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CONSTRUCTING SOCIOSPATIAL MAPS FROM INSTAGRAM IMAGES

in three urban spaces in London

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ABSTRACT

Social media have become nowadays a popular digital platform connecting societies and individuals through the exchange of information in the form of videos, images and texts. They can also be used as a powerful source of data to understand social behaviours in the built environment. This research studies the social and spatial characteristics of Instagram's public photographs. Can datasets from Instagram photos provide an understanding of human insights into society, culture, and urban environments? Three public places in London are studied to address this question and develop a methodology: Granary Square, The British Library and UCL Main Quad. All Instagram photos were mapped using the isovists concept developed by Michael Benedikt (1979). A new algorithm in Grasshopper was created to reconstruct the visual fields in the photographs and calculate two new analytical measures: Digital Space Interaction (DSI) and Digital Space Visibility (DSV). DSI and DSV measure the spatial properties of the photos and the visibility features of each place, respectively. These analyses were compared to Visibility Graph Analysis measures (VGA) and some qualitative aspects of the three places. The research found that the spatial properties of physical space featured in digital media can provide a holistic view of place in terms of visibility and digital interaction clusters, complementing the insights obtained from traditional observation techniques and configuration analysis. The results of this research show the potential of digital media in analysing and evaluating urban spaces.

KEYWORDS

Isovists, digital spaces, social media, Instagram, spatial data

1 INTRODUCTION

Technology has changed the way in which societies experience the built environment. Smartphones and other digital devices allow accessing different types of data about cities, communicating with people around the world in real-time, and affecting social behaviour. Instagram, Facebook, and more lately TikTok, may have spawned new social patterns on various dimensions. The appearance of "influencers," who can encourage new spatial behaviours in those who follow them digitally, such as visiting a recommended location or even avoiding others, is one example of these changes (Guerreiro, et al., 2019). Besides, by recording millions of points of data about places, services and behaviour these platforms offer an opportunity to understand the relationship between people and urban and architectural environments. This paper develops a method of constructing socio-spatial maps using social media photos from Instagram that can enable us to understand patterns of use in public spaces.

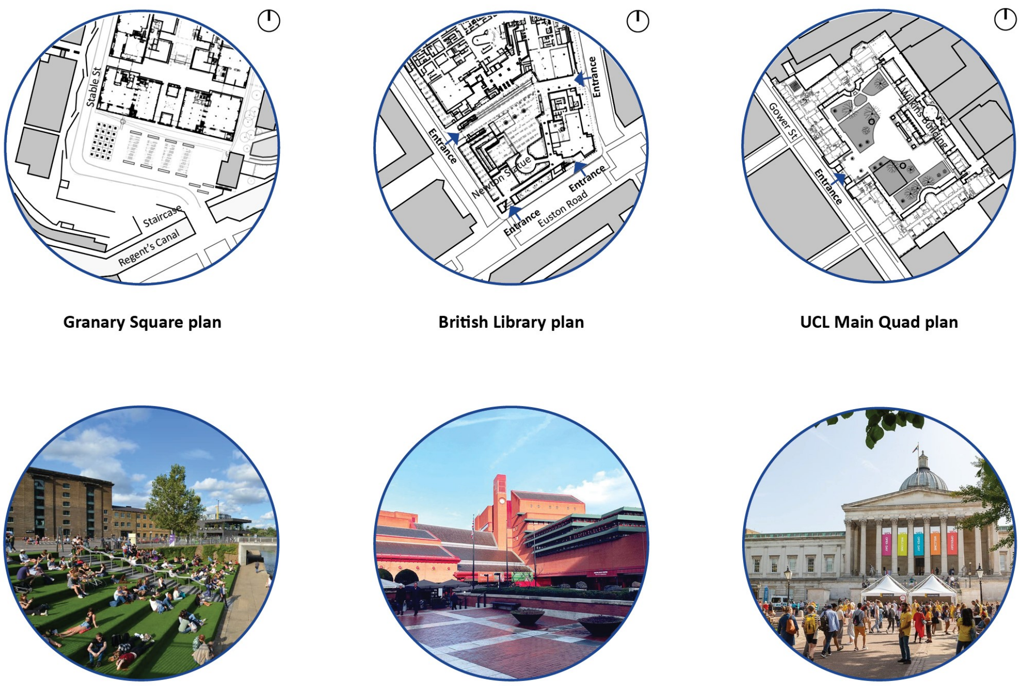
2 SOCIO-SPATIAL ANALYSES IN A DIGITAL ERA

Many studies over the last century have argued that the configuration of physical space plays an essential role in the social performance of an environment. Authors such as Bill Hillier and Adrian Leaman argue that society always comprehends something through its environments; therefore, if these environments are meaningful at an intuitive level, people can exchange meaningful ideas about them (Hillier & Leaman, 1973). Hillier and Hanson called this phenomenon ‘description retrieval’ in which people obtain and reproduce information by grasping patterns of the space (Hillier, 1984).

In the last decades, technologies such as cell phones, the internet, AI and virtual and augmented reality have begun to change our social behaviours in space also creating data about these patterns on a daily basis (Floridi, 2014). Martijin de Waal has named this type of technology digital urban media, “a collective term … for media technologies that in one way or another can influence the experience of a physical location” (De Waal, 2014, p. 8). Smartphones is a clear example. Keller Easterling states that devices such as phones do not change the spatial environment but allow that infrastructure and ideas to be shared around the world as information phenomena (Easterling, 2012). Through social media platforms, texts, images and videos can be continuously sent and received simultaneously in any place. More importantly, people’s actions in the built environment can be mobilised without physical support, affecting how they behave in ways that may have never been observed before (Netto, 2016). Despite the fact that data from smartphones has been extensively explored in recent years (Girardin, et al., 2008; Traunmueller, et al., 2013), data from digital images has not been thoroughly examined in urban studies.

A useful social media platform for the research of city processes is Instagram. By 2021, Instagram had registered more than 1 billion users worldwide (Statista, 2022). This platform differs from the rest because it prioritises digital communication through images, enabling people to exchange information about physical space and people's location (Hochman & Manovich, 2013). Studies argue that Instagram could provide insights into what people find culturally interesting in urban settings (Martí, et al., 2019) enhancing understanding of society, culture and urban environments (Hochman & Manovich, 2013; Hu, et al., 2014). Nevertheless, the geolocation of images and the visual fields portrayed in the photographs have not been extensively studied despite their infinite potential. There are some limitations to consider in the use of social media datasets such as the small percentage of sociodemographic classes who use the platform and the selective character of the pictures (Boy & Uitermark, 2016; Sulis, et al., 2018). However, exploring these types of data can yield interesting information about how people photograph places, and how they use them, and communicate with each other.

This paper uses the isovist tool to analyse Instagram photographs taken in three spaces in London shown in fig.01. All three are part of an organisation known as The Knowledge Quarter (Knowledge Quarter, 2022), a cluster of institutions engaging with knowledge and information such as universities, libraries, etc. These spaces are meant to be lively and buzzing places generating interactions, productive dialogue and knowledge exchange. The analysis uses isovists to assess the social and spatial characteristics of these environments as they feature in Instagram photographs and real space. Isovists were created by Michael Benedikt and have been used in many studies over the last few years (Peponis & Bellal, 2010; Benedikt, 2020). In this study, each Instagram photo of space is considered an isovist. All Instagram photos of the same space when examined together provide a collective representation of the space in terms of the spatial characteristics, activities and patterns of behaviour occurring in this space.



Granary Square plan | British Library plan | UCL Main Quad plan

Instagram photo. Author:@claudiansilveira
Granary Square environment

Instagram photo. Author:@keytofreedom
British Library environment

Instagram photo. Author:@studiareuk
UCL Main Quad environment

Figure 01: Study cases ground floor plans and public images. Digital media images source: Instagram Caption

3 METHODOLOGY AND DATA

3.1 Digital media spatial maps

The analytical process, shown in fig.02, starts by randomly searching a dataset sample of two hundred pictures geolocated in each of the three places on Instagram. As a selection criterion, all photos have to be pictures of any of the three selected places. A second criterion used is that it must be possible to recognise the position where the picture was taken. The app 4kStogram was employed for this purpose due to its capabilities of downloading all public images of a geolocated place during specific periods. The selection period for this study was from August 2019 to January 2020. After collecting the picture datasets, all data related to the origin and field of vision of the pictures were manually geolocated, using QGIS software. Once the mapping process was finished, the new data set was exported to Grasshopper. An algorithm script was specifically developed in this programme to calculate two new spatial measures: Digital Space Interaction (DSI) and Digital Space Visibility (DSV).

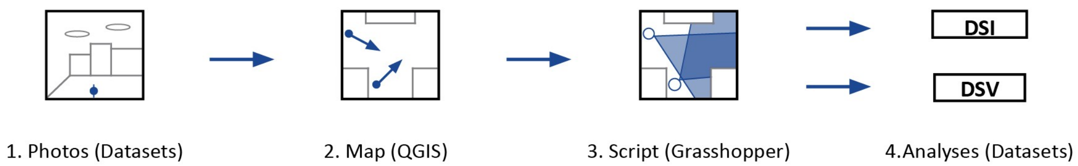


Figure 2: Digital spatial maps process diagram.

Digital space interaction (DSI) measures the spatial location properties of the pictures. After mapping the origin location of a picture, a script is used to create a circular area of three metres map radius around the origin of the field of vision (fig.03). This process highlights the locations of the origins as hotspots and explains where people digitally interact with an environment taking pictures of it, or sharing live media also known as “stories”.

Digital space visibility (DSV) measures the connectivity property of the space featured in the pictures. The Grasshopper script maps each picture as an isovist in a spatial grid map (fig.03). It also calculates how many isovists fields, each representing a picture, are overlayed over a data grid, generating a visibility map similar to a VGA map (Turner, et al., 2001). DSV is similar to the connectivity measure in VGA. It explains which spatial regions from those photographed in each space are mostly seen by viewers on Instagram and hence, the possible influence of certain photographed areas on the social patterns of a place.

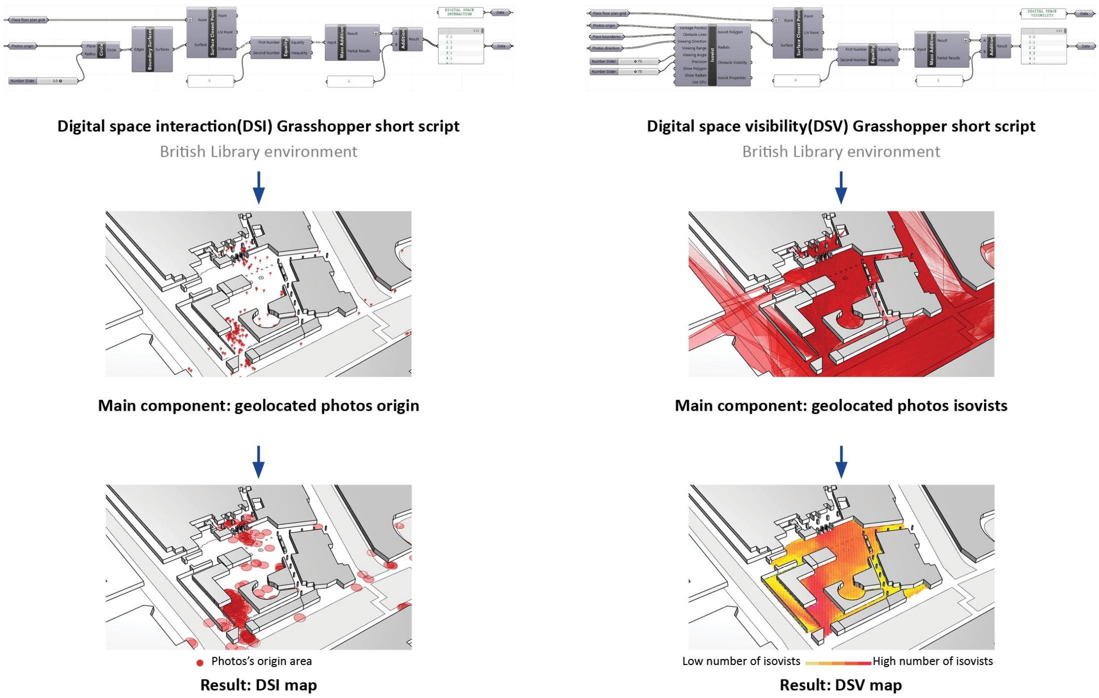


Figure 3: Digital space interaction (DSI) and digital space visibility (DSV) short Grasshopper script and 3D model explanation.

In order to normalise the obtained values and generate a comparable index, this methodology uses the information entropy formula known as the Shannon Index (Shannon & Weaver, 1964). The index formula is grounded on communication theory but in recent years has been also applied in biological and urban studies (Spellerber & Fedor, 2003; Cantarino & Netto, 2017). This study proposes a Diversity Index that assesses the entropy in the distribution of values of DSI and DSV in the spatial grid. In the case of DSI, the Diversity Index accounts for the number of circular areas located over each point on the spatial grid; in the case of DSV instead, it measures the number of isovists. The Diversity Index has a greater value if the amount of data counted at each location on the grid is perfectly homogeneous. In contrast, the Diversity Index has a lower value if the distribution of the two measures in the spatial grid is not homogeneous. This metric compares the number of cell count units accounted at each place on the spatial grid to the total quantity of all the data points on the map. This normalizes the measure and allows it to be compared across spaces. In the case of DSI and DSV, a base value of 1 is also added to all cells before counting in the grid to avoid a logarithmic error. The original Shannon formula is adapted with the variables gathered in this investigation and is as follows:

$$DSDi = \sum_{c=1}^{n} Pci \; Ln(Pci)$$

DSDi = Diversity index
Pci = total grid cell count unit
(In DSI, the 3m circular areas intersecting each cell)
(In DSV, the isovists intersecting each cell)
Ln = natural logarithm
n = number of points in the grid (spatial map)

Equation 1: Diversity index equation for DSI and DSV.

3.2 Physical spatial visibility and observation of social indicators

In order to compare this approach to Visibility Graph Analysis (VGA) (Turner, et al., 2001) measures, it was used DepthmapX software (Varoudis, 2015) to analyse each public space, calculating the values of integration and connectivity. For this study, a 150m radius model from each public space was drawn, considering all spaces that are visible (eye-level). Consequently, it was quantified the measure of intelligibility (Hillier, 2007, pp. 91-98) for all three cases. The last part of the research measures the social indicators of a place through an observational study of the same places featured in the dataset, i.e. the Instagram photographs used in the analysis. Two categories were selected to measure the social indicators of a place, both of which are based on the framework developed by the Project of Public Spaces (PPS, 2018, p. 5): sociability and uses & activities. The full classification and an observation example of sociability and use & activities are shown in fig.04.

SOCIABILITY CLASSIFICATION

PHOTO CONTENT	NUMBER OF PEOPLE	AGE GROUPS	DAY PERIOD
-Social Activity	-0	-Children	-Day
-Infrastructure	-1 to 5	-Youth	-Night
-Selfie	-6 to 10	-Adult	
-Other	-11 to 20	-Senior	
	-+20	-Mix	
		-N/A	

USES AND ACTIVITIES CLASSIFICATION

ACTIVITIES OBSERVED			SPECIAL EVENTS	
-Drinking	-Gathering	-Reading	-Christmas show	-Halloween show
-Eating	-Performing	-Relaxing	-Exhibition stand	-Strikes
-Event observation	-Playing	-Walking	-Festivals	-Summer events
-Exercising	-Posing		-Graduations	

Instagram photo. Author:@being_bolder

SOCIABILITY EXAMPLE

PHOTO CONTENT:
-Social Activity

NUMBER OF PEOPLE
-6 to 10

AGE GROUPS
-Mix

DAY PERIOD
-Day

USES AND ACTIVITIES EXAMPLE

ACTIVITIES OBSERVED
-Event observation

SPECIAL EVENTS
-Exhibitions stand

Figure 4: Social indicators classification and example. Digital media image source: Instagram Caption.

4 RESULTS

The results of the analysis using the DSI measure in Granary Square showed that there are two hotspots or a high incidence of overlapping areas of photographs situated in specific locations close to the fountains and the staircase (fig.05). These patterns could be due to the design characteristics of the spaces and their attractions such as thematic installations per season that take place in these locations. In the British Library, the hotspots concentrate close to the main Newton statue and the building entrance (fig.05). These patterns are thus, more related to the physical features of a free-standing element in the courtyard and the entrance. Lastly, in UCL Main Quad, hotspots are concentrated on the main axis, where the central portico entrance is located (fig.05). By measuring the Diversity Index of DSI, it can be seen which of the three public spaces has the highest levels of homogeneity in terms of the origins where people take pictures from (tab.01). The DSI Diversity Index value indicates whether the areas that are photographed most are homogeneously distributed in the space. In other words, this measure shows which public spaces have more locations where people stand to take photographs and consequently, different attractions to photograph. In this case, Granary Square has the highest value of the DSI Diversity Index at 8.03, showing an even distribution. In contrast, the British Library has a value of 7.04 and UCL of 7.21, showing an uneven distribution of interest due to strong attractors in both places, the Newton statue and the central portico (fig.05).

The results of the analysis using the DSV measure showed that Granary Square has a high number of photos showing the central plaza, with higher values in the fountains area, where most of the social activity and events are situated (fig.05). In the British Library, the place with the highest digital visualization in photographs is the area close to the Newton Statue, which is the main attraction in this space (fig.05). Last, in UCL Main Quad, the highest digital visualization is in the area in front of the entrance to the UCL Wilkins Building (fig.05). The DSV Diversity Index is crucial in comparing the degree of homogeneity of digital visibility in each public space (tab.01). According to the research carried out by the Projects for Public Spaces, if a place has many locations for photographic opportunities, it carries a good sense of comfort for people (PPS, 2018). In this case, Granary Square has the highest DSV Diversity Index value at 8.05. Similarly, to the results of the analysis using the Diversity Index for DSI, there is a homogenous distribution of visual fields in this space. The British Library has the second high DSV Diversity Index with 7.15, which stands in contrast to its DSI Diversity Index while the UCL Main Quad has the lowest value of all three spaces, at 7.05. It seems that UCL has the lowest DSV Diversity Index because most of the visible spaces are concentrated only in the direction towards UCL main building (fig.05). The photo datasets mapped in the DSI and DSV maps are shown in fig.06.

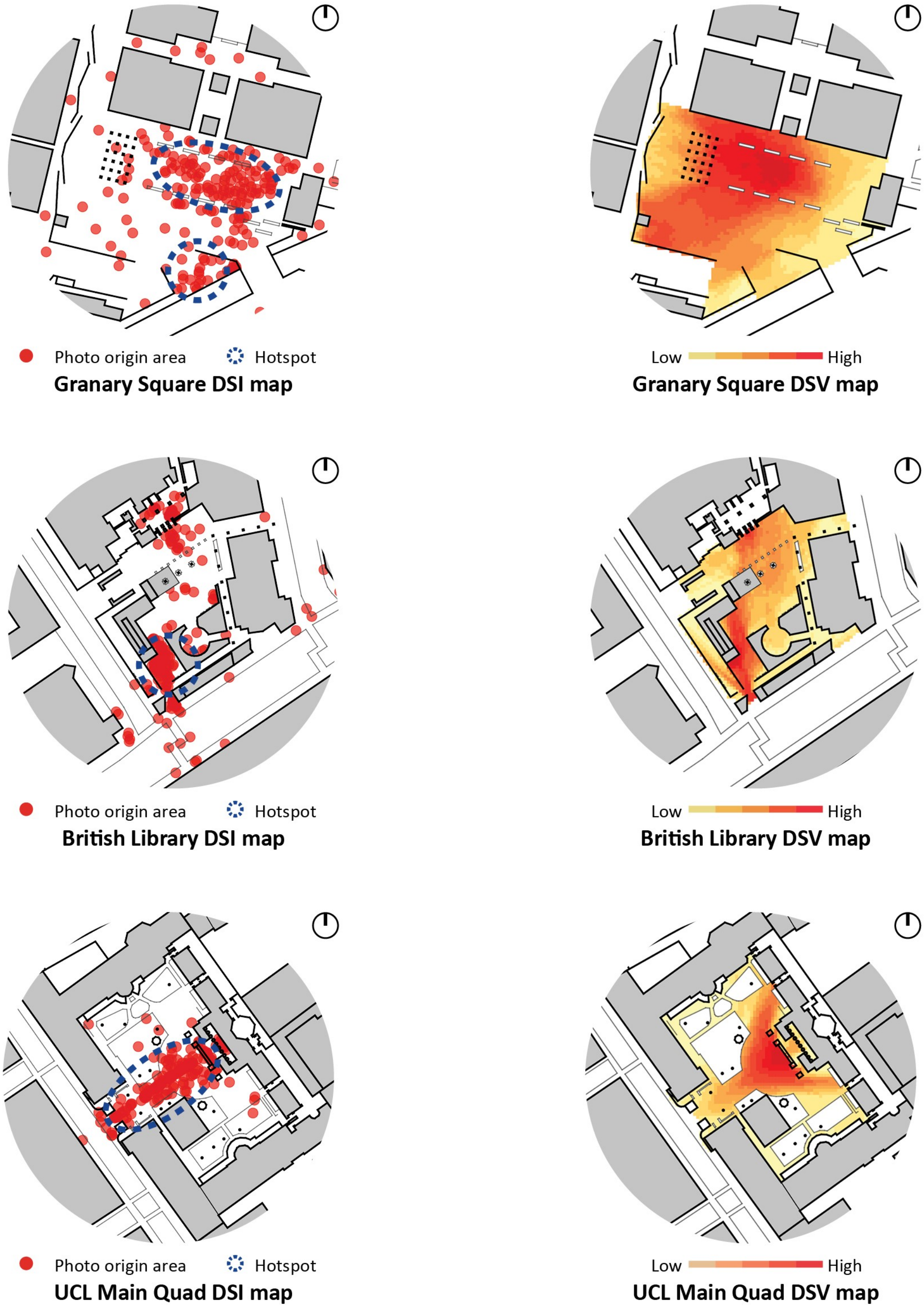


Figure 5: Study cases DSI and DSV maps.

	Granary Square	British Library	UCL Main Quad
DSI Diversity Index	8.03	7.04	7.21
DSV Diversity Index	8.05	7.15	7.05

Table 1: Study case DSI and DSV diversity index summary.

Figure 6: Study cases photo dataset used for DSI and DSV maps. Digital media images source: Instagram Caption.

Comparing these results to VGA analysis (fig.07), the Granary Square has the highest values of integration and connectivity among the three public spaces. In the British Library, despite Euston Road being highly integrated, the outdoor public space is not well integrated due to the tall walls that surround it and screen it from the outside. Likewise, the integration of the UCL Main Quad is even lower than that of the British Library due to its enclosed configuration and a small entrance. It is also essential to consider the measure of intelligibility in each public space (tab.02). The Granary square has the highest value of intelligibility with an R2 of 0.707, meaning that it is not only highly integrated but also easy to navigate and move around. The British Library and the UCL Main Quad have much lower intelligibility values with an R2 of 0.429 and 0.385, respectively (tab.02). These values suggest that by being enclosed these two spaces have limitations in terms of attracting users and visitors. However, there are security issues to take into account as well as the fact that not all spaces need to be equally accessible to all visitors. The results of these analysis show as well that institutions such as the British Library and UCL exercise control over public use of their outdoor spaces.

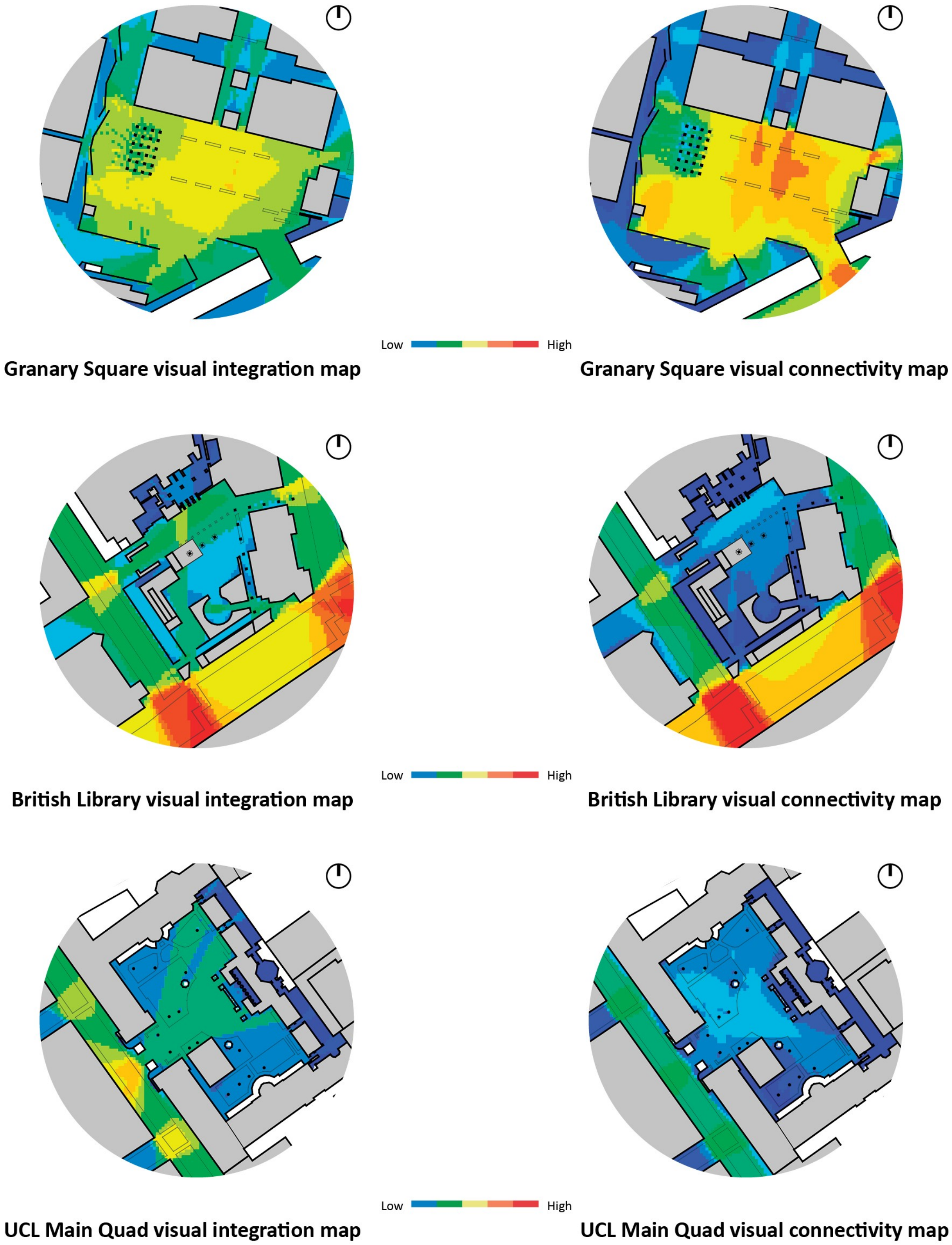


Figure 7: Study cases physical space VGA analysis maps.

	Granary Square	British Library	UCL Main Quad
Visual intelligibility	8.03	7.04	7.21

Table 2: Study cases visual intelligibility summary.

The social performance of each space is analysed using underlying social indicators of each place identified through observation of the geolocated Instagram photographs. The obtained information is used to understand how these indicators are related to the physical/digital spatial profile of each public space (fig.08).

In Granary Square, the photographs predominantly portray social activity in 47,5% of the dataset. The number of people observed is variable, but there is a substantial percentage of pictures (26%) with more than 20 people in them. There is no predominant age group as people of mixed age are observed in 48.6% of the pictures. This indicates that the Granary square is a diverse space in terms of age a critical characteristic for a successful public space. In addition, 27% of the photographs are taken at night showing that this space is successfully used in different periods. In terms of uses, around twelve activities were observed such as eating, drinking, observing an event, exercising, gathering, performing, playing, posing, reading, resting and walking. This shows that the place facilitates a diversity of social activities. The activities with a higher percentage are posing, walking, gathering and playing. Also, different events were observed in the pictures such as summer events, exhibitions, music festivals, Halloween shows, and Christmas parties. These photo dataset characteristics show the use of the space as a place for multiple social and gathering activities.

In the British Library, the photos show the building in 62% of the pictures. Adults are the predominant age group features in the pictures (68,4%). The photographs also indicate a low night usage of this space as only 3.5% of the photos in the dataset are taken at night, due to the opening office hours of the Institution. In terms of activities and social events, the photos portray six social activities such as eating, gathering, posing, reading, resting and walking. The two activities with the higher percentage are walking and posing. There was not found any picture of a special event. It is clear that the public space of the British Library allows only a limited set of social activities due to its specific function as a library and public exhibition space as well as because of security purposes.

Last, in UCL Main Quad, the photos show social activity in 40% of the sample. The pictures that show up to five people represent 30.5% of the dataset. However, since 20% of the photos have more than 20 people in them, it shows that the space accommodates gatherings by students and events for a relatively large number of people. A young age group is dominant in 70.8% of the pictures, which confirms that the primary users of this space are students. Besides, 15,5% of the pictures are taken at night showing that there is some night usage at the UCL Main Quad. In terms of social behaviour, eight different activities were observed, such as eating, drinking, observing an event, gathering, performing, playing, posing, reading, relaxing and walking, showing that this space affords multifunctional uses. It was also observed different special events such as exhibitions, festivals, Christmas shows, graduations and strikes. The last two can indicate that the space also works as a symbolic space for public celebrations and demonstrations of its users which are mostly students and teachers.

Figure 8: Study cases social indicators.

5 DISCUSSION

This research highlights the potentials and limitations of each space, and it is based on the hypothesis that visual data from Instagram can be a useful tool in helping us understand the attraction spaces hold for people, including how they are used in real life and how they attract digital behaviour. Together with the spatial analysis of physical space, the ways in which physical space features in digital media can provide an understanding of place, where the place is defined here by the preference people show for certain environments by recording them and communicating with others through photographs. Such analysis can complement the insights obtained from traditional observation techniques and configuration analyses. This hypothesis was tested using statistical correlations between the measure of physical space integration (VGA) and the digital measures of the Diversity Index of DSI and DSV. Good correlations were found in two of the three cases studied, i.e. the Granary Square and the UCL Main Quad (tab.03). The gains of the analysis of space through digital media is that DSI and DSV maps constructed by this analysis show relevant three-dimensional features of the spaces which are not described in VGA. For example, the Granary Square, the space with the highest values of DSI and DSV is indeed the one with the best indicators of social use (tab.04,05). This finding is relevant because the method used in this paper did not measure the total quantity of photos existing on social media, which can be debated as a direct consequence of high social activity or place attraction. This study compared equal samples of pictures taken in the three spaces. Moreover, the analysis proves that the spatial maps studied using digital media can provide insights into social activities taking place in urban environments.

Pearson correlation DSV – VGA Integration		
Granary Square	**British Library**	**UCL Main Quad**
0.633**	0.325**	0.58**

Table 3: Pearson correlation table physical visibility - digital visibility.

Granary Square	British Library	UCL Main Quad
DSI Diversity Index		
8.03	7.04	7.21
DSV Diversity Index		
8.05	7.15	7.05

Table 4: Digital space diversity index per study case.

Predominant social indicators based on what makes a used space (PPS,2018)					
Granary Square		**British Library**		**UCL Main Quad**	
Age group	Mix Age	Age group	Adult	Age group	Youth
N. of people	+20	N. of people	1 to 5	N. of people	1 to 5
Night activity	High	Night activity	Low	Night activity	Medium
N. of activities	11	N. of activities	6	N. of activities	10
(Socially well-used)		**(Socially not used as much)**		**(Socially standard)**	

Table 5: Social indicators of a great public space per study case. Based on (PPS,2018).

This research shows the relationships between the spatial characteristics of physical space, those of physical space portrayed in photographs and the observed social indicators. The findings can lead to several reflections about digital media and how they are already embedded in spatial behaviours in urban and architectural environments. This research does not claim that the physical space featured in digital photos mirrors the real physical experience of public space. However, it can provide important information about social use. People nowadays are continually retrieving and exchanging information through images on social media. Likewise, spatial strategies described as placemaking are being powered up by platforms such as Instagram bringing the realities of place closer to people who are not present in space (Houghton, et al., 2015; Maldonado-Gil & Psarra, 2020). Analysis using data from social media, can provide complementary accounts of the spatial and social character of a place taking into consideration how people communicate and use spaces based on the physical as well as digital social activities.

6 CONCLUSIONS

As future technological trends are currently in the making through digital platforms such as Instagram, TikTok, Facebook's metaverse, blockchain and AI, this analysis provides a modest beginning in understanding the usefulness of social media data in the description of people´s spatial behaviours. Such an understanding of physical and digital features of a place can perhaps provide information to evaluate public spaces, or other spatial environments, in the context of future interventions, taking into account the physical and digital behaviours of its users.

There are certain limitations in this study in relation to the results of the digital analysis. The use of a different sample of photographs for the analyses could result in digital visual maps and social indicators results of varying nature, quantity and quality due to the massive number of picture data on Instagram. Also, the public spaces studied here are all located in London, which is one of the most connected cities to the internet worldwide (Taylor & Derudder, 2015). The methods proposed are likely to have different outcomes in places with lower levels of digital technology used and lesser internet-based influence.

This research provides opportunities for further studies to explore the relationship between the proposed methodology and digital spatial measures (DSI and DSV) in other settings such as neighbourhoods or interiors of public buildings. These could contribute to a new multidisciplinary knowledge about which insights can digital media provide about social patterns in different urban and architecture environments.

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