and services of natural elements in urban environments and fostering relationships between people and open spaces are long-term goals. Urban planners face several challenges when designing open spaces such as the lack of an initial design, physical space limitations, high and varied demands, and the use of space and amenities. As society becomes increasingly diverse, urban green infrastructure elements should cater to various interests and recommendations. Human beings are anthropocentric and the ultimate beneficiaries of open space. Therefore, the area's design should be adapted to their different profiles, preferences, and needs. People base their decisions to use a space, their preference for a space, or their evaluation of a space's quality not only on objective reasons such as the space's structural characteristics, but also on subjective factors like age, personal experiences, lifestyle, daily activities, interests, needs, and purposes.

The analysis of the structural features of a space is valuable in creating guidelines for urban and landscape planners to design high-quality open spaces. Additionally, perceptions and values of a space can be effectively utilised in the decision-making process for planning and management to identify potential synergies or conflicts between services, indicate special meanings of places, and identify opportunities for improvement of education and the public's well-being.

This research examines the perceived quality of the outdoor environment on the campus of Universitat Politècnica de València (UPV) by linking subjective evaluations with objective measurements of structural characteristics. It explores the university community's preferences and use of space, as well as the perceived quality of landscape services provided by the campus open space. The public's evaluation of the functions and services supplied by the green infrastructure elements can contribute to identifying and implementing processes and decision-making to improve the space's design and quality.

The research also aims to help urban planners understand the functions of open space and how to satisfy the public's needs. When designing such places, it is essential to know which services are commonly well-evaluated and perceived as necessary for the well-being of users and which services could differ based on people's profiles and needs. This leads to better perceptions of the space's benefits and, implicitly, its satisfaction. Achieving the community's satisfaction with the quality of landscape, understanding the perceived benefits provided by open space and listening to people's needs and recommendations, are small steps towards transforming open *space* into a *place* that, in the case of UPV, becomes the university community's second *home*.

This research gives knowledge on how psychosocial variables such as preference, perceptions and use, can be effectively applied in open space planning and design. The thesis provides insights into the characteristics of a place that determine the level of preference and use, as well as the perceived functions. As shown in the analysis models, preference for a space can be explained by the coherence between people's needs and the structural characteristics of the environment.

While preferences and use of open spaces have been studied in the literature, an analysis of open space typology considering the structural characteristics to better explain preferences for space, has not been done in the campus context. The research results provide some clues regarding the preference and use of typologies and the quality of open space, and provide helpful information for landscape management. The landscape services used as a tool for measuring perceptions have pointed out that the preference for a particular open space is related to the valuation of the space's quality. It enables us to examine the relationships between people's reasons for a particular use of an open space and its value.

The results of this research can help Universitat Politècnica de València (UPV) meet the environmental guidelines inspired by the prerequisites of the Green Flag. Furthermore, thesis's findings provide valuable insights not only for the UPV, but also for other university campuses that aim to achieve sustainability and receive the Green Flag Award. Such findings can help landscape planners to align the goals of a green campus with the principles of a Green-Grey-Blue integrated system. The mission of green and sustainable university campuses is to establish a sustainable framework that simultaneously ensures future growth, regenerates natural systems, and enhances the campus experience for its entire community. In our opinion, outdoor areas should provide an excellent educational background in the context of a healthy and sustainable place.

8.2. Validation of hypotheses

The ***general objective*** is to evaluate the functionality of urban green infrastructure through the perceived landscape services within a campus setting, mediated by the relationships between university community members and open space, which involve their preference, the use of space, and their satisfaction regarding the current state and management of the outdoor areas.

In order to achieve the overall objective, the following research hypotheses have been completed or/and partially confirmed (validated).

Hypothesis 1. The perceived supply of LS and satisfaction with campus landscape are expected to be mediated by the profile of university community members

Hypothesis 1.1. Users'socio-demographic variables (e.g., age, occupation and branch of knowledge) and user-related characteristics (e.g., frequency and preference for spending free time in outdoor environment) are expected to influence the perceived supply of LS of campus landscape.

Hypothesis 1.1 has been validated and the results of chapters 6.3.3 and 6.3.4 support it. User's-demographic variables, age, occupation and branches of knowledge have an impact on perceptions of landscape services.

Teaching and research staff, administration and services staff, and the younger respondents evaluate more positively the supply perceived of LS.

Respondents with a focus on Health & Food Science and Agri-food & Forest Engineering tend to have negative perceptions of the quality of the campus's open spaces in terms of providing landscape services. Additionally, gender has been found to support hypothesis 1.1, since females evaluate more positively the whole range of perceived supply of LS. As for user-related characteristics, frequency of visits and user's preference referring to the place to spend their free time, influence the perceived supply of LS. Higher frequency of visits and preference for sports places elicit a more positive evaluation of LS.

Therefore, gender can be considered a relevant variable for the studies of perceptions of open space quality together with the other user's-demographic and user-related variables.

Hypothesis 1.2. There is a relationship between the profile of the respondent, especially their occupation and branches of knowledge, and the level of satisfaction with the current condition of the campus landscape.

The hypothesis 1.2 has been partially validated and the results of chapter 6.3.5 which provide partial support. Out of the seven branches of knowledge, only three (Art & Humanities, Social & Legal Science, and Health & Food Science) have established positive relationships with satisfaction with the present condition of the campus landscape. Among these, Health & Food Science is the only branch specifically related to landscape disciplines. No other links have been detected for the rest of the variables.

Hypothesis 1.3. The higher perceived supply of benefits delivered by COS, the higher the satisfaction of university community members.

The results of chapter 6.3.6 hold for the hypothesis validation. This work reveals that the perceived type of LS affects respondents' satisfaction in two ways. Respondents who more positively evaluate the perceived supply of regulating LS, like the environmental condition of campus landscape, are more satisfied with COS's condition and management. Conversely, respondents who more negatively evaluate the perceived supply of cultural LS seem to not be satisfied with the current situation of COS. The evaluation of different subgroups of respondents regarding individual LS items is relevant to understand the general satisfaction with COS's condition. Females, teaching and administration staff, and respondents who visit the open space three, four and more than four times a week, express more satisfaction with the current state and management of COS than the other groups.

Our research is able to demonstrate that LS perceptions provide a more comprehensive way to understand satisfaction with COS. Using the whole range of LS represents a way to explain the reasons for the satisfaction relationships of the university community members with COS. On the contrary, directly asking about people's satisfaction may provide negative answers, as in the case of the UPV campus.

Hypothesis 2: Structural characteristics of COS are expected to have an impact on the use of space.

Hypothesis 2 has been validated, and the results presented in Chapter 6.4.1 support it. Placement is the most significant variable able to predict the use of space, particularly the central area, followed by size and proximity to Ágora. The university community members tend to use mainly the larger open spaces that compose the green central axis of the campus or are located in close proximity to common areas, as well as spaces that provide access to campus services and facilities.

Hypothesis 3. Structural characteristics of COS are expected to exercise an impact on the respondents' preference for outdoor areas.

The results of chapter 6.4.2 support the validation of hypothesis 3. Mounds, drinking fountains, central placement, the number of tree species and space area are significant predictor variables for space preference. University community members prefer commonly located sites that are centrally situated, with different topography, diverse tree species, and sites well-equipped with elements of urban furniture such as drinking fountains.

Hypothesis 4. The activities undertaken by the community are expected to influence participants' preference for open space when considering their free time in the context of COS.

The results of chapter 6.5 and 6.6.1 are consistent with hypothesis 4. The results of the study show that activities such as relaxation, eating, sports, socialising with friends or colleagues, walking, and playing are significant factors that influence participants' preferences for open space. The respondents tend to prefer gathering in places where they have their daily meals, but when it comes to relaxation, they prefer locations that provide different conditions.

Hypothesis 5. LS-related factors are expected to serve as influential factors in the preference of the university community.

The results of chapter 6.5 and 6.6.2 hold for the validation of hypothesis 5. Peaceful locations, places near campus points of interest, and good eating conditions are landscape service-related factors that influence respondents' preferences for spending their free time. Each type of space has its own specific landscape service-related factors that influence preferences. For example, greenery is a requirement for spaces perceived as providing good eating conditions and a relaxing atmosphere, while beautiful views are required for spaces considered adequate for eating. A peaceful location is associated with a higher focus on studying or work responsibilities, but it is not necessarily associated with the place's safety.

The results of the research provide a deeper understanding of how the campus environment influences the daily lives of its members, including their preferences, usage patterns, and evaluations of services. By analysing the maps of usage and preference, as well as the LS-related reasons for choosing particular areas of the campus, it was found that at a smaller spatial scale, there is a greater synergy between various services and activities. This means that areas with similar services and activities tend to be grouped together, creating a more cohesive and integrated campus environment. This information can be used by campus planners to design and develop more effective and efficient spaces that meet the needs and preferences of its community.

The open space typologies play a crucial role in predicting space preference and understanding the factors that influence how university community members use the space, the activities they carry out, and the quality of perceived LS-related reasons. These preferred functions and characteristics transform the campus landscape into a learning environment where members feel supported and motivated in their pursuit of knowledge, a safe location, a popular and private environment for meetings, a natural setting with extensive green cover to enjoy nature and its beautiful views, and a meditative environment to disconnect and relax.

Chapter 9. Limitations and future lines of research

9.1. Limitations and exclusions

The main limitations of this work include the possible bias traditionally introduced by online surveys, which could lead to under- or over-representation of different cohorts. As discussed above, relations of causality could be affected by socio-demographic characteristics (for instance age or the time spent at UPV). The personal experience with UPV open spaces and other open places should be also inquired, as the same landscape is perceived differently by individuals who have had different experiences in that place.

The sample's size or the sample's representation groups could influence the model and the study's interpretation. But this bias would also be expected in other types of urban environments such as old neighbourhoods, in which the older people predominate unlike in the newly created neighbourhoods.

This work seeks to know why respondents prefer specific open spaces, but not their reasons for using them. Future research will address more specific aspects of the level of use of open space and also aspects for improving open spaces, e.g., the expected or preferred ratio between green space and urban space. This study included quantitative and qualitative methods, but, for a deeper understanding, more extensive qualitative techniques, such as in-depth interviews and focus groups discussions and participatory approaches should be adopted in future studies.

The way the survey items and questions were formulated could also influence the answers of respondents and the data set. Possible confusion with or a misunderstanding of the questionnaire's items could have caused a similar evaluation of cultural services, which could explain the negative relationships, e.g., *space for research* (A7) and *space to learn about the natural environment* (A8), as the setting belongs to a higher education institution. Other similar items are *play areas* (A5) and *space to do sports* (A6), as within the university context sports are more common and accessible than other types of games.

The model of study cannot rigorously explain the lack of some associations between observed and latent variables, e.g., students and perceptions of all types of LS, age or campus preference and regulating LS or different engineering branches of knowledge and perceptions of the whole range of LS.

The design outcomes identified for open spaces in general based on campus results may have limitations when applied to urban areas. Urban areas have specific user needs and diverse functions that may not be common in campus spaces. Urban parks and playgrounds often feature equipment suitable for various segments of the public. For instance, in urban areas, it may be necessary to incorporate playgrounds or recreational facilities that specifically cater to the needs of families and children. Additionally, when it comes to boulevards and streets, the impact of carbon sequestration due to traffic emissions becomes a significant consideration, as urban residents may have a greater need for clean air and mitigation of pollution.

Campus outdoor areas is a particular place designed for its particular public (university community members). We cannot compare campus population with the general population, as some age and cultural sectors are missing or are underrepresented. For example, the proportions of females up to 50 are slightly higher than males and over 50, the opposite. Besides these conditions, the functionality of campus space is different. The structure and elements of a place are responsible for the provided services which bounce in the perceptions of users and, thus, in their satisfaction with places' current condition. Some elements of campus open space can be found in the majority of urban public places like lawn, trees or benches, and could fulfil similar functions and services everywhere. However, there are other elements which are specific to achieving the daily needs of groups of university community's member, which could be detected with the use of their perceptions like tables to study or special outdoor space to do research.

Understanding the typology of open space of campus can inform campus planners and university administrators about the potential challenges and opportunities that are associated with their specific campus landscape type. In addition, proposing a campus open space typology is a key step in investigating the potential relationships between different campus types and the institutional identity of universities. Furthermore, the typology of university campuses can shed light on the dynamics of town-gown relationships.

Therefore, thesis results can be valuable for landscape planners as they seek to design open spaces in accordance with public demands and patterns of use. Understanding the demographic characteristics, preferences, satisfaction and demands of the local community, can help prioritise and improve the provision of common services and amenities. Evaluating people's satisfaction with open space in terms of landscape services is an effective strategy for determining how individuals value each service offered by these areas.

The methodology outlined in the thesis is transferable to diverse university campuses, though certain aspects, such as delineating COS and mapping them, may require adjustments based on the specific campus infrastructure and delimitation criteria (e.g., the inclusion or exclusion of grey areas, the use or non-use of building borders as reference points). Conversely, components like the survey questionnaire can be applied directly to the community members, with the potential for introducing new or adapted items depending on the public's utilisation of space. Ensuring the ongoing relevance of survey questions to capture distinct facets of the campus environment is crucial. Additionally, cultural differences on the new campus should be considered, recognizing that preferences for open spaces may vary due to regional or national cultural factors. Moreover, the thesis methodology, involving surveys and space characterization, is applicable as well to various urban open spaces, including parks, gardens, or squares. Adaptations in structural elements are expected, aligning with the services commonly provided by each space to meet diverse public needs.

This research offers a complementary methodology to a quantitative one, based on qualitative data, which helps to provide new information that may not be captured by the survey statements alone. The opinions and requests of respondents reveal care, preoccupation, and involvement in the present management of the campus landscape. The open-ended responses allowed for the identification of places with present management problems. Linking mapping with questionnaires is an easy-to-apply method that can be adopted easily. In planning and developing urban green areas, this method provides guidance to plan and manage urban green areas efficiently.

The results of the thesis are helpful, not only for universities, but also for all elements of urban green infrastructure that have yet to have a multifunctional landscape design and are adapting to the needs of their users (e.g., university community members, neighbours, town/city inhabitants).

9.2. Further research

A large amount of information was collected for this study. However, further research is needed to understand if additional factors influence people's judgement when they assess the perceived capacity of campus outdoor areas to provide LS. Additional quantitative analyses will be carried out in the future to assess high-quality benefits and users' perceptions and preferences, since are relevant for landscape planners. Future research will consider additional variables, such as viewing from adjacent university buildings and significant places for the university community. While this study might have provided some insights, further research might include, for example the presence of friends and colleagues as a factor influencing people's preference and perceptions about places and spaces. Their role in perceptions about space's restoration, health and safety, has been often inquired in the literature (Liu et al., 2022; Staats & Hartig, 2004).

Our results related to the perceived high-quality benefits are only estimated through the survey study. A reliable system of green indicators to assess the quality with which landscape services are provided by green outside areas has implications for future research, especially for current design and future improvement actions. A promising direction could be to investigate if there are differences in the perceived supply of LS among different UGI elements on campus or other urban environments.

Regarding indicators, future studies can incorporate additional data collection techniques such as daily measurement and mobile measurement to visualise both diurnal and nocturnal effects of urban morphological parameters and microclimate variables covering a larger area. Therefore, different climate scenarios based on different UGI approaches, could be analysed to discover the best strategy for climate adaptation. This research has addressed environmental parameters, such as temperature and air quality, in preference analyses through users' perceptions. Given that micro-climatic characteristics may result from spatial configurations or be influenced by the typology of plant species present, these could serve as predictors to enhance our understanding of users' preferences for open space. Consequently, there is an opportunity for further research using experimental measurement of environmental parameters as a complementary methodology.

The instrument of the survey was an online questionnaire. In situ surveys allow respondents to provide responses on perceived impacts of the UPV on their well-being more specifically and intuitively. Further in situ surveys should be carried out and compare the results with results obtained through online methods to discover if there is any difference. In situ survey give access to soundscapes and other sensory aspects of each university, which may play an important role in understanding the perceptions of university community members. In situ surveys are thought to connect more people with campus and their perceptions than the online surveys (Foellmer et al., 2021). Research on restorative environments is progressing to encompass these aspects of nature interactions and the associated benefits (Krzywicka & Byrka, 2017), as often students' perceptions and their connections to nature are examined by utilising digital photographic stimuli (van den Bogerd et al., 2018).

Moreover, our study did not reveal significant differences in campus open space needs between females and males. However, we recommend conducting further studies on the demands of the university community based on gender, which can inform campus landscape planners.

This study focused only on the role of campuses as providers of green space to university community members, so, it would be interesting in the future to consider the role spaces play for the local inhabitants, as this subject is increasingly recognized in studies on urban green space provision and use (Fassi et al., 2016; Rashidi, 2013). To conduct systematic research in this area, thesis theoretical framework for analysing links between campus landscape and university community members, is relevant.

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Annex 1. Paper related to Thesis

TUDORIE, C.A.-M., VALLÉS- PLANÉLLS, M., GIELEN, E., ARROYO, R., GALIANA, F. (2020). Towards a Greener University: Perceptions of Landscape Services in Campus Open Space. Sustainability 12, 6047, (10.3390/su12156047)

This study presents a general evaluation of how the university community perceives the landscape services provided by the Universitat Politècnica de València's campus open space. An online questionnaire was distributed to the university community members to assess their opinions, satisfaction levels, and demands regarding the current state of the outdoor areas. Moreover, the study researches their perceptions of the quality of campus open spaces with diverse urban green infrastructure elements in delivering cultural, provisioning, and regulating landscape services.

Annex 2. Survey on the benefits of the open spaces of Universitat Politècnica de València campus

Please, take about 15-20 minutes to fill out this survey.

This research is carried out by the Department of Rural and Agri-Food Engineering, the Department of Urbanism and the Department of Transportation Engineering and Infrastructure. The survey is used for the doctoral thesis of Carla Ana-Maria Tudorie, under the direction of the tutors, María Vallés- Planélls and Eric Gielen, in collaboration with María Rosa Arroyo López and Francisco Galiana.

The objectives of the survey are:

Evaluate how the university community perceives the open spaces of the UPV campus.

Explore users' preferences for different types of campus open spaces.

Discover the opinion and needs of users regarding the condition and management of the campus open spaces.

Open space means an accessible urban ecosystem, without buildings or other built structures, a heterogeneous space characterised by the presence of a diversity of functions and users, formed by different elements connected to each other: green spaces and grey spaces.

During the survey, this map will be used to help the respondents better identify the open spaces (numbered from 0 to 52) of the UPV campus. The open spaces can be: parks, gardens, outdoor terraces, lawns, walking areas and outdoor play areas. Sports fields such as football, tennis, volleyball, basketball and athletic tracks have been excluded.

CONDITION AND IMPORTANCE

1. How many times a week do you use open spaces inside campus? “Using” means spending time in a specific place (sitting on the lawn, on a bench, on the coffee shops terraces or practising some outdoor sport etc.) and small walks through open spaces.
    - Never
    - 1 time/week

- 2 times/week
- 3 times/week
- 4 or >4 times/times
- Do not know / Do not answer

2. Where do you prefer to spend your free time inside university campus?
    - Open spaces
    - Indoor spaces
    - Sport spaces
    - Other
    - Do not know / Do not answer

3. How would you rate the aspects of the current state of the open spaces of the campus in general? Campus open spaces provide:
    - Pleasant space for short or long walks
    - Space to study / work
    - Space to meet daily basic needs
    - Quiet space to relax
    - Play areas
    - Space to do sports
    - Space for research
    - Space to learn about natural environment
    - Space for art creation
    - Space to gather with friends
    - Protection against floods
    - Air quality
    - Pleasant temperature and light
    - Habitat for native species
    - Do not know / Do not answer

4. Please, value your satisfaction regarding the open spaces condition and management.
    - Very good

- Rather good
- Neutral
- Rather bad
- Very bad
- Do not know/ not relevant

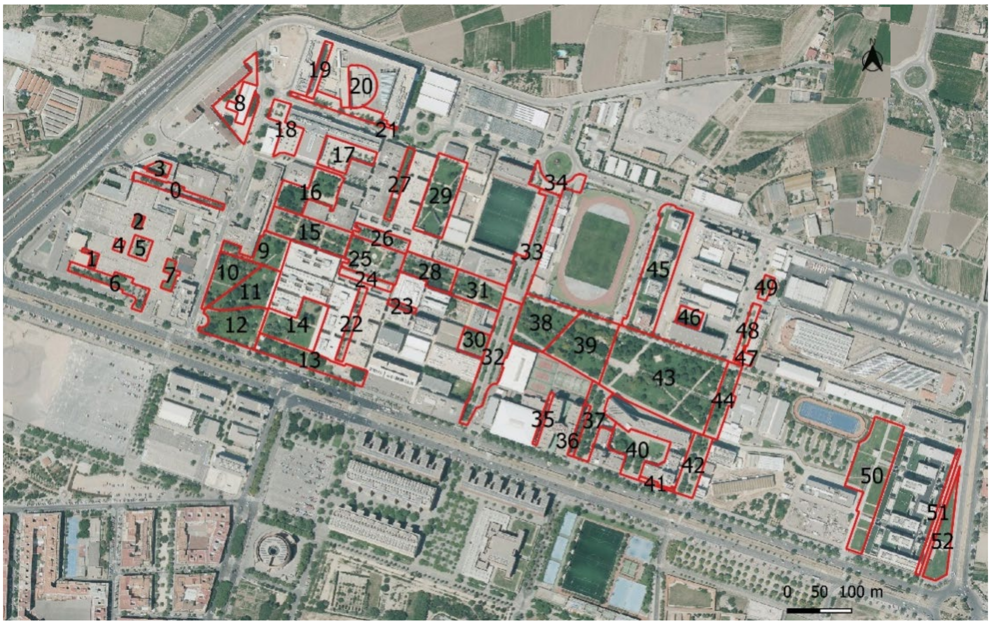
5. Please, mark your needs according to your satisfaction level regarding the open spaces.

    - More tables and benches outside in order to eat
    - More outdoor sites for recreational or sport activities
    - More tranquillity
    - More security
    - Water elements (fountain)
    - Less asphalt surfaces
    - Cleaner air
    - More trees
    - More natural shadow areas
    - More native species and higher proportions of each species
    - Use open green spaces as natural classrooms, laboratories or workshops (botany, landscape, ecology, architecture, design, photography etc.).
    - More open space next to my school/my work
    - Other
    - Do not know / Do not answer

PREFERENCES AND EVALUATIONS

Look at this map and note, please, two open spaces of the campus that you use the most. The open spaces are numbered from 0 to 52.

OPEN SPACES OF UPV CAMPUS



6. Using the same map, please note two campus open spaces that you prefer. The open spaces are numbered from 0 to 52.
    - 1………
    - 2………

7. Please, answer to the following questions thinking about these two preferred open spaces, that you have chosen in question number 4. Choose the activities carried out within the open space 1.

    - Doing short or long walks
    - Working/Studying in campus open spaces
    - Having breakfast/snack/lunch
    - Relaxing /Enjoying beautiful views
    - Playing
    - Doing sports
    - Research
    - Learning about structure and functions of natural environment
    - Painting/Drawing/ being inspired by natural environment
    - Driving a truck
    - Gathering with friends, colleagues
    - Other
    - Do not know / Do not answer

8. Please, answer to the following questions thinking about these two preferred open spaces, that you have chosen in question number 4. Choose the activities carried out within the open space 2.

    - Doing short or long walks
    - Working/Studying in campus open spaces
    - Having breakfast/snack/lunch
    - Relaxing /Enjoying beautiful views
    - Playing
    - Doing sports
    - Research
    - Learning about structure and functions of natural environment.
    - Painting/Drawing/ being inspired by natural environment
    - Driving a truck
    - Gathering with friends, colleagues
    - Other
    - Do not know / Do not answer

9. Please indicate your degree of agreement with respect to the following statements, thinking about why you prefer more open space number 1 (chosen in question number 4), than other open spaces. Mark 1 if you strongly disagree, 2 if you do not agree, 3 if your position is neutral, 4 if you agree or 5 if you completely agree.

    - Because of their peaceful location (isolated)
    - Because I can concentrate more to study.
    - Because I have plenty space to do sports
    - Provide good conditions to eat (there are tables, banks)
    - Because of beautiful views
    - Because I feel safe
    - They are the background of my research
    - Because of the green cover
    - There are more species of flowers and animals
    - Because of the natural aspect
    - Because I prefer permeable spaces
    - I prefer to breath clean air

- I am looking for sunny areas
- I prefer shady areas (natural vegetation shade)
- They are near some of campus interest points: classrooms, library, laboratories, restaurants, sport facilities etc.
- Do not know / Do not answer

10. Please indicate your degree of agreement with respect to the following statements, thinking about why you prefer more open space number 2 (chosen in question number 4), than other open spaces. Mark 1 if you strongly disagree, 2 if you do not agree, 3 if your position is neutral, 4 if you agree or 5 if you completely agree.

    - Because of their peaceful location (isolated)
    - Because I can concentrate more to study.
    - Because I have plenty space to do sports
    - Provide good conditions to eat (there are tables, banks)
    - Because of beautiful views
    - Because I feel safe
    - They are the background of my research
    - Because of the green cover
    - There are more species of flowers and animals
    - Because of the natural aspect
- Because I prefer permeable spaces
- I prefer to breath clean air
- I am looking for sunny areas
- I prefer shady areas (natural vegetation shade)
- They are near some of campus interest points: classrooms, library, laboratories, restaurants, sport facilities etc.
- Do not know / Do not answer

PERSONAL INFORMATION

12. Birth year:

13. Gender:

    - Female
    - Male

- I prefer not to answer

14. Relationship with the university

- Student (Bachelor, Master, Doctorate)
- PAS (Administration and Services personnel)
- PDI (Teaching and Research Staff)
- Other

15. Maximum level of studies reached

- Secondary education (ESO)
- High school
- Medium-grade vocational training
- Higher level professional training
- Grade
- Master
- Doctorate
- Other

16. What is your knowledge branch(es)?

- Arts and Humanities
- Sciences
- Social and Legal Sciences
- Health Sciences
- Engineering and Architecture. Agri-food and Forest
- Engineering and Architecture. Architecture and Civil and Building Engineering
- Engineering and Architecture. Science and Technology for Health
- Engineering and Architecture. Industrial and Aeronautical
- Engineering and Architecture. Information and Communications Technologies
- Other

17. What is your opinion about open spaces of UPV campus? You can answer this question even if you have filled out the survey or not.

18. What recommendations or needs do you have regarding the condition and management of open spaces of the UPV campus? You can answer this question even if you have filled out the survey or not.

Thank you very much for your cooperation. Your participation is very important for the sustainability of the campus and the well-being of the university community. The information that you provide will be very useful for my doctoral thesis. Carla Ana-Maria Tudorie.

Annex 3. Cartography of tree cover

1. Creation of a layer of points, which were classified in different land covers in function of their location. The points were classified according to four different layers, which are: trees, lawn, pavement and shade (natural and supplied by buildings). Around 50 points for each type of land cover were considered enough to cover the variability of each land cover and to provide more precise results.
   1. a. First step of classification. The “Create signatures” tool of “Spatial Analyst” GIS function was used to carry out the classification and the creation of classes. These were generated in “gsg” format, which can be opened as a Notepad document in order to observe the statistical values of each class.
   2. b. Second step of Classification. “Maximum Likelihood Classification” tool was employed to analyse the data created in the previous step and was combined with the aerial photo in order to generate a raster format layer of the demanded classified land covers.
3. Convert the raster layer to shapefile format by using the “Vectorize” function of GIS.
4. Check and modify errors. These steps were performed several times, because of the errors made by the program regarding the colours of the pixels it uses to classify the areas where were located the points drawn in the first step associated to each type of land cover. Some problems appear because of similar colours of aerial photo components. For example, dark colour made it impossible to distinguish the tree shade from the buildings shade, or the light colours of paved areas from vegetation. The errors that have appeared in the new created layer were corrected by analysing the orthophoto and using some editing and vector tools.
5. Creation of the new tree cover layer. A new layer is created with the aid of new generated areas classified as tree

Annex 4. Tables of results of descriptive analyses of campus open space of the chapter 6 (6.1.1)

Table 4. 1. Characterization of campus open space through space and users-related information.

COS	Area (ha)	UGI (%)	Tree (%)	Proximity to central axis	Proximity to Ágora	Fav (N)	Use (N)
0	0.2	0	25	1	325	5	33
1	0.0	0	46	142	439	0	2
2	0.0	57	61	65	370	3	15
3	0.1	72	9	23	360	0	11
4	0.0	0	0	110	397	3	12
5	0.1	39	6	103	363	3	6
6	0.3	44	34	167	405	0	2
7	0.1	99	7	129	318	0	2
8	0.3	0	25	158	316	4	17
9	0.3	79	18	48	170	5	14
10	0.4	85	27	102	229	36	21
11	0.4	91	29	115	200	143	55
12	0.5	95	15	172	240	118	40
13	0.5	74	35	187	190	8	2
14	0.5	79	15	142	160	14	11
15	0.5	54	34	1	109	70	94
16	0.4	62	28	60	141	43	69
17	0.3	13	11	131	165	5	16
18	0.2	8	9	144	245	4	10
19	0.1	11	0	246	302	8	53
20	0.2	0	0	241	265	8	34
21	0.2	7	33	200	233	4	4
22	0.1	43	16	119	118	11	17
23	0.0	48	25	60	89	1	5
24	0.1	19	24	24	42	11	21
25	0.5	44	12	0	1	119	176
26	0.2	0	20	35	30	22	45
27	0.1	0	54	117	119	8	3
28	0.3	59	35	5	90	74	84
29	0.6	65	15	121	139	48	48
30	0.2	73	14	76	205	13	16
31	0.3	58	27	3	173	34	41
32	0.6	36	8	86	242	7	33
33	0.5	15	4	89	246	9	25
34	0.2	17	3	190	278	4	2

35	0.1	0	24	148	364	1	14
36	0.1	43	30	148	417	4	7
37	0.4	32	33	127	426	3	16
38	0.6	75	44	12	279	101	85
39	0.7	76	45	21	356	212	116
40	0.4	47	16	146	507	8	12
41	0.0	69	18	188	563	1	3
42	0.3	30	23	141	593	4	3
43	2.0	79	35	28	488	284	123
44	0.3	55	23	32	587	7	10
45	0.9	36	7	128	442	22	19
46	0.1	71	0	73	499	6	16
47	0.0	0	0	42	600	5	14
48	0.1	21	6	84	592	9	23
49	0.1	43	5	156	611	3	5
50	0.9	74	0	65	845	6	11
51	0.1	0	0	42	958	2	5
52	0.3	86	0	124	987	2	2

Table 4. 2. Characterization of campus open space through structural diversity.

COS	Structural diversity			
	Biotic	Abiotic	Infr.	Av
0	0.3	0	0.5	0.3
1	0.1	0	0.1	0.1
2	0.1	0	0.3	0.1
3	0.3	0	0.3	0.2
4	0	0	0.1	0
5	0.7	0	0.3	0.3
6	0.6	0	0.6	0.4
7	0.3	0	0.1	0.1
8	0.1	0	0.5	0.2
9	0.9	0.3	0.6	0.6
10	0.9	0.3	0.5	0.6
11	0.7	0.3	0.5	0.5
12	0.9	0.3	0.6	0.6
13	0.7	0.3	0.3	0.4
14	0.6	0.3	0.6	0.5
15	0.4	0.3	0.6	0.5
16	0.4	0	0.5	0.3
17	0.6	0	0.6	0.4
18	0.4	0	0.4	0.3
19	0.1	0	0.5	0.2

20	0	0	0.1	0
21	0.3	0	0.5	0.3
22	0.4	0.3	0.4	0.4
23	0.3	0	0.4	0.2
24	0.4	0.3	0.5	0.4
25	0.6	0.3	0.4	0.4
26	0.3	0.3	0.4	0.3
27	0.1	0.3	0.5	0.3
28	0.6	0.3	0.5	0.5
29	0.7	0.3	0.6	0.6
30	0.4	0	0.4	0.3
31	0.6	0.3	0.5	0.5
32	0.3	0.3	0.4	0.3
33	0.3	0.3	0.5	0.4
34	0.3	0	0.3	0.2
35	0.1	0	0.5	0.2
36	0.3	0	0.4	0.2
37	0.6	0.3	0.6	0.5
38	0.9	0.3	0.5	0.6
39	0.9	0.7	0.5	0.7
40	0.4	0.3	0.6	0.5
41	0.4	0	0.1	0.2
42	0.1	0.3	0.5	0.3
43	0.6	0.7	0.8	0.7
44	0.4	0.3	0.5	0.4
45	0.4	0.3	0.6	0.5
46	0.3	0	0.3	0.2
47	0.1	0	0.6	0.3
48	0.3	0	0.1	0.1
49	0.7	0	0.3	0.3
50	0.1	0.3	0.4	0.3
51	0	0	0.3	0.1
52	0.1	0	0.1	0.1

Table 4. 3. Characterization of campus open space through structural characteristics related to placement and green elements.

COS	PLACEMENT	UGI ELELEMENTS	NUMBER OF TREE SPECIES
0	Between build.	Asphalt with street trees	2
1	Adjacent to build.	Playground	2
2	Adjacent to build.	Yard	1
3	Adjacent to build.	Yard	2
4	Adjacent to build.	Asphalt	0
5	Adjacent to build.	Yard	2
6	Adjacent to build.	Green verge	3
7	Adjacent to build.	Yard	3
8	Adjacent to build.	Asphalt with street trees	2
9	Adjacent to build.	Garden	4
10	Adjacent to build.	Garden	5
11	Adjacent to build.	Garden	3
12	Adjacent to build.	Garden	4
13	Adjacent to build.	Garden	3
14	Adjacent to build.	Garden	2
15	Central	Park	7
16	Adjacent to build.	Garden	5
17	Adjacent to build.	Atrium	5
18	Adjacent to build.	Atrium	3
19	Adjacent to build.	Green verge	0
20	Adjacent to build.	Asphalt	0
21	Adjacent to build.	Green verge	1
22	Between build.	Green verge	3
23	Adjacent to build.	Green verge	1
24	Central	Balcony green	0
25	Central	Park	4
26	Central	Asphalt with street trees	2
27	Between build.	Green verge	5
28	Central	Park	5
29	Adjacent to build.	Garden	4
30	Adjacent to build.	Garden	4
31	Central	Park	5
32	Between build.	Green verge	1
33	Between build.	Green verge	2
34	Adjacent to build.	Green verge	1
35	Between build.	Asphalt with street trees	1
36	Adjacent to build.	Green verge	1
37	Between build.	Green verge	2
38	Central	Park	6
39	Central	Park	4
40	Adjacent to build.	Garden	1

41	Adjacent to build.	Green verge	1
42	Between build.	Green verge	1
43	Central	Park	5
44	Central	Green verge	2
45	Adjacent to build.	Garden	1
46	Adjacent to build.	Yard	0
47	Adjacent to build.	Asphalt	0
48	Adjacent to build.	Green verge	1
49	Adjacent to build.	Garden	1
50	Adjacent to build.	Street green	0
51	Adjacent to build.	Asphalt with street trees	0
52	Adjacent to build.	Street green	0

Annex 5. Tables of results of descriptive analyses of university community of the chapter 6 (6.2.1 and 6.3.1)

Table 5.1. Description of university community. Crosstabs according to socio-demographic characteristics (first population sample).

		AGE			
		<18-22	>22-30	>30-50	>50
OCCUPATION	Student	**59.1**	**29.1**	9.9	1.9
	AdSS	0.0	1.4	**53.5**	**45.1**
	TRS	0.0	4.5	**40.9**	**54.5**
		<18-22	>22-30	>30-50	>50
TIME SPENT IN UPV	<1-1	**77.9**	13.1	7.4	1.6
	2-5	**74.1**	13.0	10.8	2.2
	6-10	46.1	45.1	5.9	2.9
	>10	0.0	17.3	**41.3**	**41.3**
		TIME SPENT IN UPV			
		<1-1	2-5	6-10	>10
OCCUPATION	Student	25.9	58.5	12.4	3.2
	AdSS	1.3	5.8	6.5	**86.5**
	TRS	0.8	2.3	3.0	**94.0**

Table 5.2. Description of university community. Pearson correlation matrix between respondents′ characteristics.

CORRELATIONS	AGE	GENDER	OCCUPATION	LEVEL OF STUDIES	BRANCH OF KNOWLEDGE	TIME SPENT AT UPV	COS FREQUENCY
Age	1	.080*	**.719****	**.722****	-.054	**.756****	-.124**
Gender		1	.128**	.063	.181**	.122**	-.080*
Occupation			1	**.650****	-.012	**.662****	-.185**
Level of studies				1	-.003	**.667****	-.187**
Knowledge branch					1	.040	-.121**
Time spent at UPV						1	-.114**
COS Frequency							1

*. Correlation is significant at the 0.05 level **; Correlation is significant at the 0.01 level (2-tailed).

Table 5.3. Description of university community. Crosstabs according to socio-demographic characteristics (second population sample).

		AGE			
		<18-22	**>22-30**	**>30-50**	**>50**
OCCUPATION	Student	**50.4**	**37.0**	10.9	1.7
	AdSS	0.0	1.4	**48.2**	**50.4**
	TRS	0.0	3.9	**37.5**	**58.6**
		<18-22	**>22-30**	**>30-50**	**>50**
TIME SPENT IN UPV	<1-1	**75.4**	17.6	5.5	1.5
	2-5	**42.3**	**43.3**	11.3	3.1
	6-10	0.0	73.2	18.3	8.5
	>10	0.0	0.8	**44.2**	**55.0**
		TIME SPENT IN UPV			
		<1-1	**2-5**	**6-10**	**>10**
OCCUPATION	Student	**43.5**	**40.7**	12.7	3.1
	AdSS	2.0	4.7	6.7	**86.7**
	TRS	1.6	1.6	3.1	**93.8**

Bold is used to highlight the biggest values of respondents group

Annex 6. Tables of results of descriptive analyses of perceptions, satisfaction and needs related to campus open space of the chapter 6 (6.2.2 - 6.2.4)

Table 6.1. Descriptive analyses of perceptions, satisfaction and needs related to campus open space. Percentage of perceived landscape services according to respondents′ characteristics (gender, occupation, knowledge and age). Source: Tudorie et al. (2020).

LANDSCAPE SERVICES	GENDER		OCCUPATION			KNOWLEDGE		AGE			
	FEMALE	MALE	STUDENT	ADSS	TRS	LRD	OD	18–20	22–30	30–50	>50
Walks	82.8	79.2	80.5	80.4	82.5	76.0	83.7	84.8	76.7	79.1	78.9
Study/work	54.5	43.6	51.5	42.2	48.8	48.8	49.2	56.6	43.8	49.7	38.0
Daily needs	66.8	50.7	61.1	58.7	50.4	56.3	60.4	65.0	58.2	59.3	46.3
Relax	84.1	79.0	83.2	78.7	80.2	77.9	83.9	84.0	82.9	81.0	76.2
Play	56.9	47.6	55.8	50.0	42.5	48.8	53.9	59.9	48.3	49.1	42.2
Sports	73.1	66.3	71.5	67.1	66.1	66.6	71.6	73.8	69.9	68.0	63.6
Research	31.2	19.0	28.9	21.3	14.7	27.0	23.4	31.7	26.7	21.2	14.3
Learn	44.3	31.0	38.8	42.2	29.4	42.2	34.8	41.0	35.2	34.7	37.7
Art	61.3	49.6	59.5	57.8	38.8	55.1	56.2	63.7	57.2	48.6	46.9
Meeting	90.5	78.8	87.0	84.2	78.0	83.4	85.5	89.8	84.2	83.7	76.5
Floods	19.7	21.1	22.2	14.2	17.7	19.5	20.4	21.0	22.9	21.7	12.9
Air	75.1	69.4	74.3	74.5	62.3	68.2	74.1	76.9	74.7	68.9	65.5
Temp./light	78.3	73.8	77.2	76.6	71.4	72.5	78.0	81.8	72.6	72.9	73.2
Species	37.4	28.4	31.4	41.9	28.8	33.8	33.0	33.0	28.0	33.5	39.8

Table 6.2. Descriptive analyses of perceptions, satisfaction and needs related to campus open space. Percentage of perceived landscape services according to respondents′ characteristics (time spent in UPV, COS frequency and preference) based on Tudorie et al. (2020).

LANDSCAPE SERVICES	TIME SPENT IN UPV				COS FREQUENCY			COS PREFERENCE			
	<=1	2-5	6-10	>10	LOW	MEDIUM	HIGH	OPEN	INDOOR	SPORT	HOME
Walks	84.4	81.0	76.5	80.8	78.6	74.0	83.7	81.5	71.7	79.5	75.0
Study/work	65.0	51.6	47.5	42.9	43.3	44.1	52.6	47.0	40.0	57.8	31.3
Daily needs	67.8	58.8	66.3	54.0	52.5	54.3	63.0	57.9	51.7	62.7	45.7
Relax	86.0	80.4	79.4	81.2	81.1	80.3	82.6	80.0	81.7	81.9	82.4
Play	64.7	58.7	53.9	42.9	46.8	50.4	54.5	48.5	58.3	55.4	45.5
Sports	79.2	69.4	72.5	66.1	67.9	73.8	69.2	66.1	65.0	77.1	60.6
Research	47.9	26.0	23.5	17.8	12.4	28.2	28.5	23.7	15.0	26.5	16.1
Learn	55.0	38.0	31.7	33.8	28.8	40.3	40.3	36.3	28.3	38.6	34.4
Art	68.3	61.3	57.4	48.4	41.7	61.3	59.3	53.4	50.0	53.0	58.1
Meeting	90.9	87.4	85.3	81.1	82.6	81.0	86.6	83.1	78.3	81.9	78.8
Floods	28.0	19.8	20.0	16.2	14.9	23.0	21.2	17.4	18.3	20.5	19.4
Air	79.2	73.2	74.0	68.9	69.1	70.2	74.0	72.5	63.3	63.9	59.4
Temp./light	83.5	76.5	76.5	73.6	71.9	73.0	78.2	76.3	71.7	71.1	48.5
Species	36.7	32.4	31.7	31.6	29.0	27.6	36.6	29.5	26.7	42.2	45.5

Table 6.3. Descriptive analyses of perceptions, satisfaction and needs related to campus open space. Percentage of campus open spaces needs perceived by university community. Source: Tudorie et al. (2020).

Needs	Gender		Occupation			Knowledge		Age				Time spent in UPV				COS Frequency		
	Female	Male	Student	AdSS	TRS	LRD	OD	18-22	22-30	30-50	50	<=1	2-5	6-10	>10	Low	Medium	High
Furniture	66.1	48.9	63.3	59.1	38.1	55.8	58.9	59.6	68.2	59.9	43.5	54.8	62.4	73.5	51.7	61.6	52.3	57.7
Nearby COS	32.1	29.1	34.2	25.8	24.5	30.2	31.3	41.4	27.0	25.8	21.8	35.5	36.6	31.4	26.0	25.0	37.5	31.4
Water	63.2	58.2	65.3	54.1	55.4	60.7	61.9	71.7	60.1	51.6	57.8	62.1	68.8	64.7	56.0	60.5	60.9	61.7
Recreational	18.0	19.0	20.0	17.0	13.7	15.9	20.2	22.5	16.2	20.3	12.2	18.5	23.7	13.7	16.6	18.8	15.6	19.5
Tranquillity	18.3	31.5	25.7	22.0	26.6	26.6	24.7	26.1	23.0	26.9	25.2	21.0	26.9	27.5	25.7	28.5	18.8	25.9
Security	5.9	6.5	4.8	8.8	7.2	7.5	5.3	5.0	2.7	9.9	6.1	3.2	6.5	2.9	7.4	5.2	7.8	6.1
Classrooms	49.9	36.1	50.2	37.1	26.6	51.6	38.5	50.0	51.4	39.0	31.3	46.0	43.5	65.7	36.0	38.5	50.8	43.3
Less asphalt	40.6	43.5	39.9	49.1	44.6	44.5	41.5	33.2	47.3	53.3	40.8	28.2	34.4	53.9	48.0	41.3	38.3	44.4
Cleaner air	27.5	34.8	33.4	27.7	28.1	33.1	30.2	31.8	37.2	28.0	29.3	28.2	29.0	42.2	31.1	29.7	28.1	32.8
Trees	53.5	61.7	53.9	62.9	65.5	60.1	56.4	49.6	59.5	64.8	61.9	47.6	48.4	65.7	63.7	62.8	58.6	55.9
Natural shade	68.9	68.8	68.1	71.9	75.8	71.1	67.7	67.1	70.9	67.6	73.5	66.9	67.2	66.7	70.9	75.0	66.4	67.6
Native species	32.6	35.1	35.1	35.2	32.4	39.3	31.9	34.6	35.1	34.6	34.0	27.4	31.2	51.0	34.3	34.3	36.7	34.3

Table 6.4. Descriptive analyses of perceptions, satisfaction and needs related to campus open space. Significant differences between respondents′ perception of landscape services according to respondents′ characteristics. Kruskal–Wallis nonparametric test (H), P-values and significant pairs of groups. Dunn′s post hoc comparations (Wi, Wj - Median).

		A1. Pleasant space to pass through		A2 Space to study/ work		A3 Space to meet daily basic needs		A4. Quiet space to relax		A5 Play areas		A6 Space to do sports*		A7 Space for research		A8 Space to learn about nat. environ.		A9 Space for creating art		A10 Space to gather with friends		A11 Protection against floods		A12 Air quality		A13 Pleasant T/L		A14 Native species	
AGE																													
H				**25.351**		**18.272**				**21.412**		**28.689**		**42.001**		**14.085**		**34.753**		**34.674**		**27.231**				**17.785**			
P				**<0.001***		**<0.001***				**<0.001***		**<0.001***		**<0.001***		**0.007***		**<0.001***		**<0.001***		**<0.001***				**0.001***			
		Wi	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**
< 18-22	> 22-30											428.800	384.556																
< 18-22	> 30-50											428.800	379.728	435.836	355.359			420.524	352.006	421.369	363.072					416.675	368.251		
< 18-22	> 50			420.267	321.614	408.625	336.484			420.267	332.312	428.800	338.769			408.819	357.669	420.524	347.994	421.369	329.948	410.006	312.130			416.675	368.360		
> 22-30	> 30-50			402.235	321.614	408.109	336.484							411.564	355.359			417.304	352.006	415.749	363.072	417.905	312.130						
> 22-30	> 50									393.905	332.312	384.556	338.769	411.564	310.808			417.304	347.994	415.749	329.948	379.931	312.130						
> 30-50	> 50			379.129	321.614					379.928	332.312																		
GENDER																													
H		**17.783**		**11.787**		**26.443**		**16.330**		**18.899**		**10.329**		**14.323**		**20.985**		**20.703**		**23.188**						**17.546**			
P		**<0.001***		**0.008***		**<0.001***		**<0.001***		**<0.001***		**0.016***		**0.002***		**<0.001***		**<0.001***		**<0.001***						**<0.001***			
		Wi	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**
Fem	Male	411.459	358.954	406.106	364.187	420.394	347.879	409.831	360.083	409.017	361.330	406.075	361.379	408.409	362.085	416.416	353.220	414.169	357.541	416.603	353.476					413.059	353.656		
Fem	Not Ans	411.459	293.854	406.106	306.438	420.394	334.063	409.831	319.958					408.409	288.396	416.416	291.979	414.169	281.917	416.603	295.021								
Male	Not Ans																												
COS FREQUENCY																													
H		**9.967**				**16.212**		**12.565**		**10.301**				**16.384**		**13.407**		**19.809**		**8.076**						**12.120**		**12.087**	
P		**0.019***				**0.001***		**0.006***		**0.016***				**<0.001***		**0.004***		**<0.001***		**0.044***						**0.007***		**0.007***	
		Wi	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**
Low	Medium													330.909	409.900	335.694	390.912	323.472	414.420										
Low	High					356.734	400.067	349.631	396.747	342.016	397.249			330.909	394.917	335.694	398.332	323.472	396.156	359.591	396.646					350.259	401.695	421.650	366.744
Medium	High	353.692	397.538																							359.244	401.695		
COS PREFERENCE																													
H		**10.673**		**21.487**		**12.905**		**16.894**		**17.813**		**22.749**				**13.769**				**23.446**				**13.885**		**22.040**			
P		**0.030**		**<0.001***		**0.012***		**0.002***		**0.001***		**<0.001***				**0.008***				**<0.001***				**0.008***		**<0.001***			
		Wi	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**	**Wi**	**Wj**
Open	Indoor					383.782	360.917																						
Open	Sport									375.607	433.259	376.478	459.434																
Open	Go home			381.426	287.053	383.782	313.842	385.304	291.224			376.478	298.421							394.495	280.882			392.997	295.711	396.373	262.211		
Indoor	Sport			373.217	451.753																								
Indoor	Go home							383.217	291.224	427.550	337.039	402.492	298.421													368.117	262.211		
Sport	Go home	400.657	320.145	451.753	287.053	430.494	313.842	417.247	291.224	433.259	337.039	459.434	298.421			415.837	333.132			386.904	280.882					363.313	262.211		

Table 6.5. Descriptive analyses of perceptions, satisfaction and needs related to campus open space. The degree of satisfaction of university community with state and management of COS. Significant differences between respondents′ satisfaction according to respondents′ characteristics. Kruskal–Wallis nonparametric test (H), P-values and significant pairs of groups. Dunn′s post hoc comparations (Wi, Wj- Median) based on Tudorie et al. (2020).

	RESPONDENTS	GOOD (%)	NEUTRAL (%)	BAD (%)	H	P	GROUPS	WI	WJ
	UNIVERSITY COMMUNITY	33.19	33.87	32.92					
Variables	Groups of users								
Age	18–22	32.97	34.43	32.6					
	22–30	27.97	36.36	35.66					
	30–50	33.53	32.37	34.10					
	>50	39.84	29.69	30.47					
Occupation	Student	31.40	33.76	34.84	10.641	0.030*	Stdent&TRS	390.339	330.911
	AdSS	41.89	32.43	25.68			AdSS&TRS	405.295	330.911
	TRS	28.81	35.59	35.59					
Knowledge branch	LRD	33.79	32.08	34.13					
	OD	32.95	34.77	32.27					
Time spent at UPV	<=1	36.67	37.5	25.83	3.762	0.005*	<=1&6-10	398.163	334.301
	2-5	32.40	34.08	33.52					
	6-10	31.68	29.70	38.61			2-5&6-10	396.795	334.301
	> 10	31.65	35.44	32.91					
Gender	Females	29.03	32.9	38.06	17.350	0.001*	Females& Males	411.524	355.292
	Males	27.64	39.02	33.33					
	Prefer no answer	38.10	28.57	33.33					
COS Frequency	Low users	30.77	29.37	39.86	8.859	0.030*	Low&High	347.278	398.563
	Medium users	28.57	37.82	33.61					
	High users	35.41	33.63	30.96					
COS Preference	Open	34.85	32.48	32.66					
	Indoor	29.31	36.21	34.48					
	Sport	24.36	41.03	34.62					

(P<0.005) *significant differences

Where: LRD = Health&FoodSc + Agrifood&ForestE + Arch&BuildE; OD = Art&Hum + Social&LegalSc + Sc&TechHealthE + Ind&AeroE + Inf&CommTechE

Table 6.6. Descriptive analyses of perceptions, satisfaction and needs related to campus open space. Pearson′s correlation matrix between satisfaction (S) and perceived landscape services.

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	S
A1	1	,536**	,598**	,719**	,495**	,528**	,407**	,483**	,501**	,598**	,384**	,609**	,632**	-,031	,478**
A2		1	,771**	,671**	,818**	,818**	,715**	,746**	,802**	,708**	,674**	,625**	,716**	,042	**,737****
A3			1	,708**	,711**	,791**	,631**	,694**	,779**	,757**	,618**	,630**	,691**	,059	**,657****
A4				1	,654**	,698**	,536**	,638**	,662**	,708**	,506**	,721**	,748**	,089*	,597**
A5					1	,858**	,759**	,783**	,763**	,652**	,676**	,576**	,661**	,054	**,726****
A6						1	,726**	,735**	,764**	,698**	,684**	,616**	,739**	,040	**,676****
A7							1	,801**	,748**	,606**	,742**	,543**	,592**	,042	**,690****
A8								1	,842**	,608**	,677**	,619**	,675**	,073*	**,778****
A9									1	,690**	,685**	,643**	,669**	,056	**,736****
A10										1	,571**	,665**	,728**	,059	**,600****
A11											1	,535**	,583**	,051	**,688****
A12												1	,778**	,034	**,612****
A13													1	,039	**,726****
A14														1	,071
S															1

* Correlation is significant at 0.05 level; ** * Correlation is significant at 0.01 level; Bold is used to highlight values higher than 0.6.

A1=Pass through; A2=Study/Work; A3=Daily needs; A4=Relax; A5=Play; A6=Sports; A7=Research; A8=Learn natural environmental; A9=Art creation; A10=Gather with friends; A11= Water floods; A12=Air quality; A13=Temperature/light; A14=Native species

Annex 7. Tables of results of descriptive analyses of factors influencing the preference of campus open space of the chapter 6 (6.5.1)

Table 7.1. Descriptive analyses of factors influencing the preference of campus open space. Activities developed in favourite COS.

COS	WALK	WORK	EAT	RELAX	PLAY	SPORTS	RESEARCH	LEARN	PAINT	MEET
0	1	1	3	2	0	0	0	0	0	2
2	2	0	2	1	1	0	0	0	0	2
4	1	0	3	1	2	0	0	0	0	3
5	1	2	1	2	1	1	0	0	2	2
8	0	1	4	2	0	0	0	0	1	4
9	5	2	4	4	1	1	0	1	1	5
10	21	11	24	33	5	1	4	3	11	17
11	108	58	84	118	28	16	7	17	38	81
12	84	51	65	102	20	13	8	17	35	68
13	8	2	5	6	1	3	0	1	1	2
14	10	5	10	11	2	2	1	1	1	9
15	51	26	43	52	9	4	1	7	9	44
16	14	18	36	30	7	0	1	3	8	34
17	3	0	4	2	0	0	0	1	1	1
18	2	1	3	1	0	0	0	0	0	3
19	1	3	8	4	0	0	0	0	2	8
20	4	5	7	6	1	0	1	1	6	5
21	2	1	2	3	0	0	0	0	0	3
22	5	2	4	6	0	2	0	1	1	5
23	0	0	0	0	0	0	0	0	0	0
24	6	4	9	8	0	1	0	0	1	9
25	66	38	107	74	13	8	1	9	9	91
26	7	4	22	12	3	3	1	1	0	19
27	6	3	3	7	0	1	0	1	1	3
28	54	29	56	57	9	7	1	6	9	47
29	28	14	33	31	6	2	1	4	8	30
30	5	4	11	8	4	1	0	0	0	10
31	28	13	23	26	5	5	2	2	4	23
32	7	2	2	4	0	1	0	0	0	2
33	5	0	2	4	0	7	0	0	0	2
34	3	2	3	3	2	2	0	2	2	4
35	0	0	0	0	1	1	0	0	0	1
36	2	0	2	2	1	1	0	0	0	2
37	3	0	3	2	1	1	0	0	0	3
38	70	36	52	79	19	17	5	10	14	50
39	160	72	122	168	37	52	10	17	36	113
40	5	0	3	6	0	1	0	0	0	5

41	1	0	1	0	0	0	0	0	0	0
42	1	1	2	3	0	1	1	0	0	1
43	218	102	160	233	66	60	18	27	52	164
44	5	2	4	3	2	2	0	0	1	5
45	9	4	10	8	8	13	0	2	3	12
46	2	1	3	3	1	2	0	0	0	4
47	0	1	5	1	2	0	0	0	0	4
48	0	2	9	1	1	1	0	0	0	9
49	2	0	3	2	0	0	0	0	0	1
50	4	2	4	3	2	2	1	3	1	6
51	0	1	2	1	0	0	0	0	0	1
52	0	0	1	1	0	0	0	0	1	2

Table 7.2. Descriptive analyses of factors influencing the preference of campus open space. Dominant activities in the respondents' favourite COS.

COS	WALK	WORK	EAT	RELAX	PLAY	SPORTS	PAINT	MEET
0			X					
2	X		X					X
4			X					X
5		X		X			X	X
8			X					X
9	X							X
10				X				
11				X				
12				X				
13	X							
14				X				
15	X			X				
16			X					
17			X					
18			X					X
19			X					X
20			X					
21								X
22				X				
24			X					X
25			X					
26			X					
27				X				
28				X				
29			X					
30			X					
31	X							
32	X							
34						X		X
35					X	X		X
36			X	X				X
37			X					X
38				X				
39	X			X				
40				X				
41			X					
42				X				
43				X				
44								X
45						X		
46								X
47			X					
48			X					X
49			X					
50								X
51			X					
52								X

Table 7.3. Descriptive analyses of factors influencing the preference of campus open space. Evaluation of perceived LS-related reasons in all COS.

COS	QUIET LOCATION	CONC. WORK	SPACE SPORTS	CONDITION EAT	BEAUTIFUL VIEWS	FEEL SAFE	RESEARCH SETTING	GREEN COVER	MORE SPECIES	NATURAL ASPECT	PERM. SPACE	CLEAN AIR	SUNNY AREA	NATURAL SHADE	INTEREST POINTS
0	2	1	0	2	1	1	1	1	1	1	0	2	2	1	3
2	2	0	2	3	1	1	1	1	1	1	0	1	0	1	3
4	2	0	0	3	1	2	0	0	0	1	1	2	1	1	3
5	2	2	1	2	3	1	1	3	3	3	1	3	1	2	1
8	2	0	0	3	3	3	0	1	1	2	0	1	2	2	2
9	4	2	0	1	4	3	0	4	3	4	2	4	3	4	3
10	25	14	8	7	27	20	0	28	13	26	14	29	16	24	21
11	98	45	38	37	100	75	10	111	64	110	30	105	37	99	68
12	77	35	25	39	87	66	6	93	55	87	32	86	32	87	49
13	3	1	1	1	4	5	1	4	0	5	3	3	0	5	6
14	8	3	5	5	11	7	2	12	8	11	4	13	6	11	8
15	31	12	15	26	41	34	8	51	30	46	18	47	16	47	47
16	26	15	3	8	27	18	4	31	11	31	9	31	13	28	24
17	2	1	1	3	2	2	0	2	1	2	1	3	2	3	2
18	0	1	0	2	2	2	0	2	1	2	0	2	1	2	2
19	4	1	0	4	4	5	0	5	0	3	1	5	4	4	6
20	3	2	0	3	4	3	1	3	2	3	1	5	4	4	5
21	3	2	0	2	2	3	1	2	2	2	0	2	3	3	4
22	6	5	3	2	9	5	3	9	4	8	5	10	6	8	7
23	1	0	0	0	1	1	0	1	1	1	1	1	0	1	0
24	5	0	2	6	5	8	0	4	2	1	1	4	5	3	8
25	48	22	20	53	73	62	6	70	38	62	26	72	44	65	80
26	10	5	2	11	11	10	2	14	6	12	3	12	7	14	15
27	2	1	1	1	3	3	0	2	0	3	1	3	0	3	5
28	40	18	12	29	53	42	4	56	29	49	19	52	20	49	46
29	26	6	5	10	24	22	2	36	14	31	7	32	15	31	35
30	6	3	5	8	7	9	0	7	6	9	5	10	5	6	9
31	16	6	5	15	24	18	2	25	16	25	8	25	13	19	22
32	1	1	0	1	2	2	0	3	1	3	1	3	1	4	3
33	5	2	4	4	5	6	0	4	1	3	2	6	2	5	6
34	1	0	1	2	0	0	0	3	1	2	1	2	2	2	2
35	1	0	1	1	1	1	0	0	0	0	0	0	0	1	1
36	2	1	1	0	1	1	0	1	0	1	0	0	0	0	2
37	2	0	0	1	1	1	0	1	0	1	0	1	0	1	1
38	62	31	29	25	77	56	4	77	36	80	34	78	34	74	55
39	130	53	57	61	153	104	16	163	78	155	52	149	59	142	118
40	1	0	2	2	3	3	0	2	0	4	1	3	4	4	4
41	0	1	0	1	1	0	0	1	1	0	0	1	0	1	0
42	1	0	1	2	2	1	0	1	0	2	1	1	0	4	2
43	173	70	80	81	202	144	12	214	117	205	71	199	87	184	150
44	5	0	1	2	3	1	0	4	2	4	1	5	1	3	4

45	12	6	10	7	12	8	1	15	7	13	7	14	7	14	13
46	3	1	1	1	2	1	2	3	2	2	2	2	2	2	5
47	2	0	1	4	3	4	0	2	1	1	0	4	1	2	4
48	2	1	0	6	2	5	0	4	2	3	2	6	1	7	9
49	1	1	0	1	2	1	0	1	1	1	0	1	0	1	1
50	2	2	3	2	2	3	1	4	1	4	5	5	2	4	3
51	1	0	0	0	1	0	0	1	1	0	0	1	0	0	0
52	2	0	1	2	0	0	0	0	0	0	1	1	1	1	2

Italics is used to show common units between all three categories

Bold is used to show common units between poor and medium perceived categories

Table 7.4. Descriptive analyses of factors influencing the preference of campus open space. The highest frequency of agreement with certain reasons and more functional open space

LS-RELATED	QUIET LOCATION	CONC. STUDY	SPACE SPORTS	CONDITION EAT	BEAUTIFUL VIEWS	FEEL SAFE	RESEARCH	GREEN COVER	MORE SPECIES	NATURAL ASPECT	PERM. SPACE	CLEAN AIR	SUNNY AREA	NATURAL SHADE	INTEREST POINTS
0															X
2				X											X
4				X											X
8				X	X	X									
9	X				X			X		X		X		X	
11								X		X		X			
12				X				X							
13															X
14								X		X		X			
15															
16								X		X		X			
17				X										X	
18				X	X	X		X		X		X		X	X
19															X
20												X			X
21															X
22												X			
24						X									X
25															X
26															X
27															X
28								X							
29								X							X
30												X			
31					X			X		X		X			
32														X	
33						X						X			X
34								X							
35	X		X	X	X	X								X	X
36	X														X
37	X														
38										X					
39															
40										X			X	X	X
41		X		X	X				X			X		X	
42														X	
43															
44	X											X			
45															
46															X
47				X		X						X			X
48															X
49					X										

50											X	X			
51	X				X				X			X			
52	X			X											X

Annex 8. Tables of results of Hierarchical linear regression analyses of the chapter 6, subchapter 6.4

Table 8.1. Hierarchical linear regression analyses. Regression coefficients (coeff) (unstandardized coefficie = unstd. and standardized=std.), significance and collinearity statistics by considering a confidence Interval of 95%.

Model	Unstd. coeff		Std. coeff	t	Sig.	95% Confidence Interval for B		Collinearity Statistics	
	B	SE	B			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	45.423	17.485		2.598	.014	9.962	80.883		
Abiotic site cond.	39.973	436.21	.214	.092	.927	-844.708	924.655	.001	671.738
Area COS	.005	.003	.422	1.759	.087	-.001	.010	.141	7.117
Art elemt.	-7.002	10.947	-.095	-.640	.526	-29.204	15.199	.367	2.723
Average SID	46.532	1211.1	.215	.038	.970	-2409.757	2502.82	.000	3883.66
Bins	14.995	14.281	.195	1.050	.301	-13.969	43.959	.235	4.247
Biotic features	-3.830	405.89	-.026	-.009	.993	-827.013	819.352	.001	945.103
Proximity to central axis	-.080	.074	-.144	-1.082	.287	-.230	.070	.456	2.194
Drinking	-5.853	18.202	-.044	-.322	.750	-42.768	31.062	.438	2.284
Mounds	-1.323	33.434	-.009	-.040	.969	-69.130	66.483	.170	5.898
Infrastructure element.	-67.699	408.83	-.326	-.166	.869	-896.843	761.445	.002	478.612
Placement (Central)	40.455	14.499	.447	2.790	.008	11.049	69.861	.314	3.180
Paths	-29.709	30.197	-.418	-.984	.332	-90.950	31.533	.045	22.325
Proximity to Ágora	-.047	.019	-.284	-2.400	.022	-.086	-.007	.577	1.732
Row of trees	-2.891	9.808	-.040	-.295	.770	-22.783	17.000	.440	2.274
Shrub	-11.092	9.947	-.157	-1.115	.272	-31.265	9.081	.410	2.436
Tree sp. richness	.871	1.269	.167	.687	.497	-1.702	3.445	.136	7.327

Dependent variable: Use

Table 8.2. Hierarchical linear regression analyses. Final regression model including regression coefficients (coeff) (unstandardized coefficie = unstd. and standardized=std.), significance (sig.) and collinearity statistics by considering a confidence Interval of 95%.

Model	Unstd. coeff		Stand. coeff	t	Sig.	95% Confidence Interval for B		Collinearity Statistics	
	B	SE	B			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	19.649	6.786		2.896	.006	6.013	33.285		
Area COS	.004	.001	.361	3.775	.000	.002	.006	.857	1.167
Placement (Central)	45.673	8.968	.505	5.093	.000	27.652	63.694	.795	1.257
Proximity to Ágora	-.036	.015	-.221	-2.378	.021	-.067	-.006	.907	1.103

Table 8.3. Hierarchical linear regression analyses. Residual statistics used to identify outliers.

	MIN	MAX	MEAN	STD. DEVIATION	N
Cook's Distance	.000	.644	.032	.099	53
Mahal Distance	.267	28.012	2.943	4.297	53
Stud. Residual	-2.240	4.333	-.005	1.027	53

Dependent variable: Use

Table 8.3. Hierarchical linear regression analyses. Summary of multiple regression analysis for prediction of use of space. Pearson correlation coefficient (R), coefficient of determination(R2) and standard error (S.E.).

MODEL	R	R^2	ADJUSTED R^2	S. E.
1	.692	.479	.469	26.039
2	.757	.573	.555	23.815
3	.785	.617	.593	22.778

Dependent variable: Use
Model 1 = Predictors: (Constant), Placement (Central)
Model 2 = Predictors: (Constant), Placement (Central), Area COS
Model 3 = Predictors: (Constant), Placement (Central), Area COS, Proximity to Ágora

Table 8.4. Hierarchical linear regression analyses. ANOVA analysis.

MODEL	ANOVA	SUM SQUARE	DF	MEAN SQUARE	F	SIG.
1	Regression	31763.011	1	31763.011	46.846	.000
	Residual	34579.291	51	678.025		
	Total	66342.302	52			
2	Regression	37983.484	2	18991.742	33.485	.000
	Residual	28358.818	50	567.176		
	Total	66342.302	52			
3	Regression	40918.550	3	13639.517	26.288	.000
	Residual	25423.752	49	518.852		
	Total	66342.302	52			

Dependent variable: Use
Model 1 = Predictors: (Constant), Placement (Central)
Model 2 = Predictors: (Constant), Placement (Central), Area COS
Model 3 = Predictors: (Constant), Placement (Central), Area COS, Proximity to Ágora

Table 8.5. Hierarchical linear regression analyses. Regression coefficients (coeff) (unstandardized coefficie = unstandar. and standardized=stand.), significance and collinearity statistics by considering a confidence Interval of 95%.

M	VAR.	UNSTANDAR-COEFF.		STANDAR-COEFF.	T	SIG.	COLLINEARITY	
		B	SE	B			TOLER.	VIF
1	(Constant)	16.930	3.971		4.264	.000		
	Placement (Central)	62.570	9.142	.692	6.844	.000	1.000	1.000
2	(Constant)	7.421	4.630		1.603	.115		
	Placement (Central)	52.138	8.935	.577	5.835	.000	.876	1.142
	Area COS	.004	.001	.327	3.312	.002	.876	1.142
3	(Constant)	19.649	6.786		2.896	.006		
	Placement (Central)	45.673	8.968	.505	5.093	.000	.795	1.257
	Area COS	.004	.001	.361	3.775	.000	.857	1.167
	Proximity to Ágora	-.036	.015	-.221	-2.378	.021	.907	1.103

Dependent variable: Use

Table 8.6. Hierarchical linear regression analyses. Regression coefficients (coeff) (unstandardized coefficie = unstd. and standardized=std.), significance and collinearity statistics by considering a confidence Interval of 95%.

MODEL	UNSTAND COEFF		STAND-COEFF	T	SIG.	95% CONFIDENCE INTERVAL FOR B		COLLINEARITY	
	B	SE	B			LOWER	UPPER	TOLERANCE	VIF
(Constant)	15.379	14.129		1.088	.285	-13.401	44.159		
Abiotic site cond.	74.840	329.866	.258	.227	.822	-597.074	746.754	.001	768.295
Area COS	.006	.002	.356	3.559	.001	.003	.010	.168	5.963
Art el.	-.006	9.294	.000	-.001	.999	-18.938	18.926	.255	3.926
Average SID	455.123	910.32	1.356	.500	.621	-1399.15	2309.39	.000	4388.38
Bins	11.068	11.464	.093	.966	.342	-12.283	34.420	.183	5.474
Biotic features	-128.849	297.78	-.565	-.433	.668	-735.419	477.720	.001	1017.47
Proximity to central axis	-.026	.055	-.030	-.479	.635	-.138	.085	.417	2.398
Drinking	12.186	13.116	.059	.929	.360	-14.530	38.901	.422	2.372
UGI cover	-.036	.135	-.021	-.270	.789	-.311	.238	.292	3.430
Group of trees	6.073	9.739	.045	.624	.537	-13.765	25.911	.324	3.083
Mounds	49.607	24.275	.209	2.044	.049	.160	99.055	.161	6.219
Infrastructure el.	-201.655	309.10	-.625	-.652	.519	-831.281	427.970	.002	547.222
Placement (Central)	41.683	10.145	.297	4.109	.000	21.018	62.347	.321	3.114
Paths	-86.894	21.842	-.787	-3.978	.000	-131.384	-42.403	.043	23.362
Proximity to Ágora	-.020	.016	-.080	-1.270	.213	-.053	.012	.421	2.376
Row of trees	-6.312	9.699	-.056	-.651	.520	-26.068	13.444	.225	4.448
Shrub	-6.337	8.191	-.058	-.774	.445	-23.021	10.346	.303	3.304
Solitary trees	-5.772	9.763	-.051	-.591	.559	-25.658	14.114	.222	4.506
Tree cover	-.067	.220	-.018	-.304	.763	-.516	.382	.457	2.189
Tree sp. richness	3.570	2.518	.116	1.418	.166	-1.559	8.699	.249	4.024

Dependent variable: Fav

Table 8.7. Hierarchical linear regression analyses. Residual statistics used to identify outliers.

	MIN	MAX	MEAN	STD. DEVIATION	N
Cook's Distance	.000	.875	.046	.134	53
Mahal Distance	.397	32.515	4.906	6.619	53
Stud. Residual	-2.425	3.622	-.008	1.056	53

Dependent variable: Fav

Table 8.8. Hierarchical linear regression analyses. Summary of regression model to predict preference of space.

MODEL	R	R^2	ADJUSTED R^2	STANDARD ERROR (S.E)
1	.567	.322	.309	46.111
2	.799	.638	.624	34.020
3	.814	.662	.641	33.208
4	.936	.875	.865	20.374
5	.951	.905	.895	17.963

Dependent variable: Fav

Model 1 = Predictors: (Constant), Placement (Central)

Model 2 = Predictors: (Constant), Placement (Central), Area COS

Model 3 = Predictors: (Constant), Placement (Central), Area COS, Tree species richness

Model 4 = Predictors: (Constant), Placement (Central), Area COS, Tree species richness, Mounds

Model 5 = Predictors: (Constant), Placement (Central), Area COS, Tree species richness, Mounds, Drinking fountains

The ANOVA is statistically significant for all three models ($p<0.01$), where the fifth model indicates a significant improvement for the prediction of the dependent variable (F=89.718 and $p<0.01$) (Table 30).

Table 8.9. Hierarchical linear regression analyses. ANOVA Analysis

MODEL	ANOVA	SUM SQUARE	DF	MEAN SQUARE	F	SIG.
1	Regression	51478.697	1	51478.697	24.212	.000
	Residual	108436.586	51	2126.208		
	Total	159915.283	52			
2	Regression	102046.611	2	51023.305	44.085	.000
	Residual	57868.672	50	1157.373		
	Total	159915.283	52			
3	Regression	105880.760	3	35293.587	32.005	.000
	Residual	54034.523	49	1102.745		
	Total	159915.283	52			
4	Regression	139990.488	4	34997.622	84.311	.000
	Residual	19924.795	48	415.100		
	Total	159915.283	52			
5	Regression	144749.451	5	28949.890	89.718	.000
	Residual	15165.832	47	322.677		
	Total	159915.283	52			

Dependent variable: Fav

Model 1 = Predictors: (Constant), Placement (Central)

Model 2 = Predictors: (Constant), Placement (Central), Area COS

Model 3 = Predictors: (Constant), Placement (Central), Area COS, Tree species richness

Model 4 = Predictors: (Constant), Placement (Central), Area COS, Tree species richness, Mounds

Model 5 = Predictors: (Constant), Placement (Central), Area COS, Tree species richness, Mounds, Drinking fountains

Table 8.10. Hierarchical linear regression analyses. Regression coefficients (coeff) for preference for a space

M	VAR.	UNSTANDARDIZED COEFF		STANDARDIZED COEFF	T	SIG.	COLLINEARITY	
		B	SE	B			TOLERANCE	VIF
1	(Constant)	13.744	7.032		1.955	.056		
	Common area (Central)	79.656	16.188	.567	4.921	.000	1.000	1.000
2	(Constant)	-13.370	6.614		-2.022	.049		
	Common area (Central)	49.914	12.763	.356	3.911	.000	.876	1.142
	Area COS	.010	.002	.601	6.610	.000	.876	1.142
3	(Constant)	-21.694	7.849		-2.764	.008		
	Common area (Central)	40.581	13.426	.289	3.023	.004	.754	1.326
	Area COS	.010	.002	.557	6.077	.000	.819	1.221
	Tree species richness	5.510	2.955	.180	1.865	.068	.742	1.348
4	(Constant)	-11.832	4.937		-2.397	.020		
	Common area (Central)	31.130	8.303	.222	3.749	.000	.742	1.347
	Area COS	.005	.001	.261	4.019	.000	.613	1.631
	Tree species richness	5.713	1.813	.186	3.151	.003	.742	1.348
	Mounds	133.978	14.780	.564	9.065	.000	.671	1.489
5	(Constant)	-7.057	4.527		-1.559	.126		
	Common area (Central)	38.465	7.566	.274	5.084	.000	.695	1.439
	Area COS	.003	.001	.177	2.887	.006	.535	1.869
	Tree species richness	3.592	1.691	.117	2.123	.039	.663	1.509
	Mounds	133.734	13.031	.563	10.263	.000	.671	1.489
	Drinking fountains	42.822	11.151	.206	3.840	.000	.702	1.425