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The histology atlas of campus form: A framework to explore liveability and sustainability in university campuses

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Abstract

This paper focuses on the concept of university campus form, aiming at exploring the sustainability and liveability parameters in relation to campus form. The research intends to provide a theoretical framework to evaluate physical and morphological dimensions of campus form which affect sustainability and liveability of campus setting and surrounding urban context. The study primarily has conducted an extensive literature review on the subjects of sustainability, liveability, urban form, and university campus physical features. Then, it has done a content analysis of fifty university campus masterplans, selected from throughout the world to identify common strategies, and actions of campus development plans. Afterward, it has identified the principal criteria which influence the sustainability and liveability of campus form. To evaluate the university precincts according to the proposed set of criteria, a Histology Atlas of Campus Form has been developed which provides a model to measure each morphological dimension of campus according to a 3-point Likert scale system. The developed model has been applied to case studies to assess their performance. The ultimate objective of this study is to investigate the campus form attributes on the ability to generate liveability and sustainability.



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Keywords

University campus, Campus form, Sustainability, Liveability, Histology atlas of campus form.

1. Introduction

University is by nature a place-bound entity and university's mission is tightly linked to its physical form. The physical form and mission of universities have largely changed within centuries. Primary universities were mono-functional and isolated entities aiming at nurturing elite citizens. However, the recent global transformations have made a radical shift in mission and consequently on the physical space of universities. The mission of primary universities was focused on education and research while contemporary universities have adopted new roles and new responsibilities. The third mission of universities is dedicated to urban outreach activities and addresses economic, socio-cultural, spatial, and environmental challenges of the societies (Razavivand Fard et al., 2017). Accepting these new roles, universities have become more collaborative and integrated objects in their societies.

The mission of a university is the basis of the institution's strategies and actions and is directly linked to the university's vision and general philosophy. The educational programs, university's built-space, the social dimension of the university, and its connection with the broader society is grounded on the institutional values. In this respect, the campus physical environment plays a fundamental role in the realization of the objectives and core values of the institution (Kenney et al., 2005). As Chapman (2006) argues, "the institutional story is told through the campus . . . The campus is an unalloyed account of what the institution is all about."

The physical setting of a university, its physical features, and configuration, has a large impact on the quality of a university and academic life (Caldenby, 2009). Campus physical space is not just the mean to facilitate learning but it has a larger influence on the educational, social, cultural, economic life of the academic community and the broader society. A university campus with a high-quality urban space can attract and nurture high quality human

capital, assure the presence of people and support diversified activities, stimulate the flow of synergy, foster social and economic well-being, and consequently contribute to vibrancy, livability and sustainability of campus space, the hosting neighborhood, city, and region.

2. Sustainability and liveability in relation to urban form

University is a microcosm of a city. Considering the large dimension and the diversity of functions, the university campus has many common attributes of an urban space including built space, open space, circulation networks, and their configuration and the relationships between these components. Therefore, the design principles that are applied to urban space can be applicable to a university campus as well. Building on this, the sustainability and liveability factors which are related to an urban form can be referred to the campus form.

Urban form sustainability and sustainable development have been lately at the core of academic debates. It is underlined by scholars that the physical form of an urban space influences its sustainability (Jabareen, 2006; Jenks, 2004; Salat, 2006, 2011; Wheeler, 2003). Developing a sustainable urban environment signifies to set a group of morphological strategies and relationships through arranging the components of urban form. These principles intend to diminish the urban sprawl, increase compactness, decrease commuting distances, reduce energy consumption, CO₂ emissions and pollutions.

Jabareen (2006) in his eminent research on the urban form sustainability has identified seven key factors to achieve urban sustainability. These parameters include compactness, sustainable transport, density, mixed land use, diversity, passive solar design, and greening. These items are very comprehensive and have been mentioned in many other studies.

Salat (2006, 2011) have conducted comprehensive researches on the concept of sustainable urban form through analyzing the urban form of various

cities throughout the globe. They adopt a three-dimensional model including urban form, social and economic, and environmental elements and emphasize on the importance of the urban context. In this model, urban morphology is a key component in achieving sustainable development. Salat (2011) note that “The form of a city is constituted by the spatial and social patterns that compose it and that allows us to describe its networks, its built spaces, and its empty spaces in geometric, topological and hierarchal terms in two, three and even four dimensions, incorporating the temporal depth that every city contains.” (Salat, 2011). They have discussed the importance of connectivity, consistency, diversity, mixed land-use, in various urban contexts. According to Salat (2006), three fundamental factors for sustainable urban development are: protecting the environment, supporting diversity and mix of building types in neighborhoods, and creating a downtown which is compact and walkable. They state a sustainable urban setting should support inhabitants’ walking, biking and using public transportation. It should be compact and support mixed land-use where the social and functional mix decreases travel needs and reduces social segregation.

In literature related to urban form, concepts of sustainability and liveability are interrelated. Accordingly, sustainability endorses a better quality of life and a more liveable urban environment.

Liveability is a broad concept. Regarding Girardet (2004) liveability and sustainability are correlated though may not always imply the same issue. He defines a liveable urban space as a setting with well-organized neighborhoods with proper facilities within a walking distance, appealing public spaces, with dynamic streets, and well-connected. Livability and the concept of livable urban space are very much related to the notion of quality of life while it is associated with the vitality and congeniality of urban space. Thus, a livable urban space indicates an inspiring quality of life situations with attractive public space, social activities,

sense of community, environmentally resiliency and economic vigor. Lynch (1981) in his renowned book “good city form” has identified five significant features as: vitality (a healthy environment), sense (sense of place or identity), fit (a setting’s adaptability), access (to people, activities, resources, places, and information), and control (responsible control of the environment). The attributes of the urban space including being fit and vital foster safety, satisfaction, and sustainability. Gehl (1987) has investigated the outdoor activities that take place within an urban setting and has defined three different types of activities as necessary activities, optional activities, and social activities. Thus, urban space can encourage social interaction and diverse activities and behaviors. Norbert-Schulz (1979) highlights the significance of identity and genius loci as well as Lynch (1960, 1981) who emphasizes on the importance of image, place identity and components of a good city form. Hillier (1984) describes the prosperity of urban space is relevant to the presence of people and their activities. Thus, permeability, connectivity, and accessibility are key factors of the space in generating activities. Existence of diversified functions enhances the potential of occurring diversifies activities and interactions. In this sense, an urban space with a high level of mixed land uses and diversity contribute to the presence of people and consequently promotes vitality. Jacobs (1961) has underlined the importance of the mixed-use urban environment that can enhance urban diversity and foster the presence of people in the urban fabric. She supports the issue of diversity and vibrancy in urban settings.

In this context, universities because of their educational mission, their large size, and impact on their societies are key agents in directing the society, forming its future and the transition towards a liveable sustainable environment. Universities are among chief organizations in the society that comprise infrastructure, facilities, land, human and economic capital, and function as large urban enterprises. So, sustainability initiatives can be

incorporated into their research and educational agendas and their operations and should be manifested in their physical setting. To do so, universities have concerned that they need strategies that profit students, staff and also a broader community. Today, many universities are attempting to improve their facilities considering the concepts of sustainability and liveability to be more connected, coherent, green and pedestrian friendly (Wheeler, 2004) as well as being an integral part of their surrounding urban context.

3. Physical features of university campus

The physical environment is a setting that diverse activities take place within it. This is evident that the quality of space and the physical characteristics of the setting have an impact on the activities (Whyte, 1980), interactions, participation, feelings, and perceptions. Although this fact is not exclusively indicating a campus setting, it is a common sense that can be ascribed to a campus space as well. Therefore, it can be admitted that there is a correlation between the spatial quality of university space and the quality of academic and urban life. The influence of campus space on the academic and social life of university is vastly examined in the literature mainly through a pedagogical and psychological perspective (Boyer, 1987; Griffith, 1994; Strange & Banning, 2001; Temple, 2009), but the subject has not much acknowledged in the academic debates concerning architecture and urban design attributes of the campus space. Whilst, physical features of the campus create a great impact. The scale of this impact can differ from the visual qualities such as micro-scale artifacts to more macro consequences.

Strange and Banning (2001) note that “although features of the (campus) physical environment lend themselves theoretically to all possibilities, the layout, location, and arrangement of space and facilities render some behaviors much more likely, and thus more probable, than others.” University setting provides a platform for diversified activities including education, research, informal idea exchange,

socializing, working, and living. Campos Calvo-Sotelo (2014) refers to the university campus as a “Third place” between residential space and workplace where a different range of daily activities take place. Due to its flexibility, this outdoor space provides potentials for communications and social interactions. Kenney et al. (2005) state that more than 50 percent of learning in a university is occurring in the form of informal learning and through out-of-classroom activities. In this respect, the whole campus space act as a learning environment and needs to be designed in a way that enriches the academic and social knowledge experience of students. Based on the literature on the vitality of urban space, it can be argued that within a university campus, the existence of high ratio of mixed uses and diversity of functions can enhance the presence of students for longer hours in the campus setting. Doing so, the presence of students and being involved in diverse activities d generates synergies and enhances vibrancy and vitality of the space. In this sense, residential campuses function more successfully in this regard. The combination of student housing within campus space is a key strategy that many university masterplans follow to promote the liveability of their university precinct. Clearly, a campus setting should provide a platform for diverse optional and social activities (Gehl, 1971) besides academic functions. Creating an urban space that reinforces social activities can contribute to social sustainability (Gehl, 2010). In order to provide the potentials for social functions, it is important that campus space can be accessible and permeable. Ease of access can guarantee the movement of people within the precinct and enhance their willingness to be more engaged in the setting. Thus, designing a well-distributed and connected movement network is a key issue in university campuses. It needs to enable the vehicular access of services to different buildings and meanwhile facilitate the free movement of pedestrians within the setting. A good arrangement of movement network is a fundamental issue in promoting liveability and walkability of a university campus.

Physical attributes of a campus setting can be well outlined by a comprehensive campus plan. Campus plans outline the institutional objectives of the university including attracting prospective students and faculty, promoting the quality of life, improving the academic atmosphere, contributing to sustainability goals, and enhancing the proximate urban space.

A campus plan embraces three main constituents of the setting: buildings, landscape, and circulation. The campus plan defines the configuration of landscape and then the built form is designed to frame the open space. Placemaking and Placemaking are two fundamental aspects of campus design (Dober, 1992). Placemaking is describing the arrangement of the campus plan, distribution of campus land-uses, the position of buildings and open spaces, movement (pedestrian and automobile) network and bounding campus borders and its interface with the adjacent urban fabric. This plan set a framework to address functional, programmatic, and visual objectives. A well-designed campus plan can convey university's situation within the broader society, deal with land-use challenges, and make a decision for site position. Placemaking considers the physical characteristics of the campus for generating a sense of place and visual identity. Landscape components, architectural style, and landmarks are among the elements that assist the university's placemaking.

The main elements of a campus space including the organization of uses, the arrangement of pathways connecting the uses, the layout of open spaces, the density and mix of functions widely affect the vibrancy and vitality of the campus setting. The paths, plazas, courtyards and all open spaces of the campus landscape are the places where planned and unplanned encounters taking place. Campus public space is a platform for informal learning and social interactions. It is the vital component in forming the sense of place that is inevitably associated with the campus experience. Therefore, these spaces need to be vibrant, dynamic, attractive, and memorable in order to enrich the campus experience. Many campus re-

vitalization projects, particularly post-war campuses, are conducted intending to inject vitality and homogeneity to the campus landscape as well as supporting the sustainability issues.

One of the good studies which can be fruitful for this research is the research done by Hajrasouliha (2017). He has reviewed 50 American university campus master plans which mainly created after 2000 in the USA and has identified their common objectives and challenges. He has categorized them in 10 categories and 100 recommendations which reveal the most important factors for university campus designers. Regarding these categories, it can be better understood which qualities were at the center of importance for campus designers. These 10 categories are defined as (1) walkability (2) sense of community (3) livability and safety (4) environmental sustainability (5) landscaping (6) town-gown relationship (7) identity (8) imageability (9) partnering (10) learning environment. Then, he has investigated the morphological dimensions of campus planning on the academic success of students.

Kenney et al. (2005) identifies a comprehensive campus plan encompassing nine principles:

- The priority of total plan to individual buildings and spaces.
- Using compact and mixed campus land uses to enhance livability and interactions.
- Shaping an identity through landscape elements that convey the campus unity and its relationship with surrounding urban setting.
- Forming a mutual physical connection with the surrounding urban space.
- Creating placemaking through campus architecture.
- Adding meaning and identity to campus urban space.
- Considering environmental issues.
- Controlling the auto circulation.
- Considering technology and innovative approaches.

Any campus plan needs to be comprehensive and addresses the vision of the institution, guide the growth and change, and reinforce the strategic plan. The didactic and community vision, history, culture, tradition, and

the context are bases of a good campus plan (Kenney et al., 2005).

4. Methodology

4.1. Sustainability and liveability criteria of university campus form

This paper, as a part of a broader doctorate dissertation on a multi-criteria analysis of sustainability and liveability of university campus form, has intended to develop a model to evaluate university campus form in terms of sustainability and liveability. For this purpose, a literature review was done on the subjects of the university's third mission and urban outreach activities, urban form, sustainability, liveability, and campus design principles. Then, through an interpretive study, the main issues were conceptualized. Afterwards, a content analysis of fifty masterplans was done. The masterplans were selected randomly throughout the world excluding the American campus masterplans. The content analysis was attempted to identify common goals, strategies, and actions which were identified by campus planners. The findings of masterplan content analysis were merged with the findings of the study done by Hajrasouliha (2017) on American campus masterplans.

In the next step, the whole acquired data incorporated to create a set of criteria. The proposed model comprises nine criteria including liveability, legibility, cohesion, compactness, walkability, accessibility, connectivity, integration, and sustainability and twenty-eight sub-criteria. From the whole twenty-eight criteria, twenty-two of them are directly related to campus form.

To assess the performance of campus regarding each sub-criterion the study has developed the "*Histology Atlas of Campus Form*".

4.2. Atlas of histology

The Histology is a branch of biology that examines the microanatomy of cells, tissues using a microscope. This method aims at identifying and visualizing the microscopic structures of tissues and assess the correlation between structures and function. Thus, "Histology Guide teaches the visual art of recognizing the structure of cells and tissues and understanding how this is determined by their function." (Url-1).

4.3. Developing a histology atlas of campus form

Grounded on the Histology Atlas in biology, A Histology Atlas of Campus Form was developed. The proposed Histology Atlas illustrates the structure of campus form criteria in a schematic way. In this sense, the visual dimension of each criterion and its performance level has been demonstrated in three levels between the best, the average, and the worst performance situation.

Developing the Campus Histological Atlas makes it possible to evaluate the campus spatial maps and score them for each criterion in a base of three-point Likert scale.

4.4. Applying the model on a selected university campus

4.4.1. Harvard University

Campus development:

Harvard University is a private research university and the first American university established in 1636.

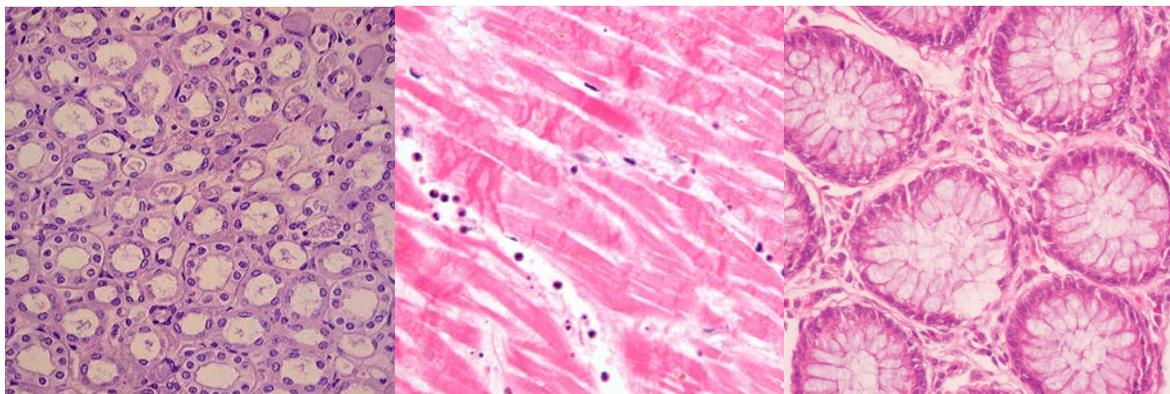


Figure 1-3. Histology of human tissues (Source: <http://www.histologyguide.com>, Retrieved at May 2019).

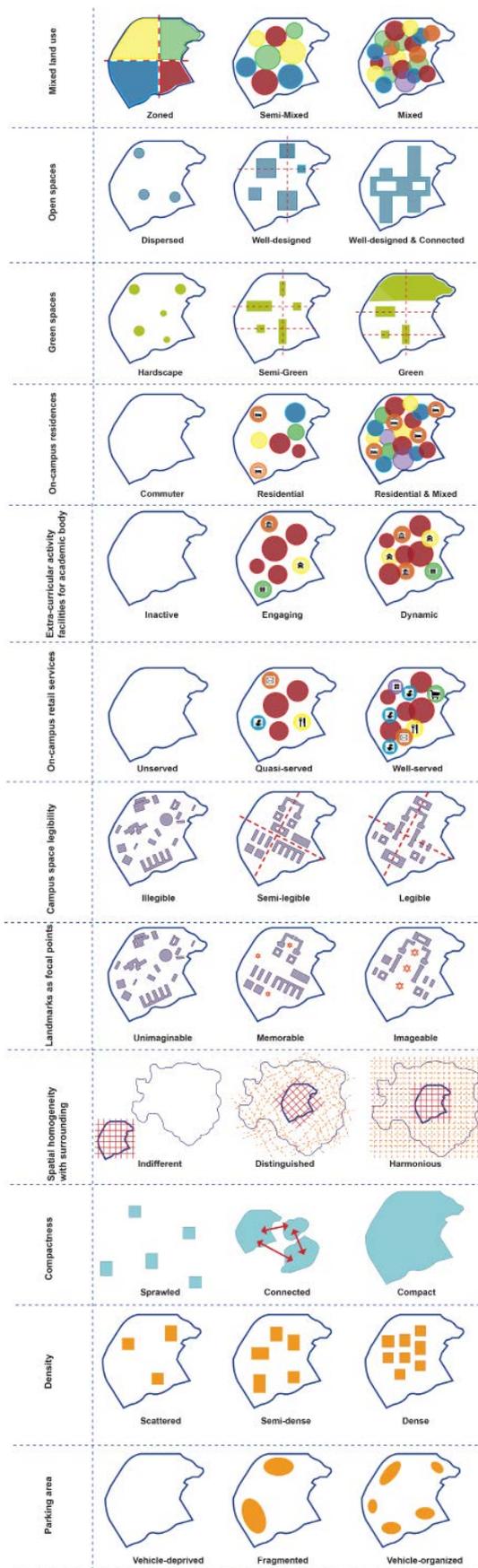


Figure 4(a). *Histology Atlas of Campus Form* (Source: Authors).

After the colonization of the United States, there was a strong belief that the New World required educated people for prosperity. So doing, Harvard College was founded on a one-acre piece of land in Newtown village –then changed its name to Cambridge. This piece of land now comprises the core of the campus, the Harvard Yard. The Harvard Hall I was the first purpose-built edifice of the campus located in Harvard Yard with an E-shape form. Indeed, design of the Harvard campus followed the ideals of the English Collegiate system and intended to shape a community for students to study, live and socialize. However, it rejected the inward-looking cloistered structures of English universities and instead outward-looking separated buildings were designed within a park-like landscape. This spatial arrangement was organized in a way that is open and accessible to serve the community. These ideas later became a prototype for American university campuses that continued within the centuries.

These early phase buildings were designed in red brick and High Georgian style and this architectural style created unity and harmony within the Harvard Yard. Another major construction phase occurred between 1869 to 1909 that 35 new structures were erected and it was massive construction in comparison to earlier 34 buildings which were built within 233 years since the foundation of Harvard University. The structures of this latter period mainly considered the functionality. They were designed with various architectural styles and were scattered around the Harvard Yard and the North Yard. Thus, there was not a unified architectural style nor an established development plan. In the period of 1909 to 1933, it was noticed that there was a need for a holistic plan for Harvard development to control the physical expansion and the architectural character. So, the Georgian Revival was chosen as the university's architectural style and a master plan was developed in 1910. The Second World War aftermath put its traces on Harvard University and caused transformations in its physical body. The International Style was practiced in the university's architecture

and new materials, forms, scales were introduced into the Harvard campus. In spite of creating new radical transformations, it was intended to create a correlation between Harvard's historical character and the newly introduced forms. Within the chronology of Harvard development, from a Colonial, Colonial Revival, Georgian, Georgian Revival, Neo-Classical, Romantic Revival to Modernist, New Modernism, Post Modernism, and New Historicism, an arrangement has been created that preserve Harvard's unique spirit so vital and dynamic and align its physical growth to its academic objectives. The edifices are human-scale and in great harmony with the surrounding neighborhood. The campus is highly integrated into its hosting city through its green areas and open spaces (Coulson, et al. 2011).

Indeed, Harvard has had a decentralized planning tradition which has served for centuries. Within this long history, diversified buildings with different morphologies and architectural styles have emerged. Brick is not the only but the common material which has been used in different architectural styles and created a continuity across the campus.

Harvard yard has been considered as the "political, academic, and spiritual center of the Harvard". However, since the foundation of Allston Campus on the southern part of Charles River, the river has become the geographic locus of the university. The Charles River has a significant role in structuring the campus because of its particular vistas and its clear directional quality. It also functions as a natural barrier and defines the edges. At the same time, the river offers potentials for connecting Harvard main campus to Harvard's other campuses and also adjacent universities.

Harvard is a single university composed of various institutes, faculties, and departments which function autonomously. This feature enhances its intellectual vibrancy and increases the diversity of physical environments. Harvard University has a decentralized characteristic. Being developed on a precinct basis, there is not a particular mechanism for sharing recourses and

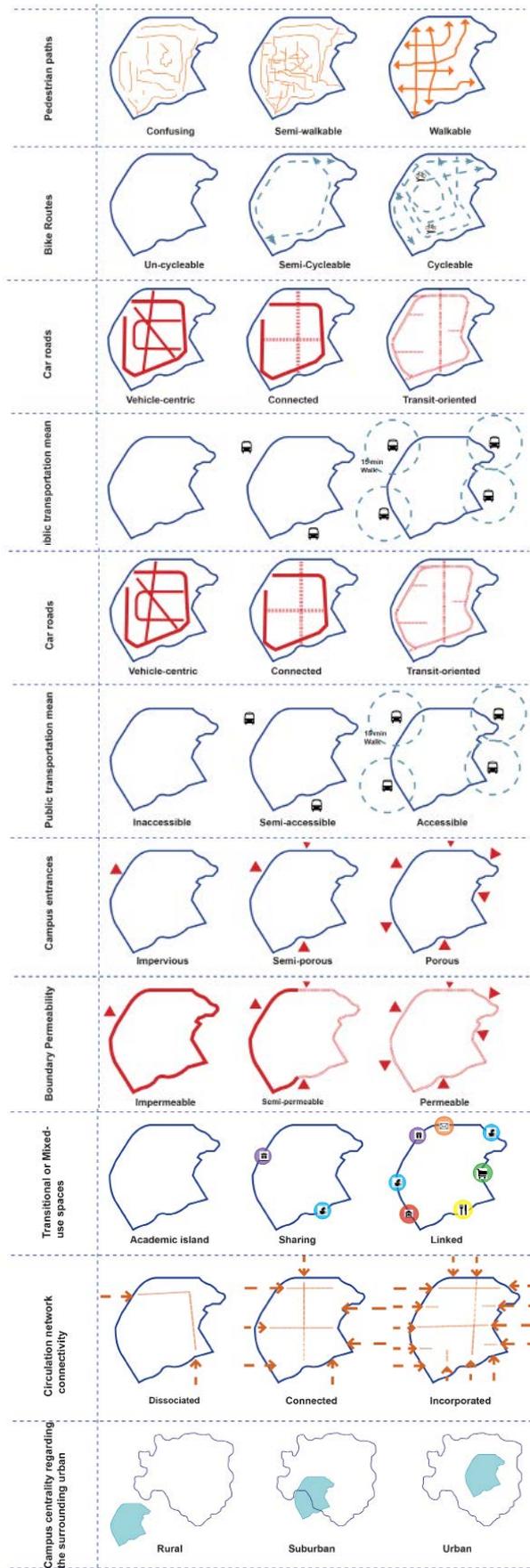


Figure 4(b). Histology Atlas of Campus Form (Source: Authors).

growth of shared facilities. In addition, Harvard faces difficulties to be expanded within its dense urban fabric.

Harvard University has developed from a single building in a rural area to a large integral campus within a dense urban fabric. Harvard University is in close interaction with its hosting urban space. Its academic prosperity and economic growth have brought a responsibility to contribute to the improvement of its urban space through providing teaching and research facilities, laboratories, offices, and affordable housing. The high level of campus and urban land-use integration is mainly at the edge of campus where most of the residential and commercial uses are situated. Diversified land-uses such as lecture halls, services, and residences are scattered around the campus and enhances the informal exchanges and vitality of the space. The diversity and balanced distribution of land-uses and activities increase the nightlife security due to the presence of 24-hour activities on the campus. There are residential areas, retail and commercial buildings, sports facilities, libraries that are active and open during the night hours. This issue increases the perceived safety not only inside the campus but also in the surrounding urban area. Providing housing is one of the core objectives of Harvard as an educational community and a residential college. There are a variety

of residences available for students and faculty members. While the students' dormitories are mainly in proximity to academic buildings, the affiliates housing are mostly located in campus boundaries. The existence of residential buildings enhances Harvard's campus liveability, informal interactions and the sense of community.

There are several facilities and services provided for Harvard students and faculty to boost their quality of life. Harvard Square can be considered the locus of many social, commercial and recreational activities. There are other activity zones forming corridors along the streets in campus edges.

Considering the greenness, approximately sixty percent of Harvard campus is devoted to open space which defines its structure and expresses its rich spatial quality. It is composed of diversified typologies of open spaces including courtyards, quadrangles, gardens, and paths which hierarchically forms a unique spatial experience for the users.

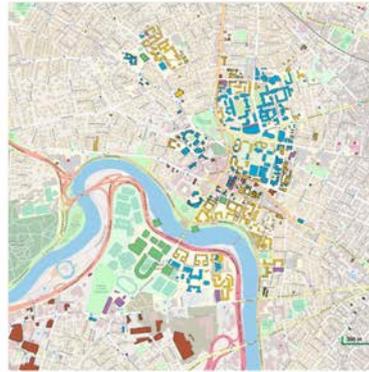
The campus edges have various forms of barriers including high and low walls, high and low fences, hedges and gates. Each type of boundary creates a different form of physical character in terms of visibility and pedestrian and vehicular accessibility. In spite of containing various kinds of boundaries, it can be noted that Harvard campus merges with the surrounding



Figure 5. Harvard University Aerial View (Source: Url-2).

Mixed Land-Use:

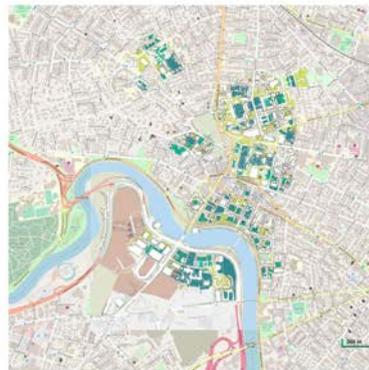
The institution is organized according to departments and faculties and all uses are scattered around the campus in a balanced way.



Land-uses Spatial Analysis Map

Green Spaces:

All the campus is like a park-like landscape with diversified green spaces.



Green Space Typology Map

Open Spaces:

There are well-designed plazas and Courtyards around the campus.



Campus Layout Map

Parking area:

Small parking areas, distributed.



Figure 6. Analytical Analysis Maps and Histology Form Scheme of each analyzed criteria (Source: Authors).

urban space. It has a high level of public accessibility in different modes and conserves its public character.

Moreover, Harvard University offers a wide range of amenities to its urban context including cultural, athletic, religious facilities, museums, exhibitions spaces. There are plenty of seminars, workshops, educational programs, art, and cultural events, theatre perfor-

mances, sports games that are held in Harvard during the year which are accessible to the public.

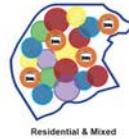
Harvard University spatial analysis:

Discussion

Harvard University has been selected as a case study because of its very high academic ranking and high per-

On-campus Residences:

Availability of dormitory for students inside the campus and accessible and also residences for faculty members mainly in the periphery.



Residential & Mixed

Extra-curricular activity facilities for academic body:

Sport field, covered gyms (In Allston campus), recreation areas, galleries, museum, ...



Dynamic

On-campus retail services:

Highly available and accessible, mainly in urban surrounding space.



Well-served

Architectural character:

Buildings, Yards, Plazas, art works.



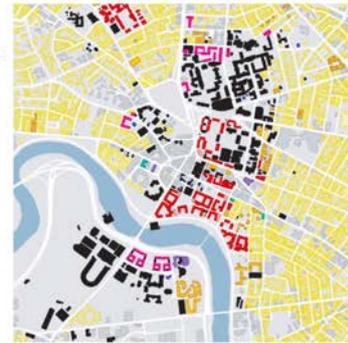
Legible

Landmarks as focal points:

There are different architectural styles. Red brick is the common material. There is an overall architectural style homogeneity.



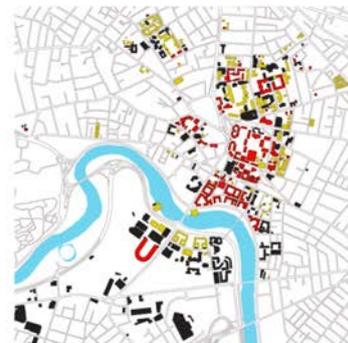
Imageable



On-Campus Residences Map



Available Amenities and Services Map



Architecture Character and Historic Landmarks Map

Figure 6 (Continued). Analytical Analysis Maps and Histology Form Scheme of each analyzed criteria (Source: Authors).

formance in sustainability, and being the best representative of an integrated university campus. Primarily, through literature review and examining campus development maps, masterplans, university annual reports, university website, google maps, and videos of the campus, the campus development process and its spatial features were described. Then using campus masterplans, Google Earth maps, Google

maps and Openstreetmaps, campus analytical maps were reproduced. Each map illustrates one or more of the criteria of the Histology Atlas of Campus Form. Then, the Histology Atlas of Campus Form was used as a benchmark to assess each spatial and morphological criterion. It is noticeable that, in most of the criteria related to spatial and morphological dimensions, Harvard University has scored very

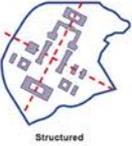
Campus space legibility:

Most of the buildings are historical.



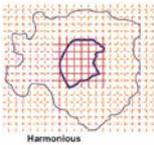
Spatial layout:

In spite of not being organized according a development plan, campus is generally well organized and there is a consistency and harmony, "a Harvard spirit".



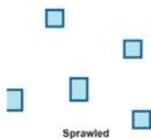
Spatial homogeneity with surrounding:

Campus and city has evolved together.



Compactness:

It is scattered within its urban fabric.



Density:

It has a mid-high density in comparison with surrounding urban space.



Spatial Configuration Analysis Map



Urban Morphology Analysis Map



Campus Density Analysis Map

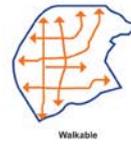
Figure 6 (Continued). Analytical Analysis Maps and Histology Form Scheme of each analyzed criteria (Source: Authors).

high. The campus has been located at the center of the city of Cambridge, Massachusetts and has been evolved with its surrounding urban context. Thus, there is a high level of spatial homogeneity, connectivity, and integration between the two domains. Campus

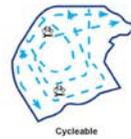
shows a low level of compactness and a high level of density considering its urban fabric context. Being constructed within a phase of history, it has several spatial structures but the entire campus is well-organized and demonstrate consistency and unity. The campus

Pedestrian paths:

Well-connected pedestrian paths.

**Bike routes:**

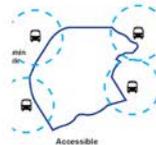
Well-connected bike routes.

**Car roads:**

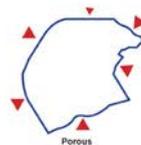
Different types of car roads.

**Public transportation means:**

Availability of various kinds of public transportation.

**Campus entrances:**

There are different kinds of boundaries, but campus is highly accessible.

**Boundary permeability**

Inserted in the urban fabric and integrated with that.

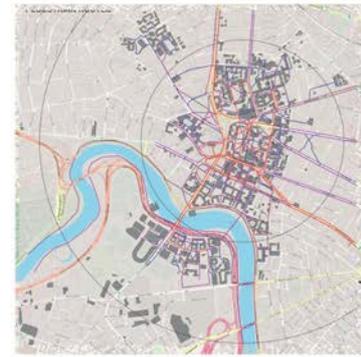
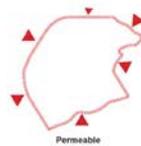
**Movement Network Analysis Map****Movement Network Analysis Map****Campus Permeability Analysis Map**

Figure 6 (Continued). Analytical Analysis Maps and Histology Form Scheme of each analyzed criteria (Source: Authors).

has a unique architectural character with several landmarks and is highly legible. Land uses are mixed with the inclusion of various types of student housing which enhances the liveability and vitality of the setting. Campus boundaries are visually and physically

preamble. There are several types of transportation means that increases campus accessibility. The campus has a high ratio of green space and well-designed open spaces that are accessible to the public. Harvard University also shares many of its amenities with the

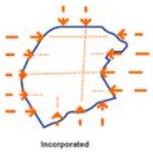
Transitional or Mixed-use spaces along the campus boundary:

Being inserted in the urban fabric, there are various shared land uses on the campus edges.



Circulation network connectivity:

Well-connected.



Campus centrality regarding the surrounding urban space:

Inserted in the urban context.



Connectivity Analysis Map



Urban Context Analysis Map

Figure 6 (Continued). Analytical Analysis Maps and Histology Form Scheme of each analyzed criteria (Source: Authors).

general public including museums, exhibition spaces, performance spaces, library, hospitals, and athletic facilities. In this sense, Harvard University itself is a landmark for the region and well integrated with its community.

5. Last remarks

Universities are large urban institutions and microcosms of society. They are agents of transformation and contribute to the socio-cultural, environmental, economic, and physical development of their hosting urban space. As place-bound institutions, they are influential entities in liveability and sustainability of their campus space and surrounding urban context. Considering the urban form, concepts of sustainability and liveability are interrelated. Accordingly, sustainability endorses a better quality of life and a more liveable urban environment. The idea is applicable to the campus form but it needs to consider the specific

physical and functional aspects of a university campus setting.

To avoid subjective evaluation of liveability and sustainability of university campus form, this research has developed "The Histology Atlas of Campus Form". The model is grounded on the interpretive study of concepts of university's outreach activities, liveability, sustainability, campus form, and campus design principles. It also benefits from the findings of campus masterplans content analysis. Campus masterplans address the university's goals, objectives, and missions. Although there are complexity and diversity considering diversified university masterplans, their defined strategies can be used as a complementary source for the existing academic literature on the subject of university campus physical features.

The research has developed a set of criteria composed of nine criteria and twenty-eight sub-criteria to assess the

sustainability and liveability of campus form. These criteria include liveability, legibility, cohesion, compactness, walkability, accessibility, connectivity, integration, and sustainability.

This research attempts to operationalize the spatial and morphological aspects of campus form in terms of liveability and sustainability and provide a theoretical framework that can be applied to various university campuses. The proposed model hopes to provide a comprehensive multi-criteria analysis to assess a university campus form in terms of sustainability and liveability.

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