

The impact of a new public transport system on neighbourhoods surrounding stations: The cases of Bermondsey and West Ham with the Jubilee Line extension in London

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Abstract. *The impact of new public transport systems on towns and suburbs has been widely considered to be a significant aspect of urban development. However, spatial configurations which could stimulate transformation around neighbourhood of stations have not been clearly identified. It could be argued that the implementation of transport systems and the creation of new stations would enhance capacity of transport network and accessibility around vicinity of stations. Furthermore, the dynamics of pedestrian flow, generated by new public transport systems, might encourage socio-economic activities around stations. Therefore, the aims of this study are to verify the impact of urban morphology on station neighbourhoods and identify whether stations are embedded in the best location for optimising urban redevelopment. This paper analyses the surroundings of two stations – Bermondsey and West Ham – along the Jubilee Line Extension in London using Space Syntax measures. A spatial analysis with demographic and land use data reveals that the location of stations within urban layout would be the determinant in optimising socio-economic development in the neighbourhoods. It also suggests that Space Syntax could be an effective analytical methodology to understand the relationship between transport system and urban morphology.*

Keywords: Space Syntax, Spatial Configuration, Jubilee Line Extension, Public Transport System, Urban Morphology, Urban Regeneration.

Introduction

In most European cities, public transport systems not only serve traveling and commuting within the metropolis but also help the spatial and socio-economic development of cities and towns. As the largest city in Europe, London has the oldest underground service, which has been known as ‘Tube’, since 1863. There are now 11 lines covering 402km with 270 stations and serving over 4.8 million people per day in the metropolitan area. With the rising population in London, the demand for travel on the underground system never stop increasing. A new public transport network,

Crossrail, which is the additional connection between West and East London will start operating in 2018. Other major cities in Europe also encounter the same increasing of demand on underground service in recent years. With the increasing demand for travel between city centre and suburban, the continuing expansion and intervention of railway infrastructure especially stations become the major impacts on shaping urban structure and economic redevelopment overtime. Stations are not only the ‘nodes’ where trains arrive and depart within the network but also the ‘places’ which allow social and spatial patterns emerging into public realms in cities (Bertolini, 1996). Stations

play essential roles by connecting local street networks and global transport networks as well as providing mobility to transport material and immaterial flows. It could also be seen as the centre of urban area which could facilitate the development of local economies and land values in vicinity of station.

John Urry (2007) proposed that mobility could be defined as different forms of physical travel, transport and communication through time and across various spaces, the overlapping of transportation systems and social entities could support the multiple forms of actual and potential movement. Mobility on public transport networks is recognised as the most sustainable aspect which could facilitate the transformation of economic and social life in cities and towns. Bertolini (2012) also indicated that it is necessary to intertwine mobility, spatial developments, and socio-economic practices in order to enhancing city welfare while urban social and economic activities are increasingly dependent on mobility. Furthermore, it would require integrated disciplines in transport systems and spatial planning to increase sustainability and accessibility in both global and local urban networks. Therefore, it is essential to understand the spatial characteristics of built environment and land use distribution in vicinity of stations for assessing the impact of the new public transport systems on urban redevelopment.

In *The Social Logic of Space*, Hillier and Hanson (1984) argued that built environment in terms of spatial configuration is significant in supporting everyday movement within street networks. The spatial and physical properties of urban space which is known as urban morphology, generates movement patterns and shapes potential co-presence and encounter, would eventually encourage local socio-economic development and regeneration. Thus, the spatial influence of station neighbourhoods and the relation between built environment and movement patterns might be the keys to evaluate the configurational effect of the location where stations are embedded.

In *Movement Economies* study (Hillier et al. 1993), the high density of urban structure and land use distribution are the factors of the

‘multiplier effect’ for generating movement within urban grids. It could be argued that the mechanism of dynamic urban development process with the diversity of land use would support long-term socio-economic development in urban area (Perdikogianni et al. 2006, Vaughan et al. 2015). Based on this concept, this study would examine density of blocks and land use patterns to assess the relation between physical environment and socio-economic properties especially the effect of spatial configuration on urban development in station neighbourhoods.

Most transport and urban research has focused on the relationship between accessibility and mobility within transport networks in regional scale. In this trend of study, stations could be seen as nodes of connector and transport hub. However, the spatial influence of station neighbourhoods and the location of stations which could be the factor to optimise the socio-economic growth has received less attention. The spatial analysis of London Kings Cross Station neighbourhood in the *Natural Movement* study (Hillier et al. 1993), the authors demonstrated that the infrastructure of railway stations would affect urban street networks in connectivity and accessibility which could determine pedestrian movement patterns. Bolton (2015) in the study of railway terminus neighbourhoods in London also suggested that the location and spatial characters of station would influence pedestrian movement patterns and the growth of urban form over time. It shows that the area behind the terminals in London have become less connected to urban grids with the development of stations and their spatial characteristics are different than the adjacent areas. On the other hand, the spatial integration of stations in the existing urban grids and the location of the stations which are the spatial configurational factors have been proved to influence the distribution of land use within both global and local street networks (Mulders-Kusumo, 2005). This study therefore investigates the embeddedness of new stations within urban layout and uncover the topological impacts of spatial configuration on socio-economic growth in station neighbourhoods by using space syntax measurements. The findings would

indicate the spatial conditions which could potentially optimise urban redevelopment with the new public transport systems.

Background

The Jubilee Line Extension (JLE) was the major London Underground project during the 90s and started to operate in 2000, it plays an essential role in connecting central London with the Docklands and Canary Wharf which are the newly developed financial district in East London. The JLE improves the accessibility over a wide sector of east and south London where the river had long been a barrier to the communication of central London. In the early proposal, the JLE also intends to support the urban regeneration along the route especially to create new job opportunity at Canary Wharf by enhancing the mobility from main terminus, namely Waterloo and London Bridge, and by linking Docklands and North Greenwich with the extension to Stratford.¹ The JLE impact study by University Westminster in 2004 reported that the JLE has helped the economic growth on employment and population by enhancing transport service and connection to west and east end. Although the previous study has investigated regional commercial and residential development, but the spatial impacts on the local scale of neighbourhoods around the JLE stations have not been widely examined by urban studies. Therefore, the aim of this paper is to assess the spatial configuration on the selected station neighbourhoods along the JLE, Bermondsey and West Ham, which represent different roles of transport nodes and the areas with particular topological and spatial characteristics. The Bermondsey Station is a completed new intervention without other connected underground service whereas the West Ham Station is an existing one which mainly serves as an interchange transport hub with the connection to Hammersmith & City, District, DLR and National Rail. The neighbourhoods surrounding these two stations have developed into different patterns of urban form and the morphological properties might give different impacts before and after the

intervention of the JLE. Therefore, this study aims to evaluate if the stations of the JLE has been successful embedded in the urban grids and how the built environment around the stations influence urban redevelopment.

Research Question

To what extent does the location of stations in terms of urban layout affect socio-economic activities in the neighbourhoods?

To what extent does the urban layout influence the local economic growth in terms of retail and commercial land uses?

Methodology and Spatial Analysis

A spatial analysis of the case study in the neighbourhoods of stations has been developed by utilising space syntax theories and techniques. Space syntax encompasses a set of urban theories and techniques for investigating the relationships between spatial configuration and a range of social, economic and environmental phenomena (Hillier and Hanson, 1984). It has been used to show that the pedestrian movement patterns in cities are strongly shaped by street network (Hillier, 1993). The analysis based on movement network allows the quantitative measurement to assess “spatial accessibility”. This study applies space syntax methodology to model the street network mathematically and investigate the spatial configuration with land use and demographic data sets. This approach allows the movement generated by the spatial layout in the street network surrounding stations to be analysed.

The Bermondsey Station has been chosen as one of the study areas because it is connected by the JLE next to the London Bridge Station and might bring positive commercial and residential redevelopment. On the other hand, West Ham is another chosen area because it located further away from central London and is an existing interchange hub with other London Underground and National Rail connection. The hypothesis is the neighbourhoods around the West Ham station would benefit with

the mobility of its transport conditions for investment in both commercial and residential use. However, the spatial conditions are varied in these two stations which might have different impacts on the socio-economic activity and movement patterns.

Stations' Usage and Performance

The stations' usage and performance data could be the indication showing the daily passengers behaviour of stations and the importance of stations to the Underground network as well as the residence and visitors travel patterns. From the JLE stations annual entries and exits number during 2003 to 2015, it shows that Bermondsey has increased from 4 million to 10.2 million while West Ham increases slowly from 2.3 million to 3.8 million. Figure 01 shows that the 2015 daily entries and exits in Bermondsey are three times higher than West Ham. However, the interchange numbers in West Ham is eight times comparing with its total entries and exits numbers. The pie chart in figure 01 also demonstrates the interchange behaviour in the West Ham Station, 88% of trips are related to the Jubilee Line either change from other Underground and rail lines or from Jubilee to others. The data suggests that the JLE brought passengers to both study areas, but the differences are that

the Bermondsey neighbourhood has mixed passengers including residence and visitors, while most of the passengers change lines inside the West Ham station and only 12% of passengers come off the station.

The Boundary of Study Area

To define the boundary of the sites, instead of randomly choosing the perimeter radius from the stations, this study uses catchment distance, which is also known as metric step depth analysis in space syntax techniques, to calculate the paths of pedestrians in the station vicinity (Figures 2A and 2B). The reason to define the site boundary by catchment is because this study focuses on the pedestrian walking pattern which connects between the station and everywhere else within the catchment. The 1200m street catchment pattern represents the route people can walk within 15 minutes from the station. It is suggested that 5 minutes to 15 minutes walking distance is the average distance which passengers would cover between destination and station.

The Urban Context of Station Neighbourhoods

In order to understand the influence of the overall morphology on these two station neighbourhoods, it is necessary to investigate

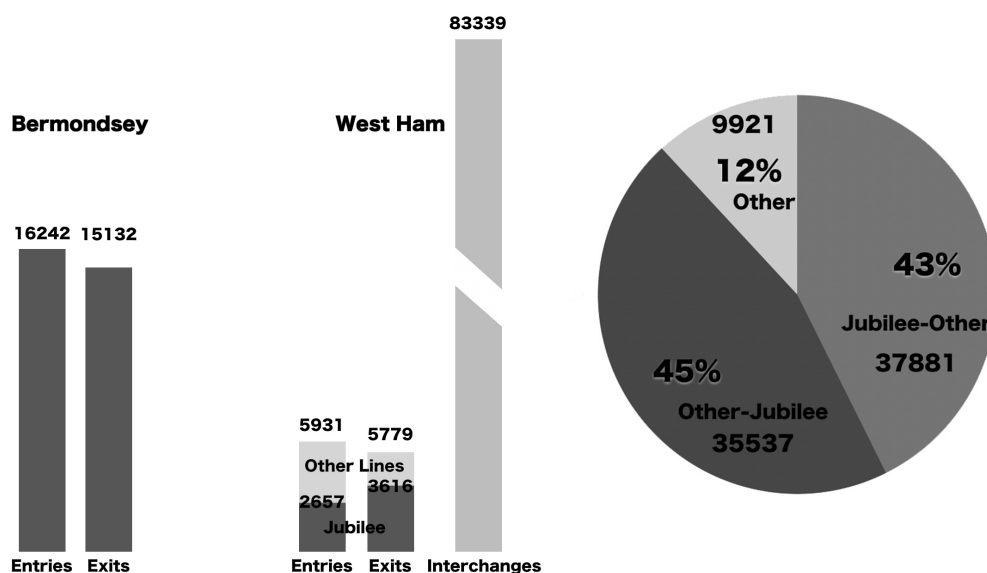


Figure 1. 2015 daily station usage in Bermondsey and West Ham and 2015 Interchange percentage in West Ham Station (Data Source: Source: Rolling Origin & Destination Survey (RODS), TfL Open Data, © Copyright, London Underground Limited, 2017)

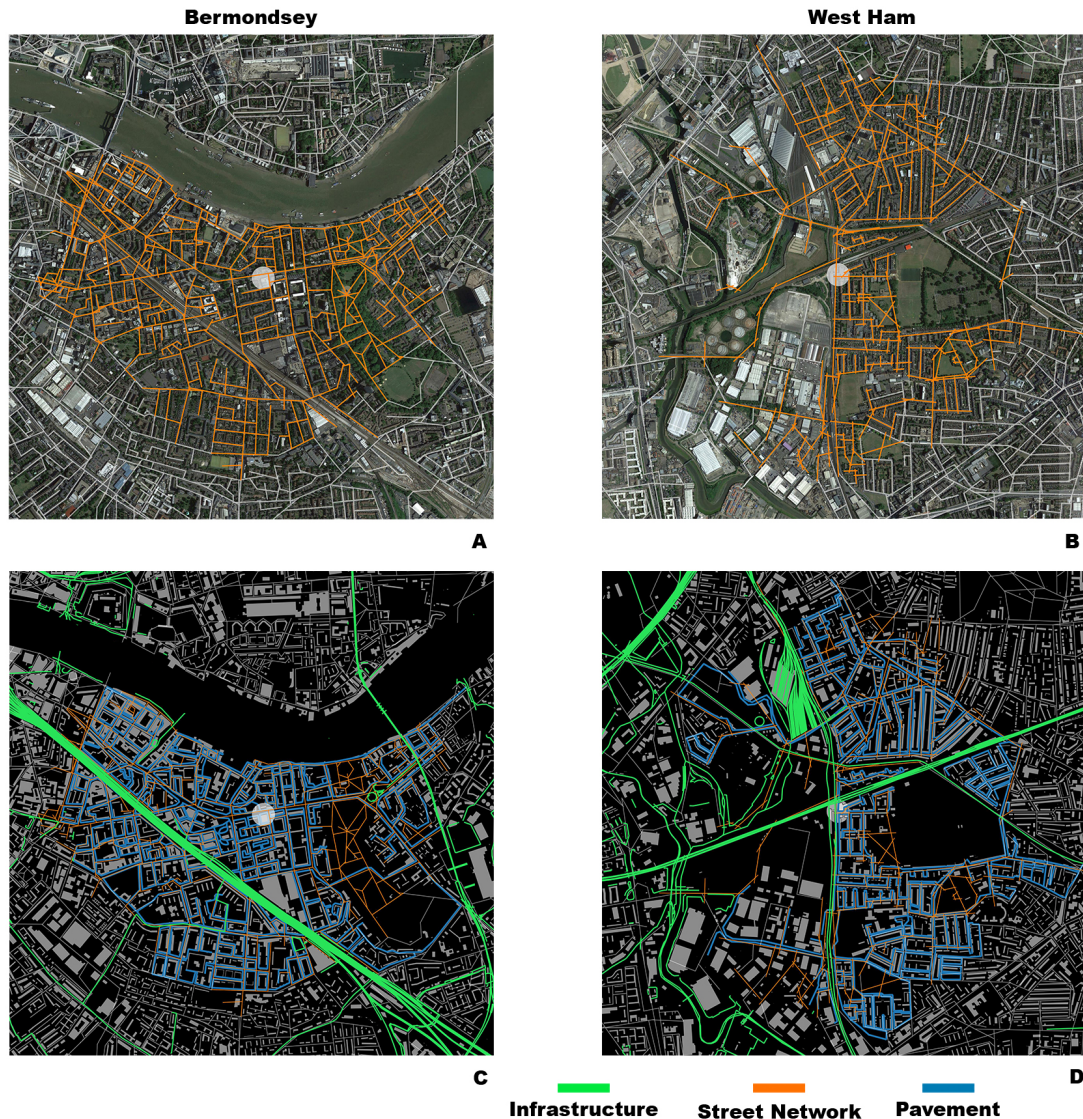


Figure 2. Street Network and Spatial Condition in Bermondsey and West Ham (Base Map Contains OS data © Crown copyright and database rights 2017)

the urban context first. The importance of the relationship between physical activity and built environment has been extensively addressed in space syntax literature. Hillier's (1993) idea of 'natural movement' suggested that the majority of pedestrian and vehicular movement is significantly determined by the structure of urban grids. Therefore, several spatial conditions in the station neighbourhoods have investigated at this stage including the distribution and density of the street network, the connection of pavements for pedestrian, the urban block size, and how the transport infrastructure penetrating or occupying these areas. Figures 2C and 2D

demonstrate the overall spatial conditions in both neighbourhoods. Both stations are located on the local main street and connected to the residential area, however, the distribution of the street networks and pavements shows that there is better connection and higher density in the Bermondsey neighbourhood than the West Ham. The average block size in Bermondsey is smaller than West Ham neighbourhood. Furthermore, Bermondsey has little interruption of the transport infrastructure whereas there are railway tracks divided West Ham neighbourhood into four sub areas which might decrease the connectivity for the pedestrian.

Spatial Analysis – Space Syntax Analysis in Choice (Through Movement) and Integration (To Movement) Measures

The street network around the Bermondsey and the West Ham Stations were analysed by space syntax choice and integration measures which represent two types of network performance. Choice calculates the shortest route from one street segment to another for every pair segments in the system, indicating the possibility that a street segment would obtain ‘through-movement’ as a part of a route from origin to destination. (Turner, 2005) Integration represents the ‘to-movement’ potential of a place, the possibility that it would be visited as a destination. (Hillier, 2009) In order to compare these two systems of street network in

two different neighbourhoods, both measures have been normalised mathematically. (Hillier 2012) Both global and local measures have been applied in the study to examine the network relationship within the neighbourhood and the connection to a wider region of city.

Figures 3A and 3B show that the normalised integration measure in radius N, representing the ‘to-movement’ around the station neighbourhood. This measure highlights that both Bermondsey and West Ham stations located on the most integrated street within the study areas. But the connecting streets are relatively segregated from the main streets. The main streets in front of both stations provide higher possibility for commercial use while the secondary streets could potentially become the residential areas.

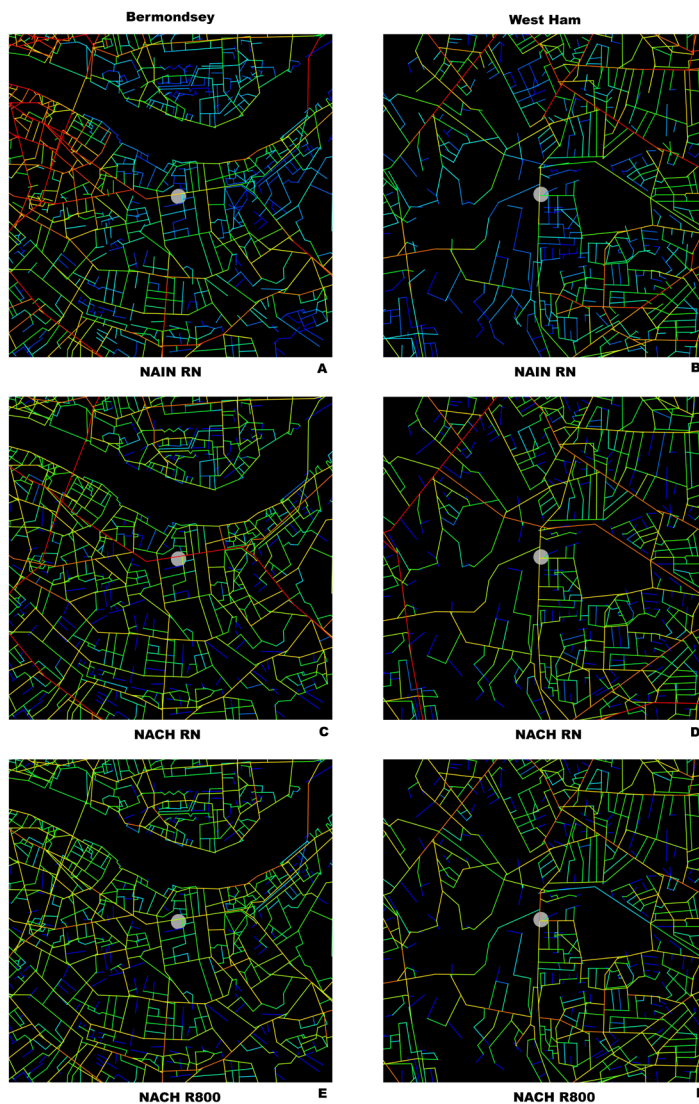


Figure 3. Space Syntax Normalised Intergration Analysis (A,B) and Normalised Choice Analysis (C,D,E,F) in Bermondsey and West Ham

Figure 3C shows that the highest choice value segment passes through the main street in front of the Bermondsey Station while in figure 3D, most of the high choice values segment street are located far from the West Ham Station. The analysis suggests that the main street of the Bermondsey Station provides higher possibility for the ‘through-movement’ of global network but the main street in West Ham is not the case.

Figures 3E and 3F show that the choice value in local measures in both station neighbourhoods are relatively low from the overall study area. However, there are more low value of segments around the West Ham Station than the Bermondsey Station. It could argue that the Bermondsey neighbourhood allows more ‘through-movement’ within the street network. The choice mean value of street segments (Figure 4A) provide the evidence to support the argument, demonstrating that the street network in Bermondsey has higher choice value than West Ham. In other words, the Bermondsey Station has higher accessibility to attract more pedestrian movement and provide more opportunity for encounters than the West Ham Station in the local scale of street network.

A Mean Value of Choice (Through-Movement)

Catchment	NACH	Bermondsey	West Ham	
400m	Mean	0.919	0.781	
	800m	Mean	0.852	0.775
	1200m	Mean	0.853	0.789
Global	Mean	0.795		
	Median	0.908		

B Segment Length within 400m Catchment

Catchment	Segment Length	Bermondsey	West Ham
400m	Total	5145m	4382m
	Avg	69.5m	71.8m

Figure 4. Choice mean value of street segments within different catchment areas and Segment length in Bermondsey and West Ham

From the step depth metric analysis in 400m, representing the 5 minutes walking routes from the station, this study calculates the total and average street segment length in both areas. The result (Figure 4B) shows that Bermondsey has a larger number of segment length than West Ham, however Bermondsey has shorter average segment length. It indicates that the street network covers more ground with higher density in Bermondsey area than in West Ham. From previous space syntax study, it has been suggested that the area with shorter street segment and higher density of street network would possibly encourage more socio-economic activity. (Hillier, 1996)

Data Analysis

Demography Data

This study provides demography data sets for evaluating the urban development before and after the JLE in both study areas.

Figure 05 Chart A shows that the population and population density gradually increased from 2001 to 2012 in the Bermondsey area but the population remained the same in the West Ham during this period.

The overall house transactions numbers in the Bermondsey area is more than the West Ham area. In order to avoid the regional economic affect for the comparison in these two areas, this study only focuses on the transactions within 400m catchment of both stations. Figure 05 Chart B shows the increasing house price in both areas. However, the increasing percentage is much higher in Bermondsey than West Ham. It highlights (Chart C) the year between 1999 and 2000 which was the time the JLE started to operate, there is 63% increase in house price in the Bermondsey area which was higher than any other years

Land Use Distribution

Figure 6A and 6B show that the land use diversity in the Bermondsey neighbourhood while the land use type is segregated in the West Ham neighbourhood by the transport infrastructure. Although transport infrastructure also occupied large space of the area, but from the spatial analysis, it could suggest

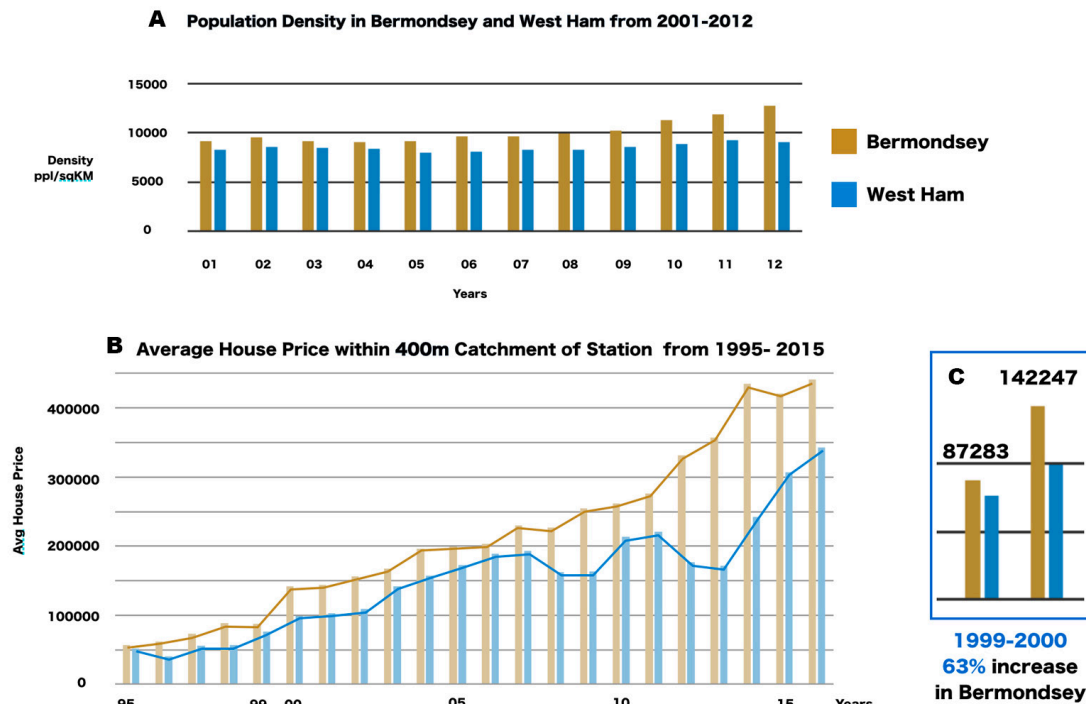


Figure 5. Demography Data (Data Source: Source: Office for National Statistics © Crown copyright 2016, Land Registry © Crown copyright 2017)

that the high density of the street network in the Bermondsey area prevent the negative effect of transport infrastructure by enhancing the connectivity within the street network. These two graphs also indicate that land use types have been mixed homogeneously in the Bermondsey area while in the West Ham area the land use distributed separately.

Site Observation

From the snap shots investigation of both stations and site photos (Figure 6C, Figure 6D), it is clear that the Bermondsey Station area has more pedestrian movement and more retails around the station while the West Ham area has less vitality with transport infrastructure disrupted the street and pavement.

Conclusion, Limitation and Future Work

The analysis of Bermondsey and West Ham

Station neighbourhoods allow the street and space networks around the stations to be characterised and compared with the station performance and demographic data sets. The result suggests that the location of stations would bring significant impacts to the neighbourhoods in both physical environment and socio-economic properties. Several spatial conditions need to be addressed in this study for future urban planning and transport development. The station which sits in the place with higher accessibility for pedestrian and diversity in land use would possibly be a more successful intervention to optimise the development not only in local neighbourhood but also in global street and space networks. The spatial analysis together with the land use data demonstrates that urban layout in station vicinity plays an important role in determining both positive and negative influences. It also reveals that how the urban structure in terms of transport infrastructure enhances urban redevelopment not only in morphology but also in socio-economies of

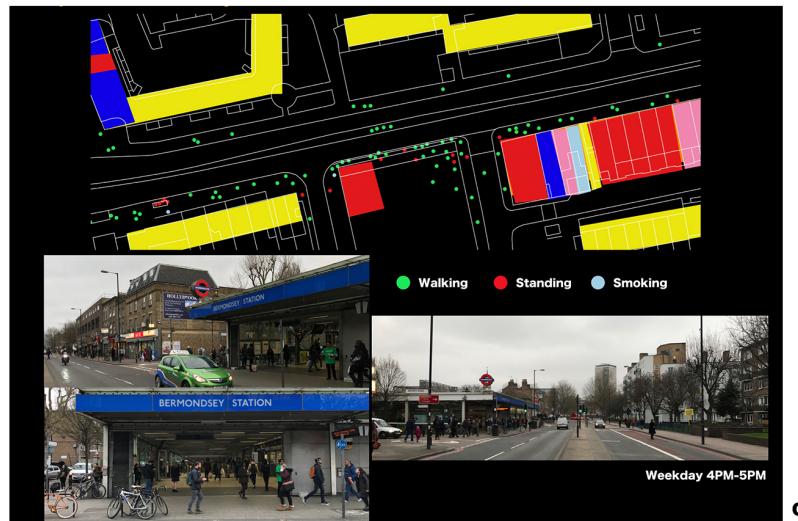
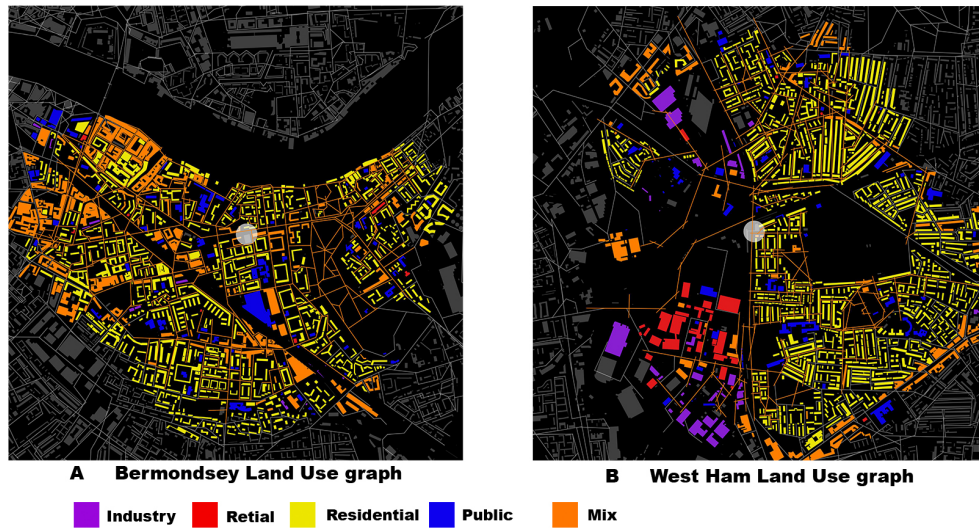


Figure 6. A,B Land Use distribution graph, C Bermondsey Site Observation, D West Ham Site Observation (Base Map Contains OS data © Crown copyright and database rights 2017)

station neighbourhoods. However, urban and transport planners still need to be aware that huge transport infrastructure and lack of street connectivity could bring negative impacts to the neighbourhoods. Although the comparison between the Bermondsey and West Ham Station provide the spatial and demographic evidence that urban morphology would give impact on the station neighbourhood, but other factors related to the urban development policy and regional economies still need to be concerned in the future study. There is no perfect pair of stations to be selected as case study, however, a more sophisticated methodology could benefit the evaluation related to the built environment, pedestrian movement, and land use around the station neighbourhood such as the walkability model and the hedonic model in assessing the relationship between accessibility and house price. In order to assess the impacts of the JLE and its stations in the local areas, it still requires more studies on other JLE stations and neighbourhoods to

Notes

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