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Built Environment in Urban Space Affect Protests: A Cross-Sectional Study in Hong Kong

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Abstract: The built environment is indispensable for conducting protests. However, we still know little about the role the built environment plays in either supporting or hindering protests. In this study, we investigated the relationship between built environment characteristics and the spatial distribution of 348 protests that occurred in Hong Kong from June 2019 to January 2020. We innovatively distinguished between peaceful and violent protests as well as legal and illegal (authorized vs. unauthorized) protests. Our study revealed several significant patterns. First, in general, areas with a higher level of building density, government and commerce point-of-interest (POI) density, metro accessibility, park density, and street greenery experienced more protesting activities. Second, illegal and violent protests, those which are less constrained by authorities and thus more likely to reflect the autonomous choices of the protestors, are more likely to occur in regions with more government and commercial buildings, high metro accessibility, and a high level of street greenery. Based on these findings, we also proposed a new framework to illustrate the relationship between certain built environment features and choice of protest locations, which we hope will provide preliminary guidance for future studies.

Keywords: protests; built environment; urban space; peaceful protests; violent protests

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1. Introduction

1.1. The Role/Properties of Urban Space in Protests

Physical space is an indispensable element for achieving massive gatherings of protests in cities [1,2]. As Marom [3] emphasized, the physical space of cities has retained central importance for protests, even in our present digital times. Although new virtual spaces enhance the possibilities for social aggregation, the centrality and multiplicity of urban space continue to be determinants for "the assembling of masses of individuals from different backgrounds within physical spaces" [4]. Therefore, physical space naturally becomes the primary battleground between protesters and power holders during protests, and it is receiving increased attention from scholars [5,6].

Many existing studies have provided insights into the value or role of space in protest activities. First, the semantic value of space in protests is mostly discussed. Space is imbued with power relations, which can be a symbolic call for action [3]. Occupying urban spaces with symbols of power (e.g., civic square, government buildings, arterial road) is considered a general strategy for protesters to resist the government and make their voices heard [1,7–9]. Contention over such symbolic space is regarded as a crucial way to challenge those in power [9,10]. In some cases, it can disrupt public services, particularly

transportation and business in cities by the occupation [5], thus attracting the authority's attention and putting pressure on the government [11]. For instance, during the "Occupy Central" protest in Hong Kong in 2014, the protesters occupied the public open space for weeks in order to convince the government to compromise, which forced the traffic to a standstill and severely affected the residents' daily lives. A similar pattern has also been used in other protests, such as "Black Lives Matter" and "Occupy Wall Street" in the US [12,13] and "Bolotnaya Square protests" in Russia [14].

Additionally, the fundamental role urban space plays in protests has also been briefly discussed and explored in previous studies. Evidence has shown that public parks, streets, and squares are the traditional sites of assembly for social movements [15]. Such public spaces have historically been places for the public to gather and for speeches to take place. They can provide sufficient physical spaces for massive gatherings and demonstrations, becoming a stage for protesters' free expression [1]. Moreover, urban areas with winding streets and densely poor neighborhoods are ideal spaces for social movements because these complex environments are convenient for barricade construction, escaping, and hiding [16–18].

To sum up, urban space plays a crucial role in different protest behaviors and different stages of the protesting process. Urban space is the main "arena" for protesters to convey their messages, exert influence, and seek support.

1.2. The Effect of Urban Space on Protests

Because of the physical and semantic value provided by an urban space in protests, certain features of the physical space, namely the built environment, could potentially affect where protests occur [9,17,18]. For example, Miller and Nicholls [9] investigated the anti-US protest activities in three Beijing universities and suggested that some campus facilities, such as dormitories, canteens, or squares, affect the mobilization of weakly organized protests. Rafail [1], considering 46 years of protest data in New York, analyzed the impact of built environment characteristics on protests and found that areas near powerful centers experienced more protest activities. Similarly, Stillerman [18] presented evidence that the design and layout of buildings in specific areas and the time–distance costs significantly affected the forms, dynamics, and outcomes of protests by comparing two demonstrations. Additionally, from a macroscopic level, Schwedler [19] found that the spatial expansion of the city, infrastructural development, and the policing of spaces where protests had previously taken place can affect future protest locations.

Although the studies mentioned above have realized and pointed out that the built environment affects social movements, the built environment in the urban space was only described in general terms by these studies, lacking a systematic and quantitative depiction of the built environment.

1.3. Built Environment and Protests

The affordance theory indicates that the relationship of humans with the environment is reciprocally defined through affordance, which means what the environment offers, provides, or furnishes either for good or bad [20]. This theory suggests that what people see will lead to a decision that they make. An affordance is a clue within the environment that becomes a trigger for an action to be taken. Therefore, specific environmental properties are functionally more significant for a given group than they are for others. When choosing protest locations, protesters may perceive and be affected by certain built environment characteristics. Hence, certain relations between the built environment and spatial distribution of protests may be exhibited.

Similarly, solid evidence from environment–behavior studies has indicated that the features of the built environment (e.g., accessibility, density, and design) affect various human behaviors, e.g., physical activities, travel behaviors, urban vitality, and social interactions [21–23].

Specifically, accessibility significantly impacts human travel behavior [24,25]. Accessible places have more opportunities to attract people to visit and use [26]. In urban protests, accessibility is also a fundamental demand. Accessible open space is necessary for both protesters and media organizations for protests to be conducted [27,28]. The main roads, civil squares, or parks that are located in urban centers are usually chosen as major protest sites because they are more accessible compared with those located in suburban areas [29]. In such spaces, there is a high flow of people, and the space can accommodate large gatherings; this helps protesters attract wider attention from the public and puts additional pressure on the government. Hence, the accessibility of urban spaces may affect protesters' choice of protest locations.

Density is one of the most common indicators of the built environment in an urban space, which is closely related to physical activities [23,30]. High-density areas are mainly distributed in urban centers with a high building density and population density. People in such areas can access plenty of urban facilities and sufficient public transport [31,32]. Protest, in essence, is the aggregation of massive numbers of individuals in a physical space [4]. The features of the built environment in high-density areas can effectively support such mass gatherings.

Moreover, the design features of the built environment, such as the structure of road networks and street environments, may also indirectly affect protests. For example, existing studies have found that street crime or violence is closely related to the street environment, such as street width, street lighting, or public plantings [33–35].

1.4. Research Gaps

Though many studies have discussed the role physical space plays in protests, there are still two major research gaps. First, no systematical or quantitative analysis of the built environment related to protests exists in the literature. In existing studies, the built environment has been generally identified as a certain spatial layout or an area where there are specific buildings or facilities available. In order to gain insight into the relationship between space and protest, further study is required to examine which specific built environment factors can influence demonstrations at a more fine-grained scale from the perspective of environment–behavior research. Second, most existing studies have analyzed the role space plays and the strategy of using space in a single protest or several protests using a qualitative approach, e.g., participant observation, archival research, secondary data, and thick description, which may be biased due to subjective factors. Moreover, these qualitative approaches also lack accurate spatial information.

In summary, the lack of understanding of the complex interaction between space and protests may lead to an incomplete understanding of protest behaviors. In this study, we investigated the association of various built environment characteristics and the spatial locations of 348 protests that occurred in Hong Kong in 2019. Hong Kong experienced a wave of Anti-Extradition Law Amendment Bill protests (hereinafter referred to as HK protests) from June 2019 to January 2020. Hundreds of protests broke out during a relatively short period of time, and they had a huge impact on society. Nevertheless, such frequent protests in such a short period of time provides a unique research opportunity. The homogeneity of the protesters' cause, political motivations, and demographic factors helps us isolate the effect of built environment characteristics from these potential confounding factors.

This study makes the following three contributions. First, we consider a comprehensive list of built environment factors based on related studies. Second, we distinguish between peaceful and violent protests as well as legal and illegal ones and explore the spatial disparity of these types of protests. Third, we establish a framework of the relation between certain built environment features and protest behaviors based on the findings of this study, which we hope will provide preliminary guidance for this line of research in the future.

2. Materials and Methods

2.1. Data Collection

In this study, we focused on the wave of Anti-Extradition Law Amendment Bill protests from June 2019 to January 2020. Both local and international media covered those protests daily. Consequently, both newspaper reports and official media were used to construct a comprehensive and detailed dataset for our quantitative study.

Newspaper data are a staple part of social movement research. Though newspapers cannot provide a complete enumeration of all events, various studies have suggested that newspaper information can provide reliable and defensible samples that do not markedly deviate from the accepted standards of data quality [36]. In this study, we manually collected HK protest data from 9 June 2019 to 31 January 2020 from two authoritative daily newspapers and one official press release: the South China Morning Post (SCMP) [37], the New York Times (NYT) [38], and the Press Release from the Hong Kong Police Force (HKPF) [39]. The SCMP is a prominent and authoritative local English-language newspaper in Hong Kong, which launched a special episode to track and report a series of HK protests [40]. The NYT is an international newspaper with a worldwide readership, which also provided detailed coverage of the HK protests [41].

As for the Press Release of HKPF, although this source rarely included information on specific protesting locations, it could help verify and supplement the data collected from the other newspapers. It is worth mentioning that most of the authorized protest events (referred to as public procession in reports) were publicized in advance, and those illegal ones were also reported and condemned on that day or the next day. Hence, the legality of the protests could be distinguished by this source.

All these data sources provided detailed coverage of almost every medium- and large-scale protest. The data allowed for us to geolocate protest events and to retrieve information on the temporal attributes and types of the protests. Two selection criteria were used to decide whether or not sources could be included in the dataset. (1) The protest must have had more than 10 participants; some small-scale protests with less than 10 participants were excluded from the analysis. (2) The sources had to contain precise descriptions of the locations and dates of the events to ensure proper geocoding.

Furthermore, we classified the protests into peaceful and violent ones for a more in-depth exploration. The distinguishing criterion is whether there were descriptive words that related to any illegal activities of the protestors (e.g., deliberately blocking the roads causing traffic jams, destroying public facilities, breaking into subway stations and shops, violence, or vandalism) in the reports.

Further, to exclude the potential impact of government policy on the choices of protest location (e.g., all protests in Hong Kong require approval from the Police Department in advance), we divided the protests into four types based on legality: (1) legal and peaceful (LP), (2) legal but turn to violent (LV), (3) illegal and peaceful (IP), and (4) illegal and violent (IV). IP and IV protests are less constrained by the government and thus more likely to reflect the real choices of protestors in a space.

The criterion for the legal/authorized protest is whether a letter of No Objection was obtained from the HKPF before the protest [42]. Those authorized protests were publicized in the Press Release. The temporal distribution of four types of protests is shown in Figure 1.

Based on the selection criteria, the location of every reported protest was geocoded in ArcGIS 10.4, as shown in Figure 2. We also manually marked the route of each protest, if any, based on the reports. Finally, we obtained the data of 348 protests in Hong Kong, including 28 LP, 15 LV, 52 IP, and 253 IV protests, or these protests can be divided into 80 peaceful and 268 violent protests, 43 legal protests, and 305 illegal protests.

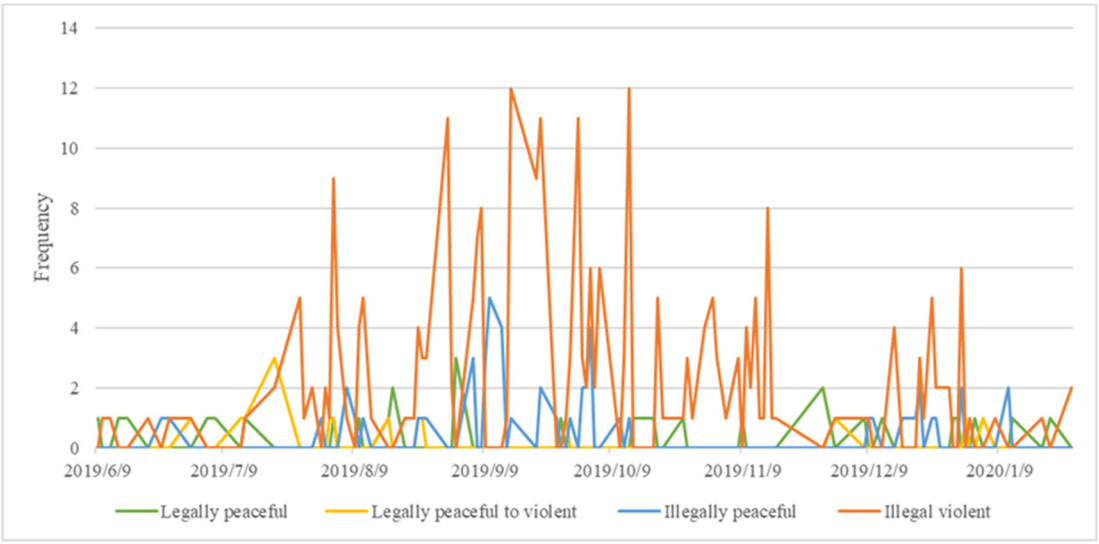


Figure 1. Temporal distribution of protests from June 2019 to January 2020.

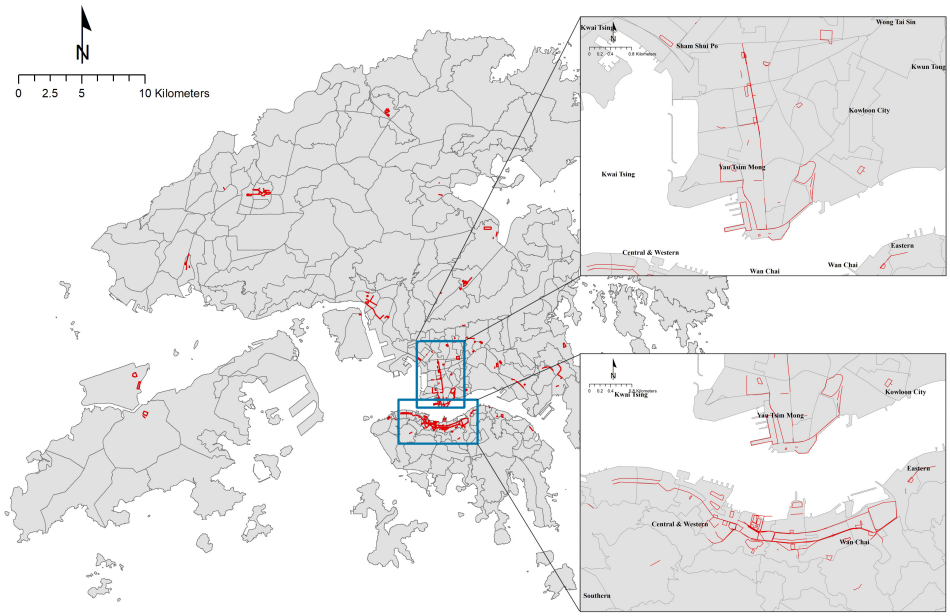


Figure 2. The locations of the 348 protests that occurred in Hong Kong from June 2019 to January 2020. These protest locations were extracted from authoritative news reports.

2.2. Dependent Variable—Frequency of Protests

To better explore the relationship between the built environment and protests, we adopted Tertiary Planning Units (TPUs) in Hong Kong as the basic analysis units. The TPUs represent a fine-grained geographic reference system developed by the Planning Department, which is used for both planning and as a system for demographic and socio-economic data collection by the Census and Statistics Department. In 2016, the whole territory of Hong Kong comprised 289 TPUs.

The frequency of protests in each TPU was the dependent variable. This was counted by the following two steps. First, the Identify tool in ArcGIS 10.4 was used to link each protest (line or point) to its containing TPU. More specifically, the route of one protest may pass through several TPUs; this tool can help break the route along the TPU boundary and link each part with a corresponding TPU. Next, the frequency of a protest in each TPU was counted using the Summary tool. Further, the different types of protests with the frequency of occurrence in each TPU were also summarized.

2.3. Independent Variables—Built Environment Features

As mentioned in Section 1.3, the built environment has a potential connection with protests in three dimensions: accessibility, density, and design. Additionally, we added a fourth dimension, destination, because previous studies showed that various destinations, such as government buildings, may attract protests [43]. Hence, nine built environment indicators from the abovementioned four dimensions were selected as independent variables to model the protests, as shown in Table 1.

Table 1. Built environment variables.

Dimension	Variables	Definition/Calculation
Density	Population density	The residential population divided by the area of each TPU
	Building density	The total building floor areas divided by the area of each TPU
Destination	Government POI density	The number of Government building POI divided by the area of each TPU
	Commerce POI density	The number of commerce POI divided by the area of each TPU
	Park density	The total park areas divided by the area of each TPU
Accessibility	Metro accessibility	The average travel time from this metro station to all other stations with metro
	Bus accessibility	The number of bus station POI divided by the area of each TPU
Design	High centrality road density	The total length of roads with high centrality divided by the area of each TPU
	Greenery	The average eye-level green in each TPU

2.3.1. Population Density and Building Density

Transportation studies have found that high-density areas with sufficient accessibility facilitate social interaction [44]. In the protesting process, we assume that protesting in areas with a high population density and building density is more likely to gather crowds and attract wider attention.

2.3.2. Government Points of Interest (POIs) Density

Previous studies have shown that protest often occurs in areas with authority departments. Government buildings are identified as significant protesting sites, and the density of government POIs in an urban space may affect the occurrence of protests.

2.3.3. Commerce POI Density

Via the newspaper reports, we discovered that many protests in Hong Kong took place in large shopping malls, and these protests attracted much attention. Therefore, we suspect that the commercial space may have potential relations with protesting behaviors.

2.3.4. Park Density

Parks are open public spaces that provide the physical space needed to assemble large bodies of people. The area of parks varies significantly. Some parks (e.g., Victoria Park) contain multiple football fields and/or swimming pools, while some are as small as a basketball court in size. Hence, instead of the density of park number, we choose the density of park area, which is calculated with the total park areas in each TPU divided by the TPU area.

2.3.5. Metro and Bus Accessibility

Previous studies have shown that accessibility is necessary in social movement [7]. Spaces with high transportation accessibility may be more prone to protests. In Hong Kong, most people use public transportation, especially the metro, for daily activities, including travel to and from protests.

2.3.6. High-Centrality Road Density

In many protests, blocking and taking over primary roads served as a way to disrupt the physical flow of the city in order for a protest to make a bigger impact. Roads are not only a part of protest routes but also a tool for protesters to express their demands and occupy space. Hence, we choose roads with high centrality (Top 10%), which are more likely to be selected by protesters. The centrality of each road was assessed as the average number of turns needed to travel from this road to all other roads in a city, which is calculated using the GIS tool SDNA [45]. Then, the total length of roads with top 10% high centrality divided by the TPU area was used to measure the high-centrality road density.

2.3.7. Greenery

It has been proven that greenery has a positive relationship with outdoor crimes because of its ability to offer concealment [46,47]. Trees (e.g., trunk and canopy) can provide protesters with shading and natural shelter when confronting the police. In this paper, we use Google Street View (GSV) images to calculate the average visible greenery in each TPU, following the lead of previous studies [48]. First, GSV sampling points were created on all street centerlines with a spacing of 50 m (Figure 3a). Second, four GSV images with a 90-degree field of view facing four directions were retrieved for each point (Figure 3b). Third, a machine-learning technique, PSPNet, was used to identify vegetation, which achieved an accuracy of 93.4% (Figure 3c). The average ratio of vegetation in all images in a TPU was used to assess greenery.

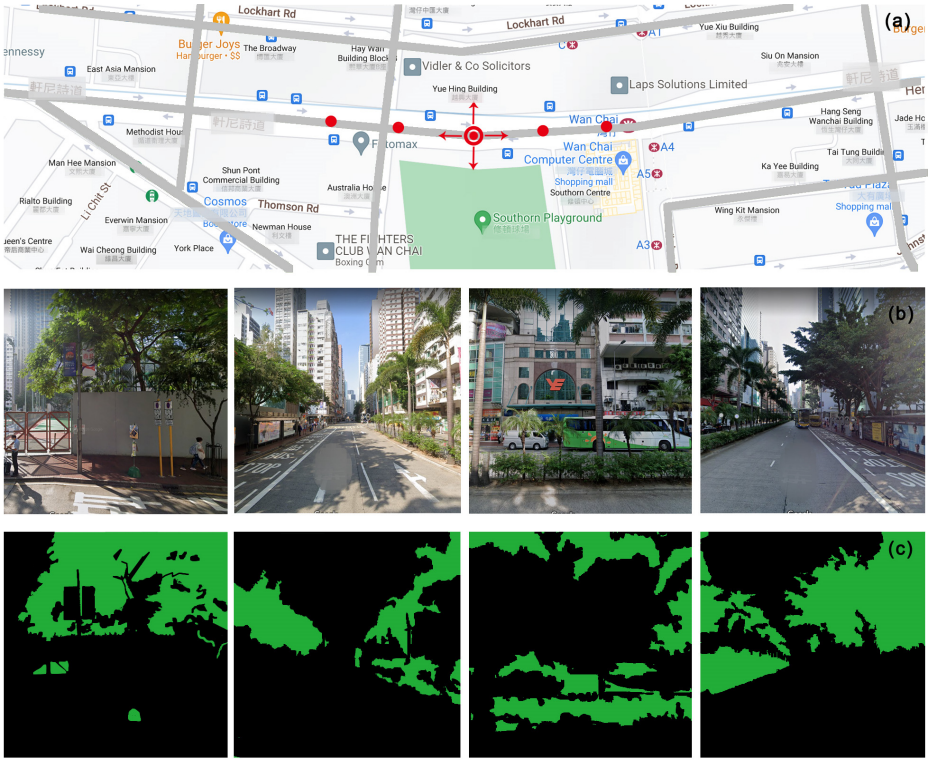


Figure 3. An example of measuring visible greenery with GSV images. (**a**) Sample points were created along the street centerlines with a spacing of 50 m. (**b**) For each sample point, four GSV images with a 90-degree field of view facing four directions were obtained from Google maps. (**c**) The PSPNet was used to identity the vegetation in the GSV images. The level of greenery at the sample points was calculated as the proportion of green pixels to the total pixels in the four GSV images.

Additionally, we added two socio-economic variables, including income and education level, as control variables. The TPU area was also considered to exclude the impact of different areas.

2.4. Model Selection

The dependent variable is the frequency of protests, that is, the count data. The dependent variable features excess zeros and overdispersion. Hence, the zero-inflated negative binomial model was adopted to estimate the frequency of protests using a series of built environment variables. The zero-inflated negative binomial model could well deal with count data with excess zeros and account for violating the assumption of equal mean and variance in the Poisson process [49,50]. The probability distribution of the frequency of protests y_i in TPU i can be expressed as follows:

$$\Pr(y_i = j) = \begin{cases} \pi_i + (1-\pi_i) f(y_i = 0) \; if \; j = 0 \\ (1-\pi_i) f(y_i) \; if \; j > 0 \end{cases}$$

where π_i is defined by the logistic link function, and $f(y_i)$ is the negative binomial distribution:

$$f(y_i) = \Pr(Y = y_i | \mu_i, \alpha) = \frac{\Gamma\left(y_i + \alpha^{-1}\right)}{\Gamma(\alpha^{-1})\Gamma(y_i + 1)} \left(\frac{1}{1+\alpha\mu_i}\right)^{\alpha^{-1}} \left(\frac{\alpha\mu_i}{1+\alpha\mu_i}\right)^{y_i}$$

The component μ_i, the mean frequency of protests, could be quantified by a set of independent variables:

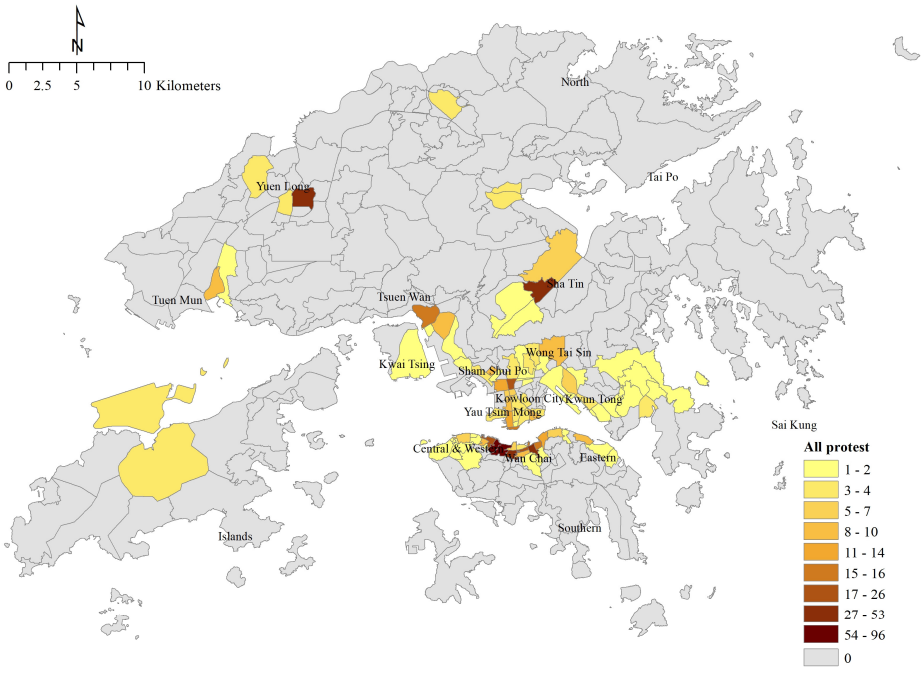
$$\ln(\mu_i) = \alpha + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki} + \varepsilon_i$$

β_1, β_2, …, β_{6k} are the regression coefficients to be estimated. k is the number of independent/explanatory variables, and ε_i is an error term. All analyses were conducted in R version 4.3.1.

3. Results

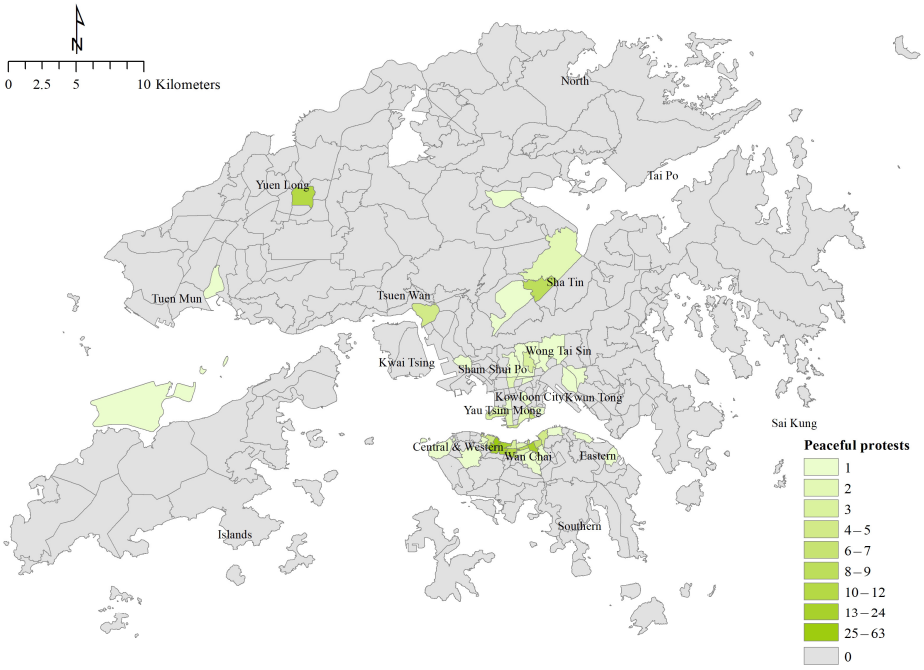
3.1. The Spatial Distribution Features of HK Protests

The spatial distributions of protests at the TPU level are visualized in Figure 4, which illustrates the frequency of both overall protests and peaceful and violent protests.



(**a**)

Figure 4. *Cont.*



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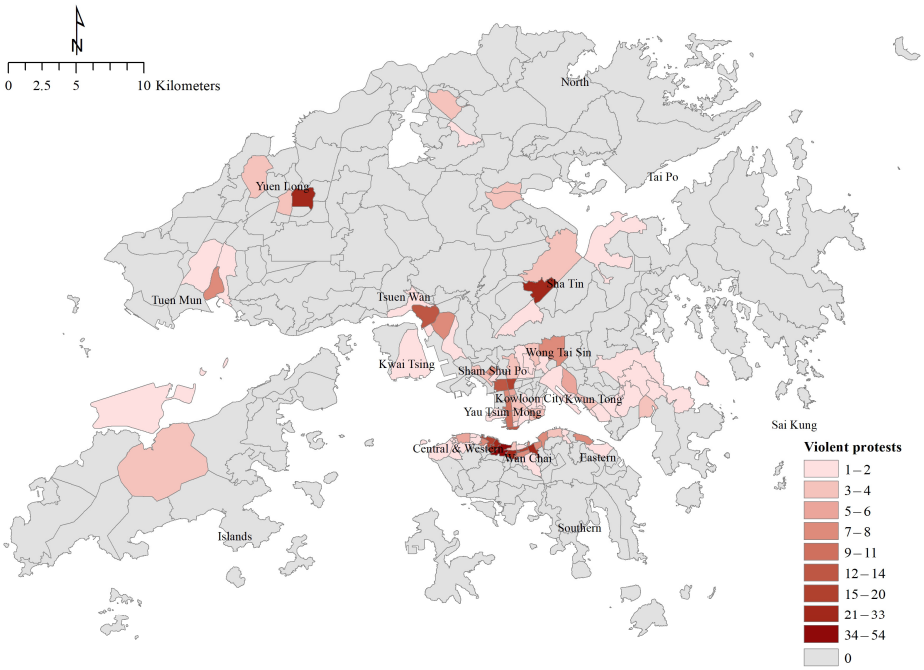


(**c**)

Figure 4. Spatial distributions of all protests, peaceful protests, and violent protests. (**a**) Frequency of all protests, (**b**) Frequency of peaceful protests, (**c**) Frequency of violent protests.

Figure 4a shows that the protests were mainly spatially concentrated in Wan Chai, Central and West, Yau Tsim Mong, Sham Shui Po, and Wong Tai Sin districts, where there is an urban center area. The area with the highest frequency of protests was Central, where Hong Kong's legislative council building is located. Some protests were clustered in peri-urban areas, e.g., Sha Tin, Yuen Long, and Tuen Mun districts. These mentioned areas all contain a power center or business center in Hong Kong.

A comparison of Figure 4b with Figure 4c shows that, although there are less peaceful protests than violent ones (80 vs. 268), the peaceful protests were more spatially concentrated than the violent protests. More specifically, Central and Wan Chai were the main sites of peaceful protests. The peaceful ones often took place in some fixed locations, such as Victoria Park, Tianma Park, or Chater Garden, which may lead to a more concentrated distribution of peaceful protests. Moreover, many government administrations, including the local legislative council, are located here, attracting more protests. The distribution of peaceful ones as well as violent ones was consistent with the distribution of legal and illegal protests, respectively (as shown in supplementary Figures S1 and S2). The reason for such a similar distribution pattern is that over 65 percent of the legal ones were peaceful, and approximately 88 percent of the illegal ones were violent. Additionally, an analysis of the distributions of the four types of protests, which are LP, LV, IP, and IV protests (supplementary Figures S3–S6), was also performed and shared a similar pattern with the peaceful and violent ones.

3.2. Relations between the Built Environment and Different Types of Protests

We constructed five regression models that considered (a) all protests, (b) violent protests, (c) peaceful protests, (d) illegal violent (IV) protests, and (e) illegal peaceful (IP) protests as the five outcomes, respectively. Such a design investigated the relationship between peaceful and violent protests and the built environment, while the illegal ones better revealed the autonomous choices of protesters by excluding legal protests, which require prior government approval. The results of the zero-inflated negative binomial models for all, violent, and peaceful protests are shown in Table 2, and the models for illegal violent and illegal peaceful protests are shown in Table 3.

In Table 2, positive associations are observed for building density, commercial POI density, park density, metro accessibility, and greenery in both violent and peaceful protests. Specifically, when all other variables were constant, the TPU with a high building density was 25% and 35% higher in the probability of violent and peaceful protests occurring compared to those lower building density areas with an Incidence Rate Ratio (IRR) value of 1.25 (95% CI: 1.03–1.51) and 1.35 (95% CI: 1.12–1.64), respectively. The TPU with a high commercial POI density was 21% and 32% higher in probability of violent (IRR = 1.21, 95% CI: 1.05–1.39) and peaceful protests (IRR = 1.32, 95% CI: 1.11–1.56) occurring. The TPU with a high park density (park area ratio) was 28% and 36% higher in probability of violent (IRR = 1.28, 95% CI: 1.10–1.50) and peaceful protests (IRR = 1.36, 95% CI: 1.12–1.65) occurring. Similarly, those with higher metro accessibility have a 63% and 50% higher probability of violent (IRR = 1.63, 95% CI: 1.34–1.97) and peaceful protests (IRR = 1.50, 95% CI: 1.13–2.00) occurring. Also, areas with more greenery have a 39% and 41% higher probability of violent (IRR = 1.39, 95% CI: 1.19–1.62) and peaceful protests (IRR = 1.41, 95% CI: 1.05–1.88) occurring. Moreover, the government POI density and bus accessibility were only significantly and positively associated with violent protests with an IRR of 1.28 (95% CI: 1.11–1.47) and 1.41 (95% CI: 1.06–1.87), respectively.

However, a negative association was observed for population density with an IRR value of 0.71 (95% CI: 0.56–0.89) for violent protests. This may be because the population density refers to resident population, and in some of the political and commercial centers where protests are high, the resident population in such areas is relatively lower than that in the peripheral residential areas.

As shown in Table 3, when we excluded the legal protests, only the building density, park density, and bus accessibility were positively significant with IRR values of 1.4 (95% CI: 1.11–1.47), 1.35 (95% CI: 1.07–1.70), and 1.58 (95% CI: 1.02–2.45), which means that the TPU with these higher built environment variables has a 40%, 35%, and 58% higher probability of illegal peaceful protests occurring, respectively. As for the model with illegal violent ones, the significant built environment variables were consistent with those in the model for violent protests, including building density, government and commercial POI density, park density, metro and bus accessibility, and greenery.

Table 2. Regression results of all, violent, and peaceful protests.

Variable	All Protests			Violent Protests			Peaceful Protests		
	Coefficient	Std. Error	Pr(>|z|)	Coefficient	Std. Error	Pr(>|z|)	Coefficient	Std. Error	Pr(>|z|)
Population density	−0.257	0.105	0.014 *	−0.344	0.118	0.004 **	−0.105	0.174	0.545
Building density	0.226	0.086	0.009 **	0.220	0.099	0.027 *	0.302	0.097	0.002 **
Government POI density	0.166	0.078	0.032 *	0.244	0.072	0.001 **	−0.159	0.154	0.301
Commerce POI density	0.189	0.066	0.004 **	0.189	0.070	0.007 **	0.275	0.087	0.002 **
Park density	0.247	0.079	0.002 **	0.249	0.081	0.002 **	0.308	0.100	0.002 **
Metro accessibility	0.459	0.093	0.000 ***	0.487	0.098	0.000 ***	0.408	0.145	0.005 **
Bus accessibility	0.339	0.135	0.012 *	0.346	0.144	0.017 *	0.137	0.222	0.538
High-centrality road density	0.079	0.089	0.374	0.033	0.096	0.733	−0.007	0.134	0.960
Greenery	0.306	0.074	0.000 ***	0.327	0.079	0.000 ***	0.341	0.147	0.021 *
Income level	−0.017	0.140	0.905	−0.157	0.161	0.328	−0.076	0.255	0.766
Education	0.425	0.163	0.009 **	0.441	0.178	0.013 *	0.898	0.295	0.002 **
TPU area	0.084	0.232	0.716	0.158	0.222	0.478	−0.016	0.462	0.972

Note: *** indicates $p < 0.001$; ** indicates $p < 0.01$; * indicates $p < 0.05$.

Table 3. Regression results of illegal peaceful and illegal violent protests.

Variable	Illegal and Peaceful (IP) Protests			Illegal and Violent (IV) Protests		
	Coefficient	Std. Error	Pr(>|z|)	Coefficient	Std. Error	Pr(>|z|)
Population density	0.041	0.152	0.790	−0.409	0.126	0.001 **
Building density	0.340	0.120	0.005 **	0.254	0.100	0.011 *
Government POI density	−0.220	0.172	0.203	0.280	0.073	0.000 ***
Commerce POI density	0.098	0.103	0.341	0.167	0.075	0.026 *
Park density	0.297	0.118	0.011 *	0.254	0.083	0.002 **
Metro accessibility	0.253	0.164	0.122	0.508	0.101	0.000 ***
Bus accessibility	0.457	0.225	0.042 *	0.415	0.147	0.005 **
High-centrality road density	−0.037	0.160	0.816	0.000	0.104	0.996
Greenery	0.174	0.128	0.174	0.329	0.085	0.000 ***
Income level	0.006	0.229	0.979	−0.179	0.168	0.289
Education	0.472	0.252	0.061	0.455	0.186	0.015 *
TPU area	−0.084	0.541	0.876	0.235	0.217	0.279

Note: *** indicates $p < 0.001$; ** indicates $p < 0.01$; * indicates $p < 0.05$.

4. Discussion

In this study, we investigated the relationships between built environment features in urban spaces and the spatial distribution of HK protests. We found that protests, whether peaceful or violent, were unevenly distributed across cities, showing markedly spatial disparity across districts. More importantly, different types of protests have collectively been associated with certain built environment factors in a TPU. Six findings corresponding to each of the significant built environment variables have been summarized and interpreted as follows.

4.1. Building Environment Features and Protests

4.1.1. Building Density

Urban areas with a high building density experienced heightened protest activity. We found that the protests mainly took place in the urban centers, which tend to have a higher building density than suburban areas. As with the classical urban design theory stated by [51], the densities of buildings and the population were regarded as the critical conditions for urban vitality. The dense building footprints could provide more street interactive interfaces and high pedestrian flow [52]. Protesting in those areas could have wider repercussions and attract more attention. Therefore, the likelihood of demonstrations in dense areas was higher.

In addition, high building density may be related to more shelters for protesters so that they can easily escape from conflicts when necessary. This is consistent with the findings in street crime. Studies have found that narrow and dense streets have a higher rate of crime [28]. Illegal activities are more likely to be hidden in such narrow spaces.

For example, in Sham Shui Po of Hong Kong, which features dense buildings and narrow streets and alleys, protesters can easily escape law enforcement during violent protests.

4.1.2. Park Density and Greenery

The park area ratio was positively associated with both peaceful and violent protests, even if excluding those authorized protests that might be potentially affected by government approval. Large city parks are traditional assembly points for collective action [15]. Especially in high-density cities like Hong Kong, public spaces including large city parks (e.g., Victoria Park, Tianma Park, or Chater Garden) are scarce, and such places could be more likely to be symbolic sites. Hence, protesters tend to choose such sites for massive gatherings and preaching their ideas to the public, potentially leading to a high frequency of protests in a TPU with a high park area ratio.

Regarding greenery, urban areas with more street greenery tend to attract more protests, especially illegal violent ones. This finding is consistent with a previous finding that dense small trees can block people's view and provide a perfect hiding place for criminals [53]. During protests, violent behaviors usually occur when protesters' demands do not receive a positive and timely response. Then, protesters may stage a shape-shifting guerilla game in the urban space to avoid police enforcement. In this process, street trees may become the natural shelter for protesters to avoid law enforcement. The canopy can provide protection from closed-circuit TV (CCTV) and surveillance by law enforcement in the surrounding buildings, while tree trunks provide shelter from ground enforcement. Additionally, the large city parks we mentioned above are often chosen as protest sites. Both of these reasons mean that it is likely that most protests will occur in areas with abundant street greenery.

4.1.3. Government POI Density

Violent protests rather than peaceful ones are spatially concentrated in areas with dense government buildings. This result is consistent with previous studies, which reported that the space around government buildings is a traditional site for social movements [1], as government buildings represent the center of political power [5]. In HK protests, many violent protests took place in front of the Legislative Council building or district police stations. In such places, protesters can convey their messages and demands in a timely and effective way, thereby putting pressure on decision-makers. Moreover, such government buildings tend to become targets for protesters to vent their discontent with the general administration. Protesters use this kind of vandalism to attract more attention from the authorities. More violent behaviors and clashes with police tend to occur at such high-frequency protest sites.

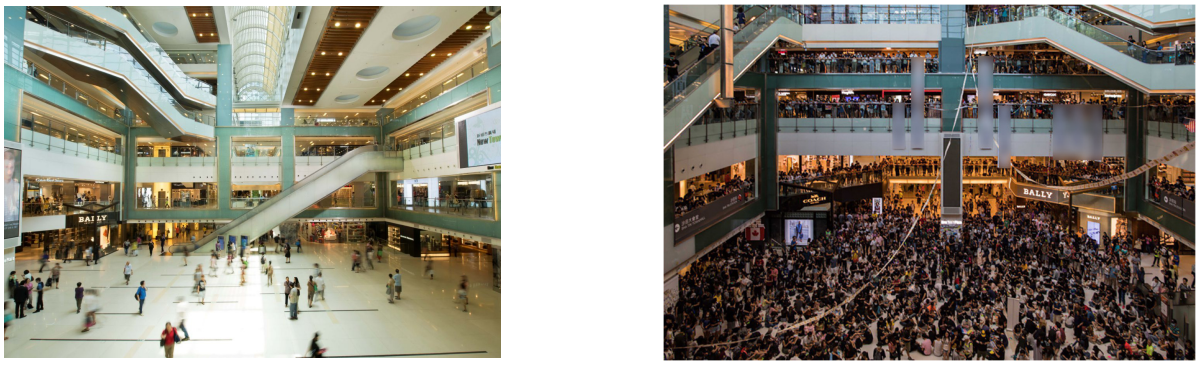
However, peaceful ones, including illegal peaceful protests, are not associated with the density of government buildings. This may be because the areas around government buildings are not normally authorized for legal protests.

4.1.4. Commerce POI Density

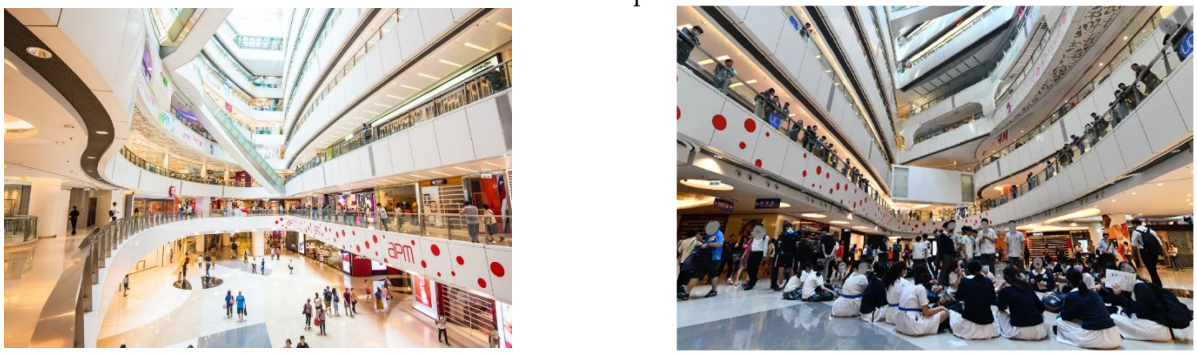
Protests, especially violent ones, are also concentrated in commercial areas. The huge flow of people in commercial areas can help draw wider attention from the public. As a well-known shopping destination, Hong Kong attracts both local and international visitors to its malls and street markets, which can provide enough "audiences" for protesters.

Commercial areas attract more illegal violent protests than peaceful ones. There are four feasible reasons for this. First, large commercial spaces are often designed with quasi-public indoor atriums surrounded by several levels of walkway spaces that provide amphitheater-like effects for visitors, like a stage (Figure 5). Traditional local festivals, public gatherings, and exhibitions are commonly held in such spaces [54]. In high-density cities, especially Hong Kong, where public space is scarce, such open commercial spaces became semi-public spaces for protesters. Second, shopping malls in Hong Kong are usually owned and managed by private enterprises. Therefore, any protests, even peaceful

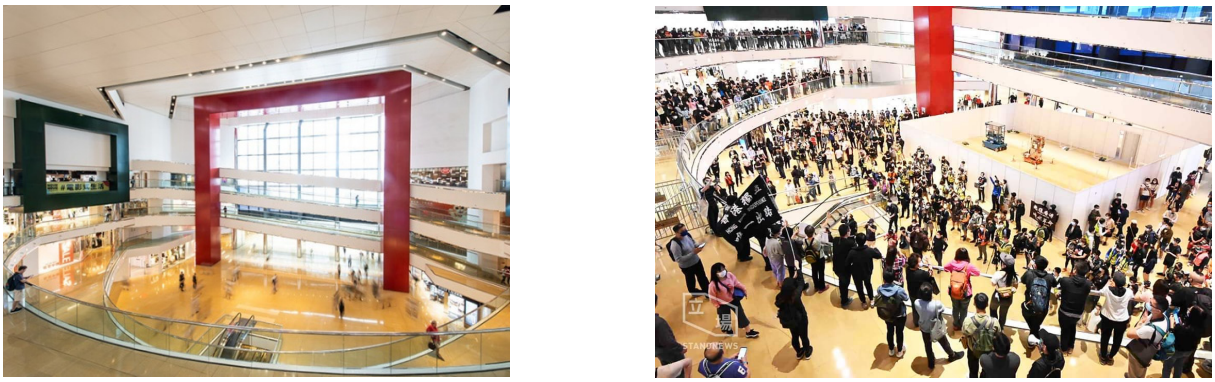
ones to start, are illegal and may easily lead to violent confrontations thereafter. Third, due to political stands, certain enterprises become targeted by people of the opposite view, which also leads to an increase in violence in these commercial areas.



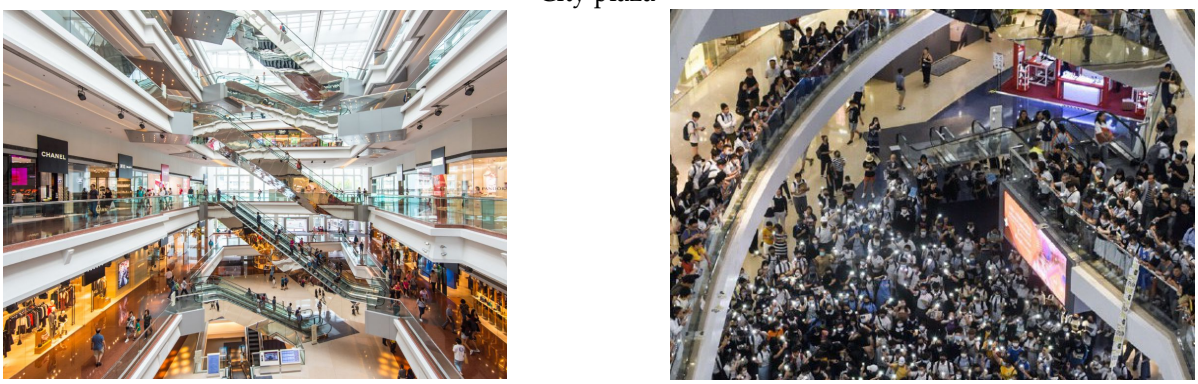
New town plaza



APM



City plaza



Festival walk

Figure 5. Comparison of atrium spaces in Hong Kong shopping malls before [55] and during the protests [55–59].

In addition, from the perspective of accessibility, many large shopping malls directly connect with metro stations. These are accessible spaces with a large flow of people and are also suitable for escaping when dispersed by the police. Hence, many shopping malls can be passively turned into protest sites, meaning conflicts are more likely to occur in such places. On the other hand, peaceful protests tend to take place in government-approved public places, such as large parks and squares.

4.1.5. Metro and Bus Accessibility

Areas with high metro and bus accessibility tend to attract more protests, especially violent ones. This finding could be well-supported by another study on the HK protest and public transportation [60]. Public transportation is a basic service and also a critical lifeline for citizens, connecting their everyday life routines. It also plays a feeder role during the protest process. Especially in densely populated and transit-reliant metropolises like Hong Kong, such powerful public transportation systems cannot support the massive mobilization of protesters for long, but also the delivery of the supplies or needed materials during protest events can be achieved via public transport. Largely accessible stations are prone to gather and disperse larger crowds participating in protests. Hence, it makes sense for areas with highly accessible public transportation services to be the target locations for a protest.

Additionally, such significant sites are usually targeted by protesters to attract wider attention from both the public and government. During the HK protests, disrupting or vandalizing public transportation facilities was a common tactic in the violent protesting events. The metro stations with a large volume of passengers, such as the Prince Edward Station and Mong Kok Station, were damaged by arson and smashing. This could be another underlying reason for a significant relationship to exist between high metro and bus accessibility and protest frequency.

4.1.6. The Proposed New Framework

Based on the above findings of our research, we tentatively established a new framework to illustrate the relationship between the built environment in an urban space and protest behaviors (Figure 6). The aim of this framework is to provide preliminary guidance for subsequent research on exploring the mechanisms underlying the link between protest behaviors and the built environment.

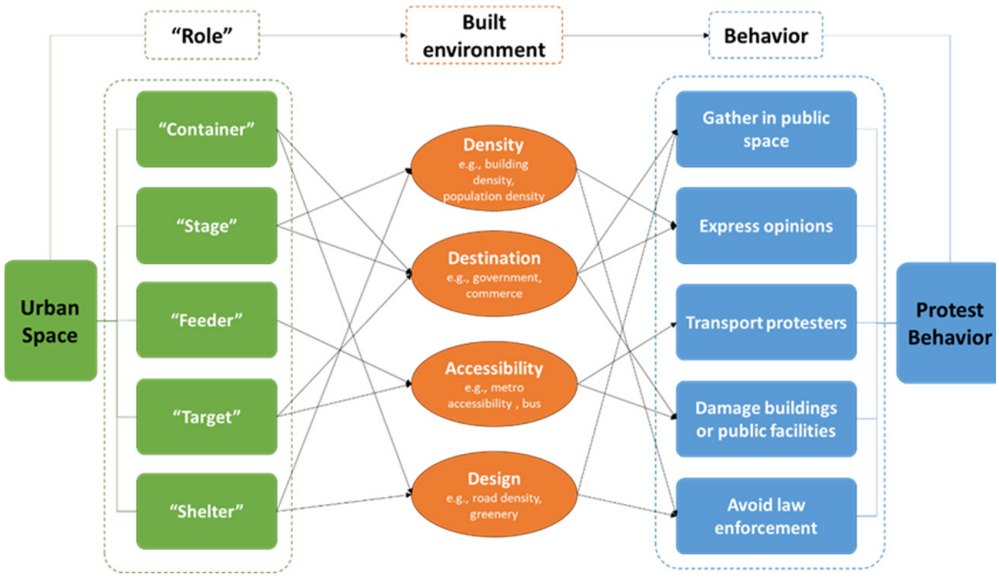


Figure 6. Framework of the relation between urban space and protests.

A protest is a process that involves several interlinked behaviors, such as gathering, expressing opinions, transporting, vandalism in some cases (e.g., damaging buildings or facilities), and/or avoiding law enforcement. Such a series of behaviors all occur in an urban space and are potentially affected by the perceived affordance of built environment characteristics. We combed through these key behaviors that occur in protests and then analyzed what roles urban space may play for these behaviors.

First, in the protesting process, protesters need to gather in a space before starting. Parks, city squares, or other open spaces in an urban space that act as "containers" are more likely to be chosen by protesters. Second, protesters need to effectively convey messages and their opinions. In most cases, protesters use peaceful means, such as shouting slogans in streets, public speech, banners, or sit-down demonstrations, to voice their opinions and put forward demands. Government buildings or places with a large volume of pedestrians (e.g., commercial buildings, metro stations, vibrant streets) are usually identified as strategic locations or a "stage" for protesters. Third, the movement of protesters or protesting goods in urban spaces is another crucial part of protesting. The transportation system in an urban space, especially the metro system, works as a "feeder" for protestors, supporting the massive gathering and movement of demonstrators in the space. Fourth, vandalism may erupt when the protesters' demands do not receive a positive and timely response from government departments. Government buildings, crucial public facilities (e.g., metro stations), and major streets become their "target". Fifth, the protesters may have to confront the police if vandalism occurs. The urban space will become the protesters' natural "shelter" to avoid law enforcement. A space with dense buildings or dense trees may be the preferred choice.

It is worth noting that this framework is not exhaustive. However, it provides a novel perspective to examine the complex relationship between an urban space and protest behaviors. More empirical findings are needed following this line of research.

4.2. Strength and Limitations

This study quantitatively explored the built environment's impact on the spatial distribution of protests, which complements previous qualitative studies in this area. We distinguished between violent and peaceful protests as well as illegal and legal ones. We found that they have notably different spatial distributions. Further, specific built environment factors pertaining to the different types of protests were identified, which provide a more precise understanding of protest behaviors in a physical urban space. In addition, the proposed framework provides preliminary guidance for future studies to explore the links and mechanisms between urban space and protests.

Limitations also exist in this study, which may present opportunities for further research. First, the accuracy of the protest location data was largely dependent on newspaper reports. Such a limitation is common across many analogous studies. Comprehensive government data, if available, may be a better choice as a data source. Second, due to the limitations of built environment data, we did not consider more micro-scale built environment indicators, such as the availability of streetlights and hand railings. Further studies may explore the influence of such micro-scale built environment features on protest location. Third, this study did not evaluate the evolving dynamics of the protest events themselves. A future analysis of how these events evolved over time may prove helpful for gaining a deeper understanding of these phenomena.

4.3. Policy Implications

Illegal and violent protests may pose a serious challenge to urban safety management. Many public facilities, such as roads, sidewalks, street lights, metro stations, or even private shops, were damaged during the HK protests. Such a wide range of violent protests have caused immeasurable economic losses and undermined public security.

This study attempted to discover the critical link between built environment features and the choice of protest locations. The findings in this study could help government

administrations predict potential protest hotspots and allow the authorities to take corresponding measures in advance, especially in response to violent protests. Specifically, violent protests are more likely to occur in areas with more government and commercial buildings, high metro and bus accessibility, and an abundance of visual greenery and parks.

5. Conclusions

Space is "tangible", but the built environment features of space are "intangible". This may be the reason why the role of space in protests has often been overlooked in previous studies. However, based on our findings, we believe that space is the "invisible hands" behind the events at every crucial stage of protests, affecting protesters' behaviors and the course of events. Whether it is the choice of demonstration sites or demonstration routes, demonstrators need to make decisions to maximize the expression of their demands with the opportunities and constraints provided by an urban space. In fact, these skills that are related to space have been summarized by demonstrators in some protesting-related websites and applied in practice [61]; however, few studies have thoroughly examined the relationship between demonstrations and space.

In this study, we summarized the spatial distribution characteristics of both peaceful and violent protests and illegal and legal protests, and investigated how the built environment in an urban space affects the choice of protest location. We found that protests are spatially concentrated in areas with a high building density, high government and commerce POI density, high park density and metro accessibility, and an abundance of street greenery. Further, our results also reveal that illegal violent protests, not peaceful ones, are more likely to occur in areas with high government and commerce POI density, high metro accessibility, and an abundance of greenery. Based on the research findings, we propose a new comprehensive framework regarding the relationship between urban space and the spatial distribution of protests, which will hopefully be able to guide future studies.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su151713096/s1, Figure S1. Spatial distributions of legal protests; Figure S2. Spatial distributions of illegal protests; Figure S3. Spatial distributions of legal and peaceful protests; Figure S4. Spatial distributions of illegal and peaceful protests; Figure S5. Spatial distributions of legal but turn to violent protests; Figure S6. Spatial distributions of illegal and violent protests.

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