THE IMPACT OF AIR POLLUTION AND NOISE LEVEL ON PEOPLE'S DWELL TIME IN OUTSIDE SPACES AND THEIR ASSOCIATED RETAIL BEHAVIOUR

by

MARTINA CECILIA ADRIANA, B.Sc

This Dissertation is submitted by the Candidate

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Name: **(PRINT using ball-point pen)**	Martina Cecilia Adriana									
Signed:										
Student ID Number:	2	0	0	9	1	1	3	7	0	
Programme of study:	MSc. Transport Planning and the Environment									
Module title:	Transport Dissertaion									
Module code:	**T R A N**	5	9	1	1	m				
3. Name of supervisor:	Dr. John Nellthorp									
Date submitted:					**Time:**					

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EXECUTIVE SUMMARY

Air and noise pollution are well-known to cause adverse health effect to human (WHO, 2011;2013, Babisch, 2011; Basner, et al., 2014; Vienneau et al., 2015; Halonen et al., 2015). People in London are in risk of those impacts since London is identified as the most polluted place in Europe (The Guardian, 2010) and being attributed as noisy place. Therefore, the City is facing significant challenges in tackling environmental crisis today and in the future.

Mayor of London is aware of such situation and has invested a lot of money and implemented several measures in improving transportation related environment sector (TfL, 2015). Since 2009, the London's Great Outdoor and Better Street programs - led by Transport for London (TfL) - has been started and has been successfully delivered more than 80 public spaces and street network projects (TfL, 2013). This program aims to enhance the urban environment, improve the vitality and sense of place, as well as to improve the quality inhabitants

TfL has undertaken a gap analysis focused on that investment and the return of economic benefit gained that will be addressed in this study. The primary objective of this research is to seek to understand how important are levels of air pollution and noise as the impact of transport activities, influence the dwell time and adjoining retail spend in the outside cafes or restaurants. To understanding the importance of those variables, three central questions rise:

1. Do the quality level of air pollution and noise influence people's dwell time in outdoor spaces?
2. How does people's perception compare with the measured urban pollution and noise level in outdoor spaces?
3. Do the quality level of air pollution and noise affect their retail behaviour including spending in adjoining outdoor spaces?

Data in this study are obtained through field survey conducted on 6,7, and 8 July 2016 in London. Three different locations are selected based on TfL's Road Task Force: have the similar "place" yet different "movement" or traffic function: The Cut as low traffic, Exhibition Road as medium traffic, and Upper Street as high traffic.

Data required consist of quantitative and qualitative: dwell time, air pollution (focus on Ultrafine Particle / PNC), noise level, and retail spend. Those will be gathered with different methods: video recording, measurement (air and noise pollution), and the online questionnaire.

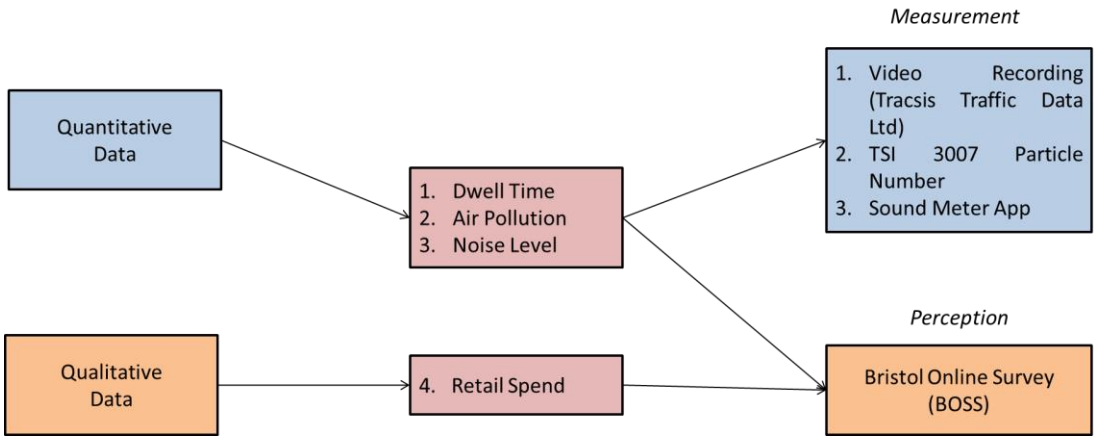


Figure 1: Data Collection Type

Source: own work

Data are analysed using correlation and multiple regression analysis. In order to show the relationship between variables, four hypotheses are created consist of:

- **H1**: If measured pollution (A) > measured pollution (B) → Dwell Time (A) < Dwell time (B)
- **H2**: If perceived pollution (A) > perceived pollution (B) → Dwell time (A) < Dwell time (B)
- **H3**: If pollution (A) > pollution (B) → retail spend per person (A) < retail spend per person (B)
- **H4**: Perceived pollution is correlated with measured pollution

Key Findings

The result shows that air pollution has a very weak correlation with dwell time (0.161) in a significant way. The regression shows the very small coefficient (β=0.000) of PNC in affecting dwell time. Noise shows stronger correlation (-0.48) than air pollution but at 60% significance level only and the coefficient changing β= -1244). This support the previous studies that acoustic presence has a bigger influence (Paas et al., 2016) in affecting people dwell time.

From the study, it also found that there is a stronger factor in affecting dwell time: group size (β =17.138). The comparison of coefficient regressions also confirms that atmospheric effect of air pollution and noise has a weak impact in affecting dwell time (Donovan et al., 1994).

Multiple Regression Analysis for Dwell Time

Factors	β	Standard Error	t-value	p-value
PNC (Particles/cm^{-3})	0.000	0.000	2.647	0.009
Noise Level	-1.244	1.230	-1.011	0.313
Group Size	17.138	2.436	7.034	0.000
PCU/minute	0.474	0.330	1.437	0.152
Children Presence	-17.359	8.961	-1.937	0.054

Source: Own work

Study finds incompatibility between measured and perceived air pollution (Hypothesis 4). The explanation for this can be explained by less capability of people in recognizing air pollution (Brody et al., 2004; Howel et al., 2002, Paas et al., 2016). Particularly ultrafine particle, it's a tiny particle, invisible, and odourless (Brugge, 2013), makes it hard for human sensory to be detected, just like many air pollutants including $PM_{2.5}$ and $PM_{10.}$ This would explain the rank order in perceptions start from Upper Street as the worst, The Cut, and then Exhibition Road doesn't match with actual data where Upper Street> Exhibition Road> The Cut.

Similar to noise, the match between measured and perceived can be identified, although in some cases, it shows the inconsistency. It may cause by other consideration on noise judgment that can be explained in soundscape concept. On the Exhibition Road, people perceived noise level to be quiet whereas the actual measured it to be fairly noisy. This possibly occurs because noise were dominated by surrounding speech, which perceives to be more pleasant than traffic noise (Miller, 2013; Nilsson and Berglund, 2006; Guastavino, 2006; Carles et al., 1999). Surrounding speech tends to be perceived eventful or exciting (Axelsson, 2010).

The results on dwell time vs pollution seem to contradict the hypothesis 1 and hypothesis 2 that reduced pollution would be associated with increased dwell time, both from the observed data and the (small sample) perceived data. PNC show very weak correlation – statistically significant - with dwell time. The noisiest street for traffic noise – Upper Street – had some of the longest dwell times. The association with retail spend can not be explored because the sample size from online survey was small so that Hypothesis 3 can not be tested.

Reflecting on the results, there may have been other social or behavioural factors – including the purpose of the visit to the cafe or the context that day (day off, working day, day as a tourist, etc.) that may have played a greater role in explaining dwell time that the environmental variables did.

The measurement and survey were conducted on three different days, with supporting by 3 days of background pollution level to get the actual traffic impact on air quality. This help to get to know the true traffic impact to the air quality.

The findings in this research create opportunities for further studies. A study focusing on environmental impact to the health damage through actual and perceptions will be essential. Another study focusing the relationship related economic benefit and environment could be focused on what is the variables in the streetscape has a significant influence on people's perceptions.

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Air pollution and noise are well-known as the cause of adverse health effects. WHO (2013) stated that air pollution cause cardiovascular, morbidity, and even mortality to the human. Moreover, noise can cause the annoyance (WHO, 2011), increased blood pressure and stress hormone (Babisch, 2011), hearing loss (Basner et al., 2014), cardiovascular disease (Vienneau et al., 2015), hypertension, stroke, and mortality (Halonen et al., 2015).

London is a global and world-class city which faces challenges and opportunities to stay in that “class” (LDA, 2008). London grows rapidly, with the population predicted to rise from 8.6 million in 2015 to 10 million in 2030 (London Assembly, 2015), which also increase the challenge in urban environmental crisis nowadays. According to The Guardian (2010), City of London is the most polluted places in Europe, which has the highest nitrogen dioxide (NO_2) concentration and the number of particulate matter (PM) hot spots that exceed the limit threshold (Kelly, 2014). People in London also exposed to the traffic noise level >55 dB, which is defined by WHO (2011) as the annoying level that can cause health problems, and in UK level causes hypertension-related myocardial infarctions and stroke (Halonen et al., 2015).

It is widely known that transport world has a significant influence on urban environment quality. According to Fecht et al. (2016), noise and air pollution in London are primarily caused by the traffic. Therefore, to support the city's growth as well as to tackle the urban environmental issue, Mayor of London has implemented several measures and invested billions of pounds through the transportation sector. These actions focus on improving, modernizing, and expanding London's transport network (TfL, 2015), which simultaneously supported by the significant investment from the private sector in new housing, retail, and office development.

London is widely connected by a network of streets, public squares, interchanges, and junctions, which account for 80% of London’s public spaces (TfL, 2015). Since 2009, Mayor has started the London's Great Outdoors and Better Streets programs and has delivered

more than 80 innovative improvement projects on capital's public spaces and street network (TfL, 2013). This primary aims of the program are to enhance the urban environment standard, improve the vitality and sense of place, as well as to improve the quality of life for inhabitants and visitors.

Resulting in the success of public realm enhancement projects through the program, and to supporting the continuing investment for improvement projects, Mayor of London again set up the Road Task Force (RTF) program (TfL, 2015). The primary goal of this program is to deliver “world-class streets and roads in London- "fit for the future” (TfL, 2015). It can be approach by providing roads, not only efficient and safe for people, goods and service movement, but also be able to contribute to city looks, feels, and its quality of life.

In respond to the RTF program, TfL is leading the program and has planned to invest £4bn in the capital's road network and the Road Modernisation Plan (TfL, 2015). The road modernisation plan includes hundreds of projects with 17 major schemes to create better public spaces and support regeneration and economic growth. TfL will improve 33 London's busiest junctions (see Appendix 4), build 4 new cycle superhighways, improve four existing routes, provide safer and faster journey to central London for the benefit of all road users. TfL also provides support to the boroughs on their Local Implementation Plans (LIPs) in delivering better local transport (TfL, 2015).

1.2 OBJECTIVES AND RESEARCH QUESTIONS

TfL Surface Transport, Strategy, and Planning have undertaken a gap analysis focused on their regeneration investment that includes outside place, street and road improvements. TfL has identified a research gap: the return of economic benefit from their investment that will be addressed by this study. The investment defined by the infrastructure change adjoining with the transport management implemented on the streets and roads. Moreover, the economic benefit will be measured with dwell time and the adjoining retail spend which consider as the potential metric in defining economic vitality and quality of Life (New York City Department of Transportation (NYCDOT), 2013).

The primary objective of this research is to seek to understand how important are levels of air pollution and noise as the impact of transport activities in influencing the dwell time and

retail spend in outside spaces primarily for leisure purposes (eating and drinking in particular). Data gather quantitatively and qualitatively by on-site measurement as well as individuals' perception. Therefore, to understand the importance of those variables, the primary objectives are broken down into three main research questions:

1. Do the quality level of air pollution and noise influence people's dwell time in outdoor spaces?
2. How does people's perception compare with the measured urban pollution and noise level in outdoor spaces?
3. Do the quality level of air pollution and noise affect their retail behaviour including spending in adjoining outdoor spaces?

1.3 RESEARCH SCOPE

This research is one of the projects to evaluate the economic benefit of the TfL's transport investment in London. Therefore, the study will take place in London, where the improvement being implemented. Three different roadside environments selected based on TfL's Road Task Force street types, which categorize by "movement" and "place" function. Furthermore, this study will only focus on the customers of street cafés and restaurants on those three sites.

Based on the requirements, three different roads are identified which has the similar "place" function yet different "movement" function. Different "movement" function defined by traffic volume on the streets: high, medium, and low traffic. The sites chosen are The Cut, Exhibition Road, and Upper Street - located in the Central London. Exhibition Road has low/very low traffic, The Cut has Medium Traffic, and Upper Street has high traffic. All of the streets have different layouts but have the similar land use for cafes and restaurants.

Figure 1. 1 Map of Site Locations

Source: Google Maps, 2016

Figure 1. 2 Road Conditions

Source: Google Maps, 2016

1.4 STRUCTURE OF RESEARCH

This research investigates the importance of the air pollution and noise in affecting people's dwell time and their adjoining retail spend in street cafés and restaurants. **Chapter I** explains the background of the study risen by Transport for London as the result of their investment in regeneration purposes and quality of life enhancement. This section also introduces the problems, primary objectives, and research questions to answer by the study. **Chapter II** will present the literature review, which describes the subject matters in this research through

previous theoretical and empirical studies regarding the interaction between air pollution and noise in influencing people's dwell time and their adjoining retail spend in retails sectors.

Chapter III will describe the research methodology explaining the data collection method, data input, and data analysis method to be used. It includes the use of air pollution and noise measurements, video recording method, questionnaire usage, and other data that also considered for the study. Hypotheses of this research will be used to answer the research questions. **Chapter IV** consists of the analysis and discussion that will present the results, findings, correlations, discussion, and hypotheses test through statistical analysis procedures. The results will be furtherly discussed to get a deeper understanding of the research. **Chapter V** shall present reflection and limitations on the study, conclusions as well as the suggestion for further studies.

CHAPTER 2: LITERATURE REVIEW

2.1 FACTORS AFFECTING CONSUMER BEHAVIOUR IN RETAIL SECTOR

Consumer behaviour in the retail business is affected by a lot of factors which can be categorized into situational, personal, psychological, and societal (Tanner and Raymond, 2012). All those factors can cause a different level of impact on people response and emotions when dealing with the retail decision.

First, situational factors are the temporary influences that consist of physical factors, social factors, time factors, reason factors and buyer's mood. Physical factors can be described as store locations and atmospheric factors. Social factors affecting behaviour because consideration of other people thinks matters to the individual. Time of day, time of year and time availability of the customer will also influence their behaviour in choosing the goods or services. Another factor such as the reason will affect the people's dwell time in the retail store as well as their mood (Tanner and Raymond, 2012).

Second, the personal factors include personality, self-concept, gender, age, stage of life, and lifestyle (Tanner and Raymond, 2012). Personality is the reflection of people's disposition, which can enhance feeling about customer itself. Gender show the different effect when women shop differently than men (Tanner and Raymond, 2012). People at different age and stage of life buy a different thing to express themselves. Furthermore, lifestyle is reflecting what people are doing, how they spend their time, their priority that affect their perception of goods or services.

Third, psychological factors consist of customer's motivation, perception, and attitude. Psychological factors is a higher needs that usually they come after basic need fulfilled. Motivation and perception can be approach by repetition through advertising, whereas attitudes are often difficult for companies to change (Tanner and Raymond, 2012).

Lastly, the societal factors such a culture, subculture, social class, family, reference group, and opinion leaders are the factors that different from previous temporary factors mentioned before. Societal factors are outward which depend on surrounding world of the customer. Culture and subculture describe how the customer live which will affect the

purchase decision. Similar social class tends to show the same purchasing pattern. Family, reference group and opinion leader can influence people decision in buying goods and services (Tanner and Raymond, 2012)

2.2 ATMOSPHERIC FACTORS

Tanner and Raymond (2012) have shown that there are a lot of factors affecting consumer behaviour in retail. Some studies that go deeper of each variable has been done and resulting in the different implication level of the customer behaviour. This research will focus on the air pollution and noise as a part of atmospheric factors that able to affecting consumer's dwell time and their adjoining retail spend.

According to Kotler (1973), the atmosphere term comes from "the air surrounding a sphere" which describe the quality of surroundings space. Atmosphere is the component that detectable by sensory terms like smell, brightness, noises, etc. Baker (1986) categorize a classification in atmospheric environment variables into three main components; ambient factors, design factors, and social factors (see Appendix 15).

Baker (1986) mentioned air quality and noise as ambient factors, which are the most suitable factors for this research. However, Baker's categorisation is mainly describing in-store variables such as music, scent, in-store temperature - different with this research focus. Even though it's more about in-store variables, Baker's categorization is supported by the environmental psychology literature that based on human psychology in response to the stimuli. So that, this categorization will be reliable to be implemented in the outside store too, although there are more factors can influence customer behaviour in the outside.

Berman and Evans (1989) propose alternative classification which describes atmospheric stimuli into 4 categories; exterior of the store, the general interior, the layout & design variables, and the point-of-purchase and decoration variables (see Appendix 16). The research mentions surrounding areas, congestion, and traffic as variables that can affect consumer behaviour. There are a lot of things can define as surrounding area, and a lot of things can be defined as an impact to traffic and congestion. In the urban environment, congestion and traffic are the main source of air pollution and noise. Sturm (2000) state that transport activities contribute significantly to pollution in urban areas. Although not

specifically mentioned in the classification, air pollution, and noise can be categorized as congestion and traffic impact as well as a component in the surrounding area.

From Baker (1986) and Berman and Evans (1989) classification, air pollution and noise can be categorized as atmospheric factors that can influence consumer behaviour in outside cafés and restaurants. Baker (1986) mention air quality and noise as variables, while Berman and Evans (1989) state surrounding area, congestion, and traffic. These two are correlated with each other as noise and air pollution are the result of the congestion/traffic, while traffic and congestion contribute to the noise and air pollution.

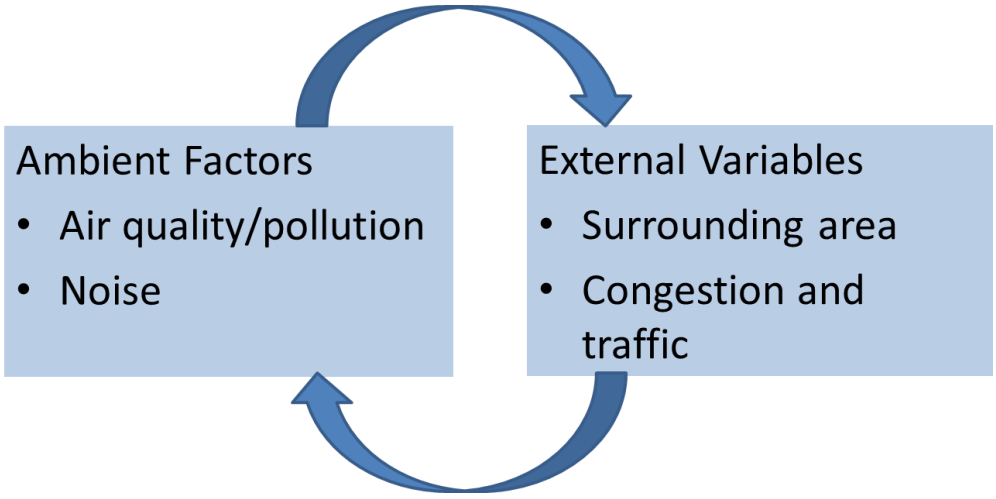


Figure 2. 1 Atmospheric Variables

Source: Own Work

2.3 ATMOSPHERIC FACTORS AFFECTING DWELL TIME AND RETAIL SPEND

The correlation between atmospheric factors and consumer behaviour is described by Turley and Milliman (2000) through stimuli – organism – response relationship. By combining human variables to Berman and Evans (1989) classification, the correlation is described in the graph as follow;

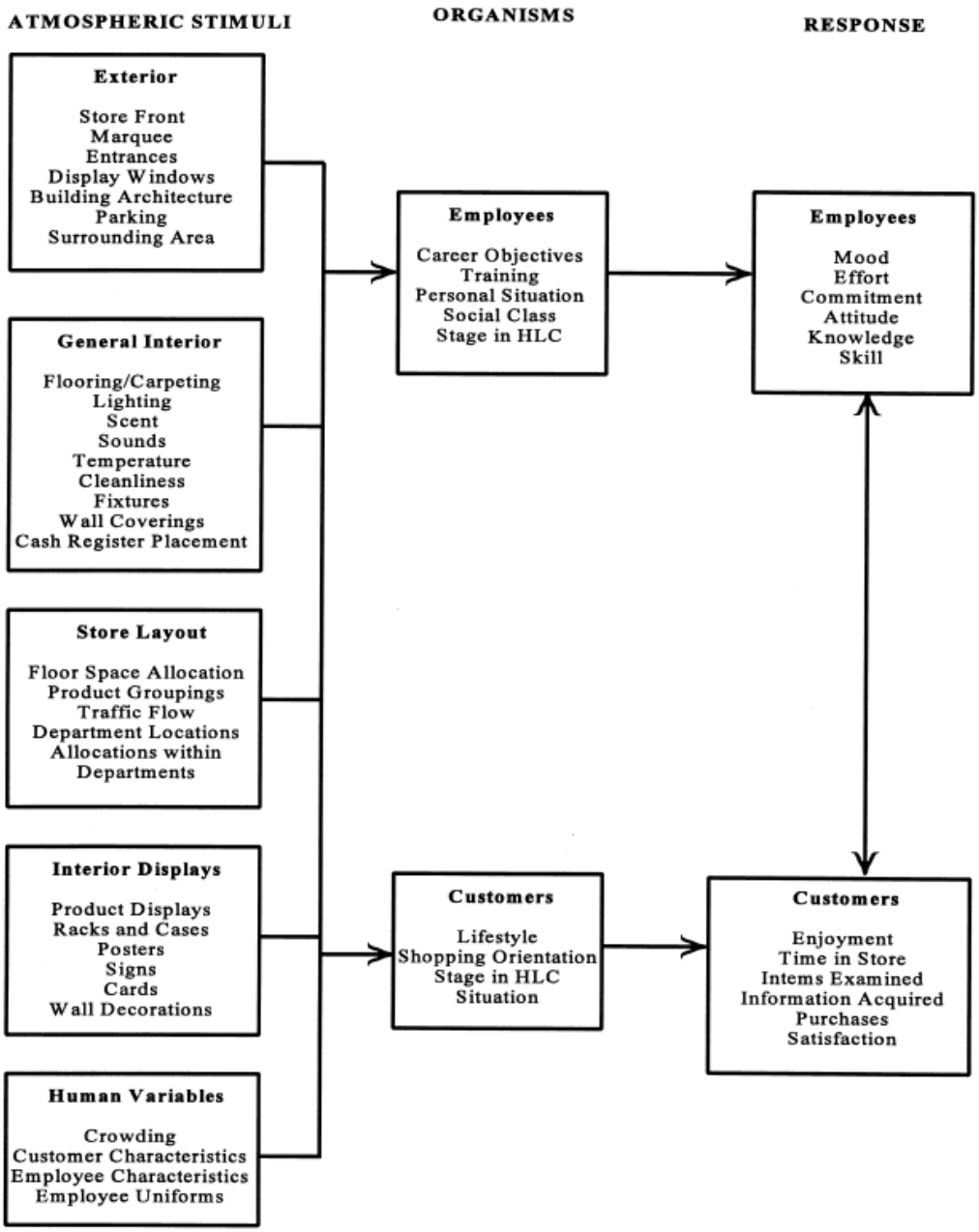


Figure 2. 2The Influence of Retail Atmospherics

Source: Turley and Milliman, 2000

Previously, Mehrabian and Russel (1974) cited in Donnovan and Rossiter (1982) emphasize that environment stimuli raise emotional states known as pleasure and arousal. Furthermore, this emotional states will create approach and avoidance behaviours in customers. This research is supported by Donnovan and Rossiter (1982), which investigate the relationship between emotional states induced by eleven different retail environments and statements of behavioural intention. They found that store-induced pleasure has a

positive correlation with willingness to buy, while store-induced arousal will influence the dwell time in the store and willingness to interact.

All the variables of atmospheric stimuli affect both the employee and the customer, inducing the emotional state according to their characteristic. The employee emotional will cause the behaviour intentions that at the end will affect the consumer behaviour. Customer response, not only affected by their emotional states but also employee response will behave differently that will affect their dwell time in a store and their purchases.

Most of the marketing research tend to be conducted to in-store studies. When considering street cafés and restaurants, the impact will be different because it has more complex variables. Consumer behaviour research in outdoor retail, which considers external variables are still rare. Grossbart et al. (1975) ever examined the external variables impact of macro-environment in the shopping district, resulting in various perception among individuals depends on shopper type. Pan et al. (2008) unable to show the evidence of the relationship between access, parking, building exterior, landscape, and outdoor exhibition area to purchasing behaviour.

Some studies have found the proof of how external atmospheric have affected the retail sales, if accessibility for pedestrian and biker are improved, they visit the area more often and as a result spend more in that retail business (Stantec Consulting Ltd, 2011; Schaller Consulting, 2006; Clifton et al., 2012; NYCDOT, 2013).

However, the research shows the correlation between the external atmospheric variables and the retail sales that more caused by the increase of the customer number. Research about the impact of the air and noise pollution as the result of the street improvement to people's dwell time and their adjoining retail spend particularly in outside retail sector are still rare.

2.4 STREET/ROAD IMPROVEMENT AND ECONOMIC BENEFIT

It has been proved that transportation investment can generate large benefit within society (Lakshmanan & Chatterjee, 2005) through the economy and social development. That investment usually forms in two types: capital expansion and capital enhancement (Eberts,

2000). The expansion aims to support and accommodate the future growth such as construct the new or expand transport network, while enhancement refers to improve the efficiency of the existing transportation system. Both of them have the similar goal, which is to achieve the economic benefit among societies.

There are increasing acknowledgments nowadays argue that transportation system can affect both positive and adverse impact on the urban resilience. Too many traffic generated by the transport investment can cause the economic collapse, environmental issue, and degradation of the quality of life within the urban areas. Those problems become bigger challenges in urban areas nowadays, raising an important question: how to accommodate the population growth and expand economic opportunity while also improving public health, environmental sustainability and quality of life (NYCDOT, 2013). Cities need to plan their transportation system carefully, how to meet the transport requirement to achieve the economic development hence minimizing the adverse impact of the transportation.

Creating connection between transportation and economic development is essential, how to balance the transport requirement in contributing economic development. In the urban context, road traffic is the main transport system, which consists of roads and streets. Street and road are used not only for walking purposes, but it has an essential role as a public space for communities. Street as public space also serve social function, to look, gaze, meet, play, shop, work alongside (Project for Public Spaces Inc., 2008), to congregate, relax, and enjoy being out in public, the place where people participate in the community (NYCDOT, 2013).

According to those function, street or road have a broad range of economic influence for government, private sector, and the local communities such as (NYCDOT, 2013);

- The job creation
- The impact of mobility on logistic cost
- The external cost of traffic accidents
- The saving between the active design of public realm and saving in behaviour cost
- The environmental cost
- Higher property values associated with higher quality public realm
- Household savings related to the lower cost of vehicle ownership and usage
- Commercial vitality of the neighbourhoods in particular streets

The influence of street/road improvement can be beneficial to the urban development and its communities. NYCDOT (2013) identified potential parameter to analyse the economic benefit, both direct and indirect. The direct benefit can be measured by safety, moving people and goods, accessibility, economic vitality, attractive place for movement, and public space. The indirect benefit can be identified by public health, environmental quality, and economic prosperity.

Table 2. 1 Parameters of Economic Benefit in Transport Improvement

Goal	Potential Metrics
Safety	▪ Crashes and injuries for motorists, pedestrians, and cyclists ▪ Traffic speeds
Access/ Mobility	▪ Volume of vehicles, bus passengers, bicycle riders and users of public space ▪ Efficiency in parking/loading ▪ Traffic speeds
Economic Vitality	▪ Number of businesses; employment ▪ Retail sales; visitor spending
Public Health	▪ Minutes of physical activity per day ▪ Rates of obesity, asthma, diabetes, etc.
Environmental Quality	▪ Air quality; water quality ▪ Urban heat island; energy use
Livability/ Quality of Life	▪ User satisfaction ▪ Public space usage

Source: NYCDOT, 2013

2.5 STREET/ROAD IMPROVEMENT AND ECONOMIC VITALITY

Urban streetscape is generally dominated by the retailing/commercial activities. A study by Meisel (2010) finds that urban businesses consider the streetscape as an important factor in attracting customers or tenants. Previous understanding of the business owners think that majority of their customer use private motor vehicle, which means by reducing accessibility of car will decrease their customer. The study found that it is not entirely correct. Surprisingly in dense area, the study finds a significant proportion of customers arrive not by car but by active transport modes such as walking, bike, and public transport.

Another study also found that improving accessibility and facility to pedestrian and bike user increases those user visits and cumulatively spend more per capita at local business (Stantec

Consulting, 2011; Transportation Alternatives, 2012; The Clean Air Partnership, 2009; Schaller Consulting, 2006; Clifton et al., 2012). Some research also finds that shopper often indicates that they would like to visit more often if the enhancements are made to street environment (Schaller, 2006; The Clean Air Partnership, 2009).

Those studies show that road design merely contributes to the visitor's retail spend and retail sales, which are two of the economic vitality parameter. Not all of studies show the positive impact of street improvement. A study in Vancouver by Stantec Consulting (2011) evaluate the economic implications of two-way separated bike lanes results in showing the negative business impacts. It was a comprehensive survey but based on self-reported data, which found to have a bias (NYCDOT, 2013).

Most of the research are based on the survey form, qualitative and lack of comprehensiveness. Those studies also do not compare before and after improvement, which is essential to see the effect of improvements. Until the research conducted by the NYCDOT (2013), using the accurate, detail, relevance with comparing times and locations, able to show the quantitative positive relationship of street improvement and local business particularly the retail sales. This research proves that the street which is safer, more inviting, and sustainable is rarely detrimental to local business. Otherwise, it will bring more profit to them and increase the local economic vitality.

2.6 STREET/ROAD IMPROVEMENT AND LIVEABILITY

Shaftoe (2008) mention liveability as deals between appropriation of public realm and the individuals using its spaces. The deals can be formed as people’s relations, readings, feelings, uses, and experiences of the space through the interaction of functions and space, which contributing to the urban life. Moreover, Rasmussen et al. (2011) explain what components in affecting the use of place consisting of sense of place, identity, inclusiveness, and feeling of safety (see Appendix 20).

Research by CABE (2000) find about 85% of respondents felt the quality of public space and the built environment affect their lives directly and the way they feel. Street/road as one of public space, reflecting the environment quality of the areas, used by people consistently.

The interaction between people and environment will create the liveability and further could affect the behaviours and activities in that place.

Transport is well-known to cause adverse impact on the built and natural environment (TRKC, 2009), and also to human health. The main problem caused by transport are diminution of resource use, climate change, waste, air pollution, noise and related vibration, land take, and water impacts (Banister et al., 2000) (see Appendix 5).

Transport will affect the street/road environment where people live and interact in the daily activities. Moreover, this will affect the uses of public realm, which further able to influence their perception, behaviour, and response.

2.7 STREET CAFES AND RESTAURANTS

According to the street function, street cafes and restaurants is not just about the retail activities anymore. It should be looked holistically as part of the public realm. It is the place where people are drinking, eating, while relaxing, enjoying the sunshine, meeting people, watching the world by (Oosterman, 1992 cited in Montgomery, 2007). Individuals who dwell in the street cafes and restaurants have more interaction with the streets, enjoy the entertaining force of the streets as the main attraction (Oosterman, 1992 cited in Montgomery, 2007), offering one of the delights of urban life (Gehl, 2001).

In street cafes and restaurants, consumer behaviour is influenced by many factors, and street condition is one of them. It does not depend on the quality of retailer only, but broader it also depends on the quality of the areas, which further can describe the liveability and economic vitality. In street cafe and restaurant, people looking for broader function such as enjoying the street. Therefore, the environment of the street/road should be designed as comfortable as people would like to enjoy it. This research will focus on air pollution and noise variable as part of atmospheric environmental variables, to understand how it affects their consumer behaviour.

2.8 DWELL TIME AND ADJOINING RETAIL SPEND

Bohl (2014) defines dwell time as a time customer spent in shops and restaurants, as measured by the time they arrive and exit. There is still lack of research trying to search more to the relation of dwell time and retail spend because dwell time is more depends on the customer itself. Mehrabian and Russel (1974) cited in Donnovan and Rossiter (1982) predict that the increase dwell time may effect on the increasing retail spend. Bohl (2014) found the positive link between dwell times and retail spend consumer in airport. However, this study only analyses the people who already bought something previously. It should be noted as well that it the term "shopping to kill time" often used to shop at the airports (Crawford – Melemar, 2003) and may have different results if it applied to another place.

2.9 INDIVIDUAL PERCEPTION OF AIR POLLUTION

Research about people's perception of air quality has been started since the 1960s and 1970s (Brody, 2004) with the main aims to understand the awareness and the factors in shaping it. Nowadays, the interest of study is changing, which tend to seek the relationship between pollution and its health effects. Improved air quality measurement technology can help to gain more data accuracy.

From some studies, it is found that people who live in extremely high-polluted area were not aware of the air quality (Kirkby, 1981 cited in Brody, 2004; Auliciems and Burton, 1970). For instance, Dworkin and Pijawka (1982) noted the insensitivity of public perception to the air quality change, which occurred in 1967 and 1978. A study by Johnson (2002) also found no correlation between measured and perceived air pollution on the day they are surveyed. Some research able to show the relationship, but it more based on location differential, for example, urban centre vs rural areas or the proximity to the industrial area (Elliott et al., 1999; De Groot and Samuels, 1966; Irwin et al., 1999).

Researchers try to find the possible reason for that disconnect relationship. First, "halo effect" tend to be found in perception data, where individuals hesitant to attribute their neighbourhood as highly polluted area (Bickerstaff and Walker, 1999; Rankin, 1969; De Groot, 1967; Schusky, 1966; Francis, 1983; Brody et al., 2004). Residents believe that their area is less polluted than surrounding areas. This halo effect confirmed by Bickerstaff and

Walker (1999) when they study the inhabitants in Birmingham, England where residents were reluctant to recognize the poor air quality and mention other factors that were shaping perceptions of air quality. Alternative explanations were stated, such as environmental perception are determined by the direct sensory experience. Since people unable to see and smell, they refuse to accept the environmental risk in their neighbourhood (Brody et al., 2004)

Second, some studies also found that people perception of air quality more based on locations area (Day, 2007; Brody et al., 2004; Bonnes et al., 2007; Howel et al. 2002), found strong correlation that people who live close to industrial area tend to concern about air quality rather than residents live further. Some research also noted the different perceptions of rural and urban dwellers, where rural residents less concerned and perceived lower level of pollution compared to urban residents (Tremblay and Dunlap, 1978; Lowe and Pinhey, 1982; Freudenburg, 1991; Liu, 1996; Wakefield et al., 2001; Brody et al., 2004).

Third, literature show, in comprehensive scope, air quality perceptions also influence by social and culture thing such experience, behaviour and economic status (Phillimore et al., 2000). Howel et al. (2002) present that older residents were significantly perceived air quality as low because they may have experienced severe air pollution and the improvement in the past (Tiefenbacher and Hagelman, 1999). The correlation between income and perception is inconsistent. Liu, (1996) and Wakefield (2001) explain that person with higher income tends to be more concern about the risk of air pollution. Otherwise, Bickerstaff and Walker (1999) found that low socioeconomic status groups also identified local air quality as worse than the rest of the city.

Race and equity issues become a great attention, although it is still rare and need further studies. Non-white minorities who lived closer to air pollution sources tend to rate air quality as poor than white people (Johnson, 2002). Influence of media become one factor shaping people's perception (Slovic, 1987; Elliot et al., 1999; Brody et al., 2004). Some studies also found that perceptions of air pollution will be different because the different sensitivity caused by the health status (Brook et al., 2010, Nikolopoulou, 2011).

Brody (2004) affirm that no pollutants consistently drive air quality perceptions. Some studies have tried to prove the relationship of particular pollutants which is become a big

concern to human health; Particulate matter. Paas et al., (2016) find that there is no connection between $PM_{(0.25-10)}$ with park user perception about air quality. Research by Nikolopoulou (2011) able to show the correlation between measured and perceived air pollution, that show association between PM count to the air clean and air quality. However, the study is lack of high air pollutant data and therefore high PM concentration does not follow the trend. This research will not be reliable for the high-polluted air.

In summary, it is not possible to identify relationship between perceived and actual levels of pollutants. Since the perceptions of people will affect the use of space and their consumer behaviour, this study will try to understand whether perception air pollution will affect their dwell time and adjoining retail spend directly and indirectly.

2.10 INDIVIDUAL PERCEPTION OF NOISE

Noise is defined as unwanted sound at the psychological level (Shepherd et al., 2010) that composed of several sources of sounds. The assessment of noise exposure is based on the observer itself, which then refers to the concept of noise sensitivity. Noise sensitivity is described as stable personality trait reflecting the tolerance attitudes towards a wide range of environmental sounds (Zimmer, 1999; Ellermeier et al., 2001). The research shows that there is no correlation between noise sensitivity and demographic characteristic, other than age (Taylor, 1984; Weinstein, 1978).

A study by Yang and Kang (2005a) confirms that there is a correlation between perceived and measured sound level. However, the studies found considerable factors between subjective and objective evaluation: there are other considerations on people tolerance to noise exposure from the different sound sources (Yang and Kang, 2005a; Miedema and Vos, 2003; Job, 1988; Davies et al., 2013; Ellemeier et al., 2001) which further can be mentioned as the soundscape concept. Schafer (1993) introduce soundscape concept, a concept beyond the noise level judgment. It is defined as the perceptual effects of the acoustic environment, which consider human experience and characteristic personal dimension.

Soundscape affects people judgment of noise; therefore it is more suitable to assess rather than sound level. Moreover, in outdoor environment, there are a lot of sound sources; wanted and unwanted ones. There are a lot of factor affecting the soundscape judgement

such as visual appearance (Adam et al., 2006), type of activity (Yu and Kanga, 2008), the listener's personal history and expectations, emotional content and culture (Dubois et al., 2006) and age (Yang and Kang, 2005b).

There are several soundscape classifications, the most common categorized into 3 types: natural, human and technological (Payne et al., 2009). Natural sound tend to be perceived as positive (Nilsson, 2007), technological sound as negative components (Guastavino, 2006; Nilsson and Berglund, 2006; Carles et al., 1999), and human sounds as neutral related to pleasantness (Dubois et al., 2006; Nilsson and Berglund, 2006; Viollon and Lavandier, 2000).

CHAPTER 3: METHODOLOGY

3.1 INTRODUCTION

The primary objective of this research is to understand the impact of air pollution and noise to people's dwell time and adjoining retail spend in outside cafés and restaurants. Quantitative and qualitative data were gathered through an on-site survey on 6, 7, and 8 July 2016. Both data were collected because it has its own benefit; quantitative data can provide the real and accurate from large participants, while perception or qualitative data can gain more depth information. Dwell time, air pollution, and noise were gathered with the qualitative and quantitative method, while retail spend collected by qualitative method only. Quantitative data were gained by video recording, air pollution measurement, and noise level measurement. Qualitative data were collected by internet-based questionnaire using Bristol Online Survey (BOS).

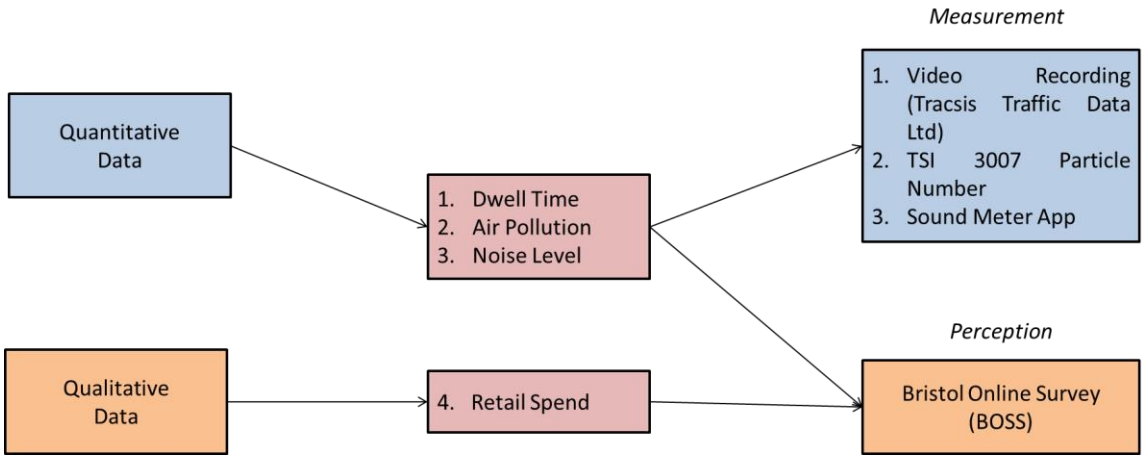


Figure 3. 1 Data Collection Type

Source: own work

The survey, carried by two postgraduate students, was taking place on three different streets in London which dominated by cafes and restaurants. The locations were selected based on TfL's Road Task Force street types (see Appendix 6), which categorize by "movement" and "place" function. All the three roads are in Central London, which identified has the similar "place" function yet different "movement" function. "Movement" function is defined by traffic volume on the streets, initially based on the observation.

The observation supports by the road layout, which shows the capacity and level of service on those three roads. The sites chosen consist of Exhibition Road with a low/very low traffic, The Cut with Medium Traffic, and Upper Street with high traffic. The last consideration of choosing the location is to find the identical type of cafes and restaurant to minimize the different gap of dwell time and retail spend on those streets.

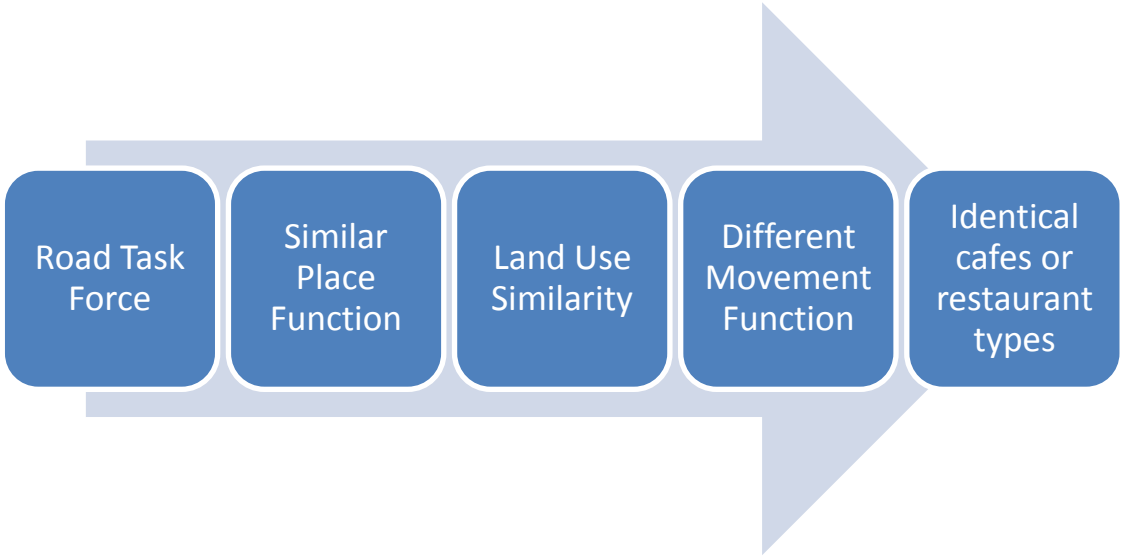


Figure 3. 2 Location Selection Phase

Source: Own work

Survey was carried on in the summer, consider as the best temperature for people to dwell outside. Furthermore, using the Met Office and BBC Weather forecast, three days with similar weather condition can be decided: sunny and almost no rain. This weather condition is a crucial consideration because the weather will be the most significant factor in affecting people behaviour in outside places. Both location and weather condition become the most important factor to minimize the bias of the data collection.

Afterward, the data are input and synchronized together. Using R software, Excel, and SPSS the data will be analysed to find the pattern, correlation, and coefficient regression to test the hypotheses emerged. Lastly, to see how the impact of the environment on the dwell time and retail spend, hypotheses will be applied. The phase series described as graph as follows;

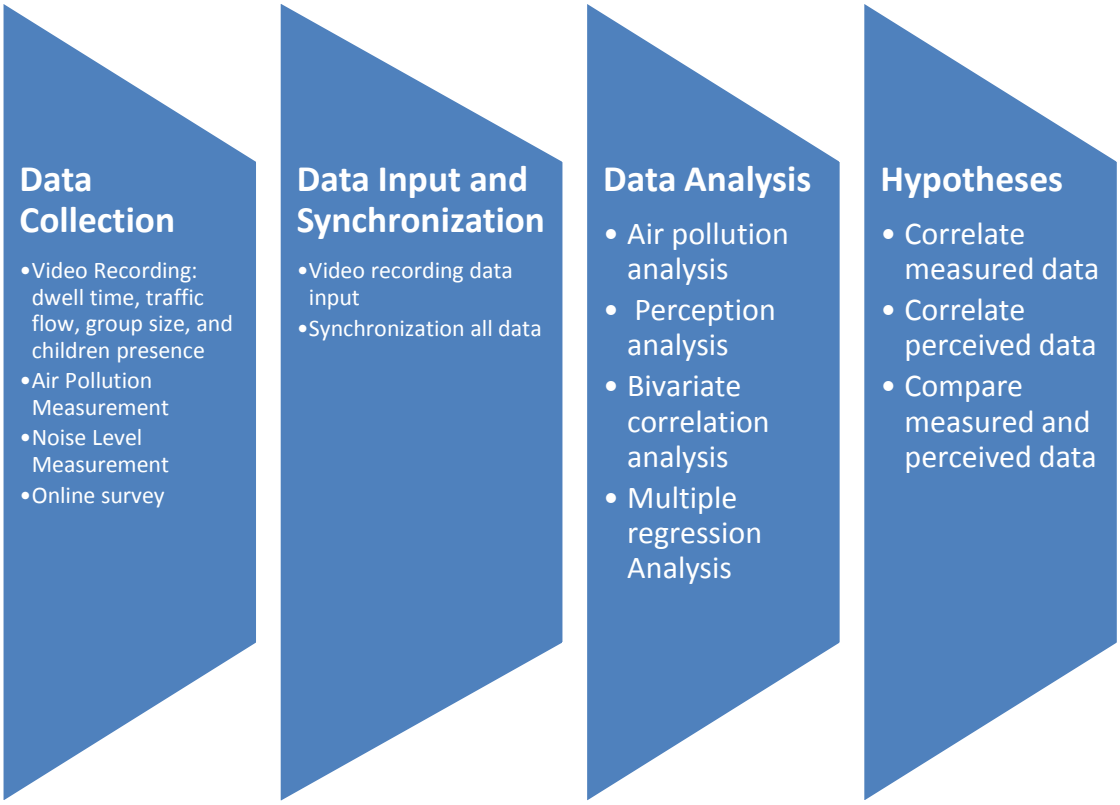


Figure 3. 3 Methodology Phase

Source: Own Work

3.2 DWELL TIME AND RETAIL SPEND

The Economic benefit of street improvement has a broad definition, both direct and indirect. NYCDOT (2013) set comprehensive parameters which, relevant to measure the economic benefit of the sustainable street: dwell time and adjoining retail spend are part of it.

Dwell time is the indicator of user satisfaction using the environment of the place. Atmospheric environment of the site are shaped by a lot of factors, air pollution and noise are part of those. Dwell time and retail also spend suitable to measure customer's response on retail activities and uses of public space in this study. Therefore, these variables are chosen to identify the economic benefit of TfL transport investment.

3.3 ULTRAFINE PARTICLES

It has been mentioned before that road transport becomes the primary source of air pollution in urban areas. Motor vehicles are known to emit pollutant and gasses such as

carbon dioxide (CO2), carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), mobile source air toxics (MSAT), and PNC (Health Effects Institute, 2010). Although a lot of studies show the effect of NOx and PM to human health, nowadays, researchers find a more relevant correlation between UFP and health hazards (Wang and Zhang, 2009; Tsang et al., 2008).

UFP is a tiny particle <0.1 µm, which able to avoid alveolar clearance (Jacques & Kim, 2000), penetrate the pulmonary interstitials and blood capillaries which potential to cause respiratory and cardiovascular diseases (Cowie et al., 2015; Sioutas et al., 2005). Campa and Castanas (2008) explain that exposure of UFP can cause pulmonary infection, asthma, bronchitis, increase the risk of heart attacks, and lung cancer.

In the urban environment, road traffic is the primary source of UFP (Oberdorster, 2001). It occurs as unburnt fuel and incomplete combustion (Klems et al., 2011), tires and brakes, resuspension of road dust (Health Effect Institute, 2010), vapours and chemicals atmospheric transformation (Sioutas et al., 2005). A study by Klems et al. (2011) found the strong correlation between poor health and exposure to UFP from vehicle exhaust.

Since UFP show the most definite correlation with urban traffic pattern, it has high potential to measure air pollution as an impact from transport activities. While UFP is also more relevant to human health effect, the UFP measurement will gain more advantage in identifying the quality of life people using public space. Further, while UFP constitutes about 90% of particulate number concentration (PNC) (Sioutas, et al., 2005; Sturm, 2000), this research will measure PNC in order to assess the UFP level in three chosen environment

3.4 DATA COLLECTION

This research involves human participant, therefore gaining informed consent, ensuring, appropriate anonymity and data protection for respondents are the critical issue. In order to gather dwell time data through video recording, the video camera will be set such a resolution and cameras placed at a height so that individual people can not be readily identified. Moreover, at no stage will anyone in the dwell time data transcribed from the video be individually identified, and anonymity will be preserved. Notices will be placed on

the street to inform people about the research being undertaken and that this involves video recording, and that individual will not be identified.

In the online survey, participants are asked for their consent to be involved and provided by information about all activities on that day including the video recording of the street. All the response from the participant will report anonymously and won't be individually identified. The data will be stored securely on university servers. Risk assessment and ethical review from the University of Leeds has been gained before the on-site survey was conducted.

3.4.1 VIDEO RECORDING

Video recording was carried out by Tracsis Traffic Data Ltd., associated professional providing services for data capture, reporting, and source optimization problems (Tracsis, 2016). The camera start every day at 06:30 – 19:00 from 6 – 8 July 2016. The main aim of video recording is to capture the dwell time data of the customers. The video also captured other information related to the place and customer. Therefore, other data can be gained such as group size, children presence, and traffic flow that further will be used in the analysis.

Table 3. 1 Summary of Video Recording Sampling Days and Times

Date of Sample	Site of Sample	Video Recording Sample Time
6 July 2016	The Cut	06:30 – 19:00
7 July 2016	Exhibition Road	06:30 – 19:00
8 July 2016	Upper Street	06:30 – 19:00

Source: Own work

The cameras were put in the lamp post and traffic light post. The location of camera will be shown in the figure as follows;

1. The Cut

The camera was placed upon one of the lamp posts on the north side of the Cut street opposite to the observed cafes/restaurants. The camera location is noticed with the red circle in the picture below. Two cafes/restaurants seen on this street are Café Nero and Pret a Manger.

Figure 3. 4 Camera Location and Cafes/Restaurants Observed on The Cut

Source: Google Map, 2016

2. Exhibition Road

The cameras were placed in two different places; one was on the traffic light post across the intersection, and other was in the lamp post in the middle of exhibition road itself which shows in the picture below. There are total 2 cafés/restaurants observed in the Exhibition Road consist of Roots & Bulbs Café and Fernandez & Wells.

Figure 3. 5 Cameras Location and Cafes/Restaurants Observed on Exhibition Road

Source: Google Map, 2016

3. Upper Street

The cameras were located in two different places, one camera is on the east side, opposite to the cafes/restaurants, and the other one is on the west side, adjacent to the cafés/restaurants. There are 3 cafés/restaurants observed which consist of Costa, Tenshi, and Radicals and Victuallers.

Figure 3. 6 Cameras Location and Cafes/Restaurants Observed on Upper Street

Source: Google Map, 2016

3.4.2 AIR POLLUTION MEASUREMENT

Air pollution measurement was carried out using TSI Model 3007 handheld CPCs which able to assess Particle Number Concentrations (PNC) in the size range of 0.01µm to above 1.0µm (TSI, 2012). TSI 3007 CPC is portable equipment (TSI, 2012) making it suitable for measurement in different locations. Equipment is able to count by using continuous Isopropyl alcohol with concentration accuracy more or less about 20% (TSI, 2012). PNC data was collected to represent the environment quality of three different locations.

The measurements were carried out on 3 various roadside conditions on 3 different days. Background level also measured on the 7th floor of Palestra Building, Southwark on those 3 days. The roadside measurement was recorded per second to get more accurate data, while the background measurement has been registered per minute in order to minimize the memory use. The measurements were supposed to be taken during the morning until the evening start from 08:00 am until 19.00pm. In some phases, it was not possible to collect the data because of some limitations.

Table 3. 2 Summary Air Pollution Measurement Sampling Days and Times

Date of Sample	Site of Sample	Roadside Sample Time	Background Sample Time
6 July 2016	The Cut	09:48:51 – 12:11:14	08:51:05 – 13:45:05
		12:41:30 – 15:24:51	15:12:01 – 19:00:01
		16:00:44 – 19:00:00	
7 July 2016	Exhibition Road	10:23:46 – 15:50:02	08:19:10 – 13:40:10
		16:28:55 – 19:00:00	14:58:04 – 19:00:04
8 July 2016	Upper Street	11:28:31 – 14:52:21	10:18:05 – 16:38:05
		15:05:11 – 17:54:57	17:12:58 – 19:00:58
		18:22:35 – 18:59:52	

Source: Own work

The equipment was located near to the observer and close to the traffic activities. Considering the long hours of measurement, seating place should be provided without

reducing the accuracy of air pollution results. The equipment was put in strategic places as follows;

1. The Cut

The equipment was put on the bench close to the road and the Pret a Manger, which is shown in the picture below. Since it was very close to the cafes/restaurant, it has the better accuracy in reflecting UFP exposure to the customer.

Figure 3. 7 TSI 3007 Location on The Cut

Source: Google Map, 2016

2. Exhibition Road

The measurement tool was placed in the middle of the road, in the median island. The function of the central island is not only to separating vehicle traffic and pedestrian but also it uses as a seating place by the people who visit the Exhibition Road. The distance from the traffic tends to be similar to a distance to the cafes/restaurant, whereas it is in the opposite of the cafes/restaurant. The PNC exposure may differ but not at significant level.

Figure 3. 8 TSI 3007 Location on Exhibition Road

Source: Google Map, 2016

3. Upper Street

The measurement was located next to the bus stop on Upper Street. There is some distance between the measurement and cafes/restaurant. It also located opposite to the cafes and restaurant. The exposure may be in different level but not significant.

Figure 3. 9 TSI 3007 Location on Exhibition Road

Source: Google Map, 2016

3.4.3 NOISE LEVEL MEASUREMENT

Noise level measurement carried out simultaneously with air pollution measurement. It was conducted using Sound Meter application for Android installed on the tablet, putting close to the air pollution equipment. The Sound meter able to measure environmental noise in decibel (dB) with the maximum values ~90 dB (Google Play, 2016). Using the sound meter application, hourly mean, hourly maximum, and hourly minimum also being reported. The measurement supposed to be taken during the morning until the evening start from 08:00 until 19:00 but due to some limitations, it was not possible to collect all the data at those time.

Table 3. 3 Summary Noise Measurement Sampling Days and Times

Date of Sample	Site of Sample	Video Recording Sample Time
6 July 2016	The Cut	10:00 – 15:00
		16:00 – 19:00
7 July 2016	Exhibition Road	10:00 – 19:00
8 July 2016	Upper Street	11:00 – 19:00

Source: Own work

3.4.4 ONLINE QUESTIONNAIRE

Online questionnaires were launched on 4 July 2016 with three different links for each site and five main sections with total 23 questions (See Appendices 1, 2, 3). It was distributed at a certain date and certain place based on the schedule from 6-8 July 2016. The links to the online questionnaire were printed in the small size of the paper and were distributed to the customer of Cafés and restaurants along those roads. One shopping voucher worth £50 was offered for prize-draw to incentivise respondents and enhance respond rate.

The customer targeted are mainly those who visit the recorded cafes/restaurants because they are more able to be observed. Otherwise, other visitors from other cafes/restaurants on those streets also asked if possible. The pieces of paper are spread when people finish their activities in the cafe/restaurants so that it won't affect to their dwell time and won't irritate the business operations and customer itself. The primary purpose of the online questionnaire is to gather perceived data of air pollution, noise level, dwell time, and retail spend.

Table 3. 4 Summary of Questionnaire Design

Section	Page	Question Topics
Introduction	1	Research aim, ethics rule, and consent question
Personal Questions	2	Age, gender, and employment status
Activities	3	Café/restaurant name, purposes, seating place, arrival time, leaving time, dwell time, group size, activities type, and children existing
Environmental Perceptions	4	Weather, air quality, dustiness, noise level, soundscape quality, pleasant and unpleasant sound, possibility to stay longer
Retail Spend	5	Individual retail spend, retail group spend

Source: Own work

3.5 DATA INPUT AND SYNCHRONIZATION

There are 4 main different data collected from the on-site survey: air pollution data, noise level data, dwell time and questionnaire data. Air pollution was reported in Comma-separated values (CSV); noise level on Excel; dwell time on excel. The customers are observed individually and are noticed with their arrival and leaving time. In putting the dwell time, several treatments should be applied. Some consideration in noting dwell time are explained as follow;

- The visitor noted only those who sit outside
- The people who sit for a long time without buying consider as the individual who wants to enjoy the street life. A visitor who only sit for the short period without buying won't be identified because most of them just waiting for other people then left afterward.
- Individuals who sit outside for a while and then move to the inside will be counted because they may get in because of the environmental factors. The people who just come and sit outside and in short period move inside won't be counted.
- The dwell time of the people who comes together, ones will take a seat while the other will go inside first to order, will be noted as the similar dwell time.

- The video only recorded until 7 PM. All the activities after that won't be counted as a data or will be deleted from the analysis
- Another data also simultaneously noted while taking note of dwell time results such as group size, traffic flow, and children presence.

Furthermore, all the quantitative data (not including questionnaire) data will be synchronized with individual dwell time, which measured in minutes. This synchronization is essential to gather accurate and exact data to be statically analysed. Meanwhile, the questionnaire is reported separately, because it won't present exact time and pollution level.

3.6 DATA ANALYSIS

The data are analysed using a different method and different software. Microsoft Excel, R software, and SPSS are used to analyse the data. Firstly, air pollution data will be analysed separately using R software to see and compare the pattern of air pollution descriptively and statistically on those three different sites. R software is used to examine the air pollution because it's more powerful in supporting the large data sets and easy to detect and fix the error (Revolution Blog Website, 2014). R software also supported by open air package, a particular package for analysis air pollution data (Openair-project Website, 2016).

Afterward, bivariate correlation analysis will be applied using SPSS software, both Pearson and Spearman Correlation. This method is the first step in determining the relationship between variables. Factors to be tested to dwell time are not limited to the noise and air pollution. Instead, it will also correlate other factors such as group size, traffic volume, humidity, temperature, location, children presence, and cafe/restaurant type. The coefficient correlation is calculated by the formula below;

$$r_P = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2 \sum_{i=1}^{n}(Y_i - \bar{Y})^2}},$$

Figure 3. 10 Equation of Correlation Coefficient

Source: Chung, M.K., no date

Furthermore, the analysis continues with the multiple regression analysis to predicts the relationship between dependent and independent variables. Regression analysis often uses as a tool to establish causality effect among variables. Multiple regression will be carried out by SPSS software because it's an advance and powerful software in predictive modelling, hence easy to use (IBM Website, 2016). The multiple regression modelling can be computed through equation as follow;

$$Y_i = b_o + b_1X_1 + b_2X_2 + \ldots + b_nX_n + e_i$$

where

Y_i is the dependent variable (estimated streamflow statistic) for site i,

b_o to b_n are the regression model coefficients determined in the analysis,

X_1 to X_n are the independent variable (basin characteristics) for site i,

e_i is the residual error or difference between the observed and estimated dependent variable for site i.

Figure 3. 11 Model of Multiple Regression

Source: (USGS Website, 2013)

3.7 HYPOTHESES

In order to understandthe the relationship search on this research, four hypotheses emerge based on the research questions. The first hypothesis will identify the relationship between actual data of pollution and dwell time. Perceived air pollution and dwell time data will be investigated in the second hypothesis. Third, it will find the relationship between perceived pollution and retail spend. Lastly, it will compare the perceived and measured pollution data to identify the correlation as well as knowing the differences between variables.

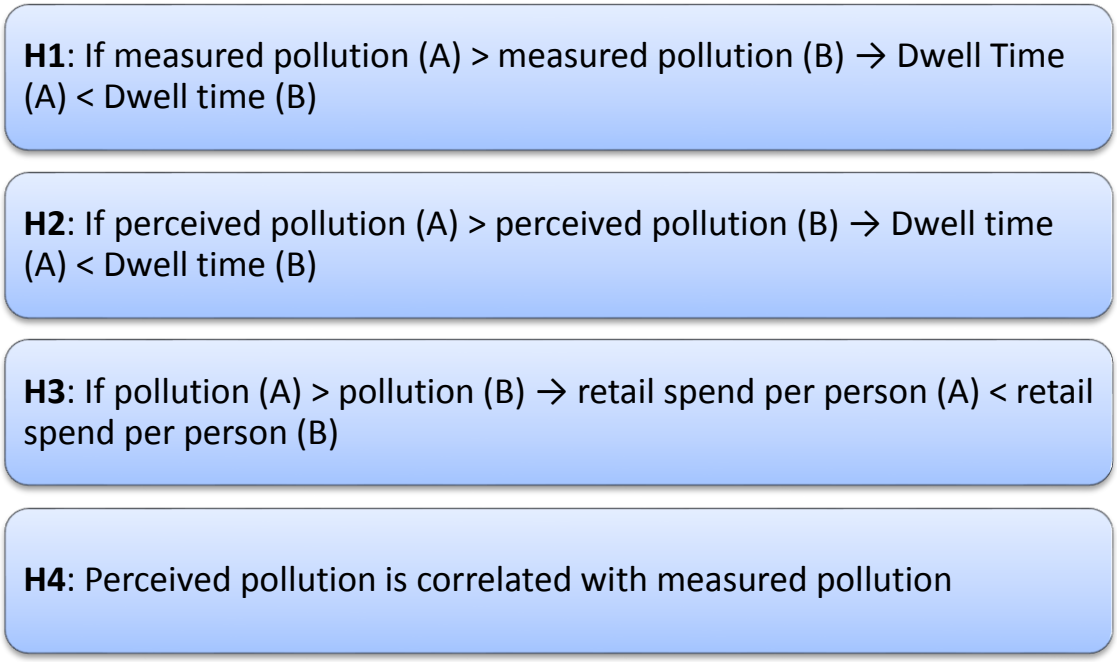


Figure 3. 12 Hypotheses

Source: Own work

3.8 LIMITATIONS

This study combines both quantitative and qualitative data to gain accuracy and deep understanding. The location was carefully chosen which has a similar typical type of cafes and restaurant. The day survey was carried on in warm weather without any rain at all. Both of the location and weather are chosen to minimize the bias.

However, regarding the availability of resources and equipments, this survey is conducted on three different days; Wednesday, Thursday, and Friday. A lot of different things could occur every day, and in this study, the results will be affected by this factor.

The online survey used in this study has an advantage in time efficiency (Lyons, et. al., 2005; Wright, 2005; Yun & Trumbo, 2000) since the survey will only gather one day for each site. Although Lyon et al. (2005) argue that quality of participants will be better, this method will be a limitation, because this study is time and place specific, where people has the disadvantage to remember the experience precisely on the different time.

CHAPTER 4: ANALYSIS AND DISCUSSION

The study investigates two primary variables consist of particle number concentration (PNC) and noise level in affecting the dwell time and retail spend. This chapter will present descriptive and statistical analysis of the variables observed from this study. The actual data will be analysed as well as perceived data. Furthermore, both data will be compared to see the connection and understanding how those relationship is affecting dwell time and retail spend.

4.1 DATA CLEANSING AND SAMPLE SIZE

There are total 503 customers observed with video recording start from 06:30 until 19:00. However, the number of samples applied for further analysis only about 355 visitors considering the data of air pollution and noise level, which start from 11:00 – 12:00.

4.2 TRAFFIC DATA

Movement function, which explains the traffic activities, is the primary consideration in choosing the survey locations. Traffic data affirms that Exhibition Road is the lowest traffic volume among the others. During that day, traffic flow in Exhibition Road accounted for only 36 PCU/hour on average. Upper Street, as expected, has the highest traffic volume with average 1307 PCU/hour. The Cut is the medium one, with average volume 685 PCU/hour on the day survey carried out.

Vehicle number in Exhibition Road tend to be steady with very low traffic around the day. There is an increase traffic since 10:00 on The Cut and before it fluctuates up and down until the survey finish. The peak of traffic activities occurs at 13:00 on Upper Street and then significantly decreased at 14:00. After 14:00 it goes up again but remain lower compared to the early afternoon.

Table 4. 1 Traffic Volume (PCU/hour)

	Passenger Car Unit		
Time	The Cut	Exhibition road	Upper Street
08:00	660	40	1233
09:00	529	31	1333
10:00	558	65	1336
11:00	674	42	1362
12:00	744	35	1382
13:00	689	39	1481
14:00	685	30	1175
15:00	708	41	1341
16:00	754	22	1289
17:00	766	33	1256
18:00	746	31	1244
19:00	704	28	1253

Source: Own Work

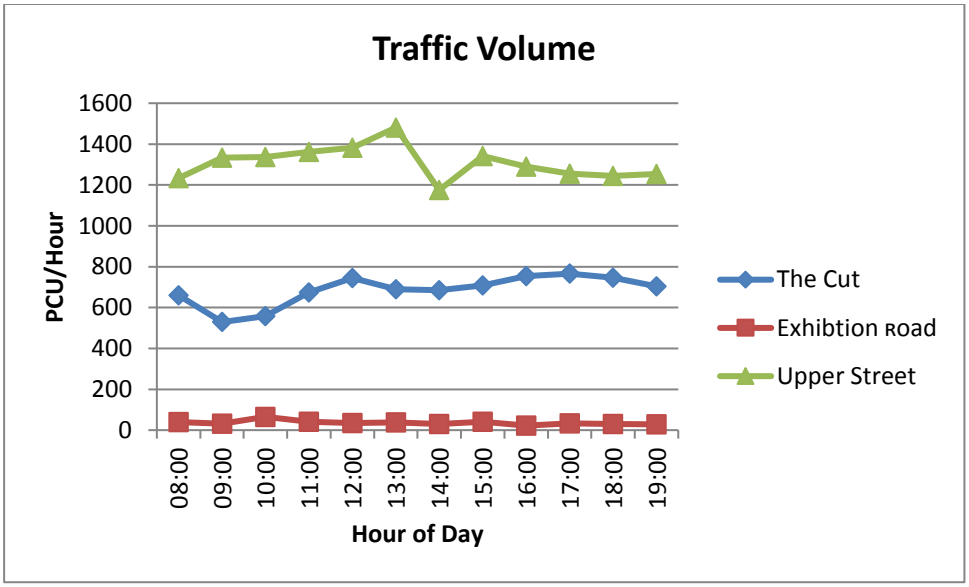


Figure 4. 1 Traffic Volume (PCU/hour)

Source: Own work

4.3 AIR POLLUTION DATA ANALYSIS

The measurement shows that The Cut has the lowest mean PNC (26458 particles cm^{-3}) with the minimum 8279 particles cm^{-3}. However, the maximum PNC is found on The Cut. The second lower PNC mean presented in Exhibition Road by 42430 particles cm^{-3} with the minimum concentration 10561 particles cm^{-3}. The highest mean PNC levels found in the

Upper Street about 48098 particles cm^{-3} and minimum concentration of 15009 particles cm^{-3}.

The measurement shows that The Cut has the lowest mean PNC (26458 particles cm^{-3}) with the minimum 8279 particles cm^{-3}. However, the maximum PNC also showed on The Cut. Exhibition Road at 42430 particles cm^{-3} with the minimum concentration 10561 particles cm-3 become the second lowest mean among others.

The highest mean of PNC levels was found on Upper Street about 48098 particles cm^{-3} and minimum concentration of 15009 particles cm^{-3}. The Exhibition Road shows the unexpected PNC results, which presents the high level of PNC even though it has the lowest traffic volume. There should be other factors causing the surprising results in Exhibition Road, which will be looked further in the analysis.

Table 4. 2 Summary of Findings from Field Sampling

		Particle Number Concentrations (particles cm^{-3})				
Date	**Site**	**Mean**	**Median**	**Standard Deviation**	**Maximum**	**Minimum**
06-Jul-16	The Cut	26458	22682	15532	282215	8279
07-Jul-16	Exhibition Road	42430	40224	16424	238872	10561
08-Jul-16	Upper Street	48098	46663	16018	225266	15009

Source: own work

PNC in The Cut tends to increase in the evening from 18:00 rather than in the afternoon, which may indicate the peak commuting hours that occur during that time. Meanwhile, PNC level in Exhibition Road seems to increase in the afternoon after 12:00 and stay stable at that level until the survey ended. The Upper Street has the highest PNC among the others in the afternoon, but the level goes down from 15:00 until 18.30. that trend may be caused by the declining traffic volume in Upper Street since 14:00 (see Table 4.1).

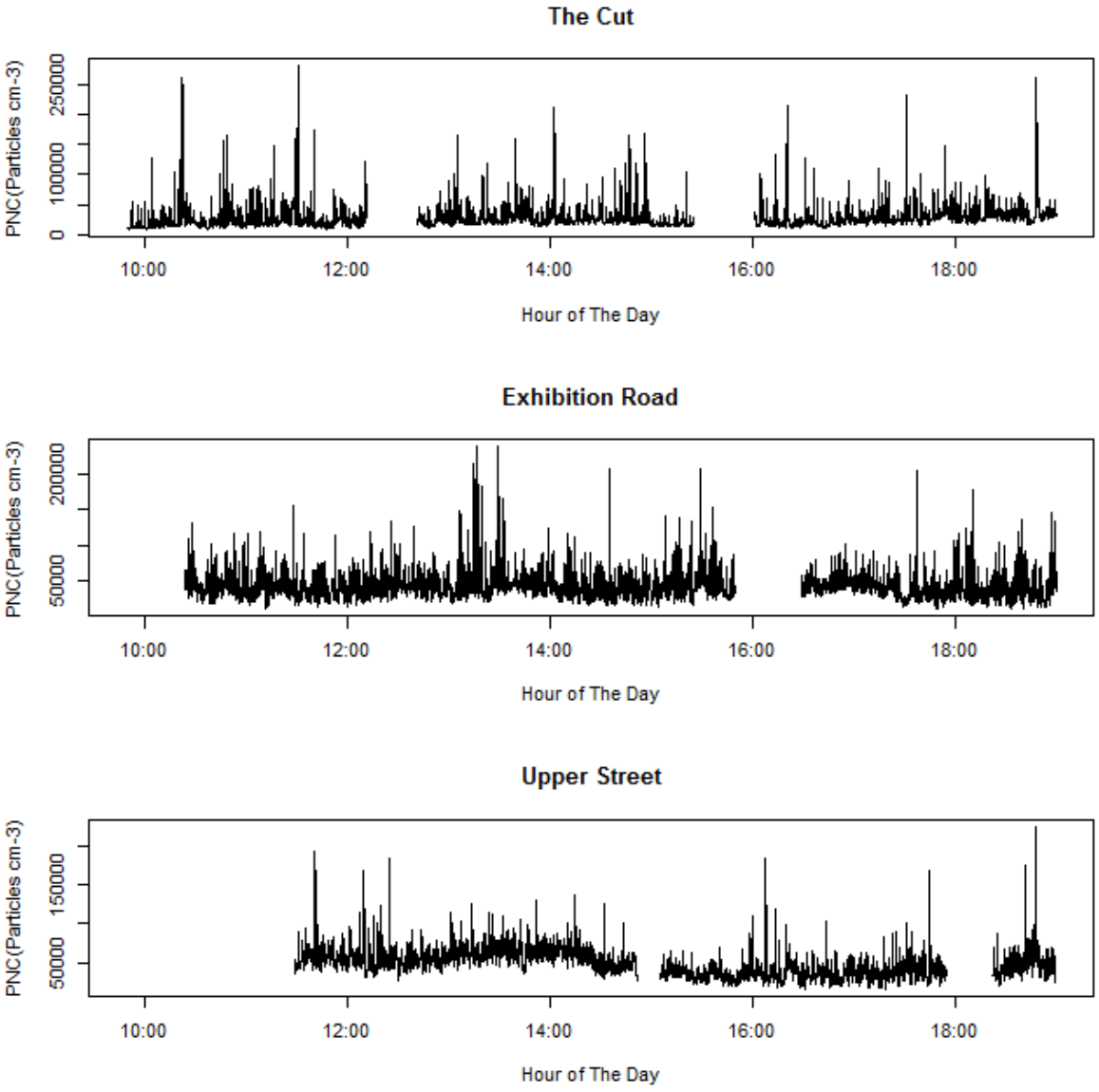


Figure 4. 2 Time Series of Roadside PNC

Source: own work

The weather conditions were mainly sunny and sometimes cloudy on 6-8 July 2016 without any rain. The temperature on those three days is likely similar from 18-22°C (see Appendix 7). The average of wind speed and humidity is the lowest at 6th July and increase on 7th July and 8th July. The meteorological data show the only modest fluctuation of wind speed and wind direction in one day (see Appendix 8). On The Cut, mostly wind come from the northwest and then from north and northeast. While in Exhibition Road, wind come from west and southwest. Lastly, on Upper Street, the wind come from West and rarely from the southwest. In all three locations, on the day wind direction was at an oblique angle to the street, this would have enhanced the street canyon effect, raising the recorded level of

particulates. However, the wind speed on day three would probably have been sufficient to reduce this effect as air circulated. This can't be confirmed exactly without an adequate wind direction data from different angles.

There are various sources of PNC; traffic is believed to be one of the primary sources in the urban environment (Sioutas et al., 2005). In order to understand the genuine traffic contribution to the PNC, background level should be subtracted from roadside concentration (Klose et al., 2009). Background levels during the field survey tend to be steady. The comparison between background and roadside level are presented in graph as follow;

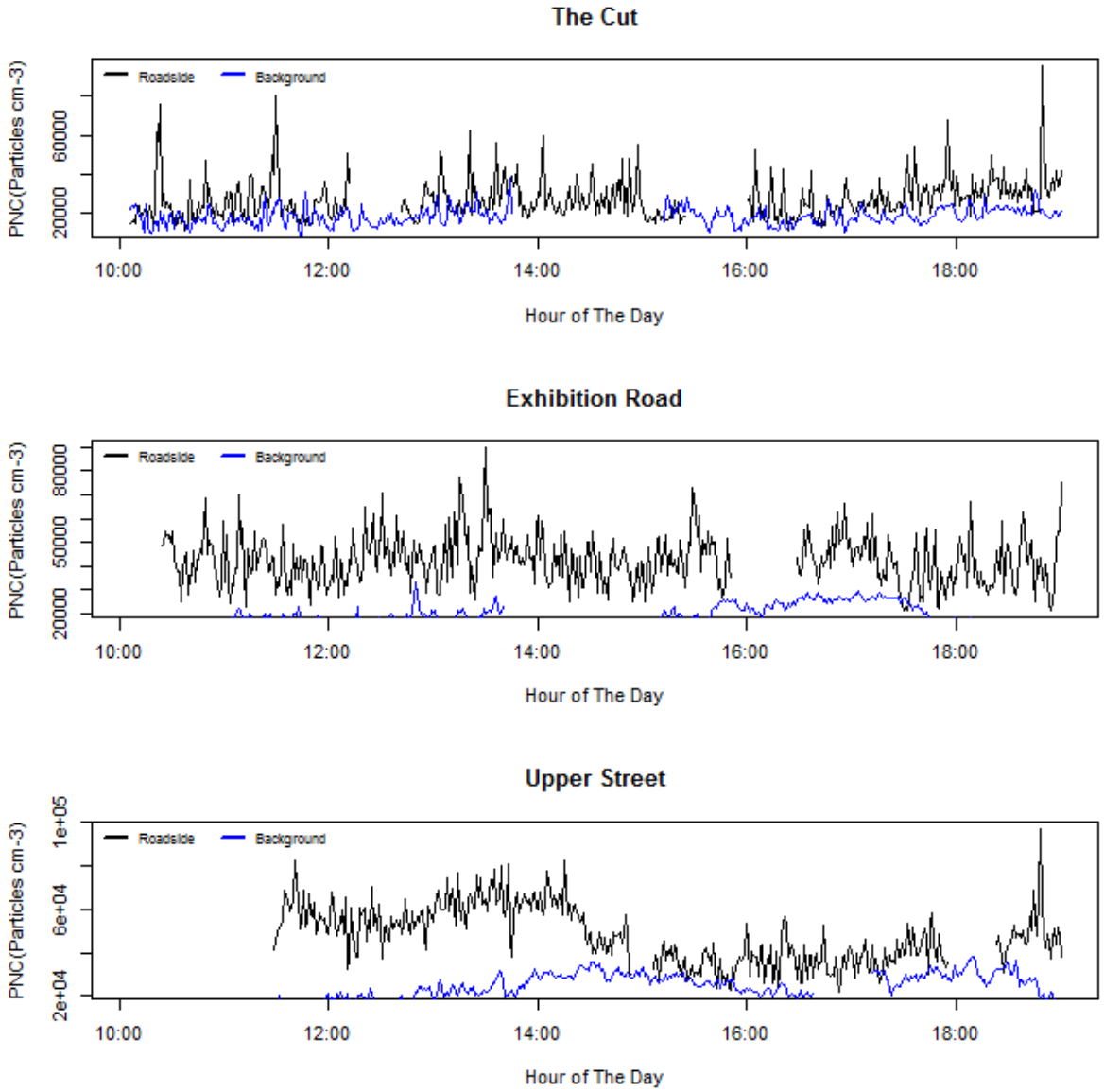


Figure 4. 3 Time Series of Roadside and Background PNC

Source: Own work

The traffic activity is likely to be the main primary source in Upper Street roadside. Upper Street is the important route (A1) with total length 330 m and has 4 lanes (Transport and Environmental Analysis Group, 2013). Meanwhile, The Cut is a busy high street with residential access and many pedestrians. It has two lanes with total road length is 340 m. Exhibition Road is a single surface road with high pedestrian usage with the road length about 590 m. The Cut is the main high street which is busy with vehicle mostly all the time, which make it become the highest roadside increment among sites.

The second highest roadside increment is on Exhibition Road, followed lastly by The Cut. The traffic activities in The Cut tend to be greater than Exhibition Road. Otherwise, the PNC level is less on The Cut. Taking into account the steady background level on those three days, this high level in Exhibition Road may be caused by the high activities of cooking from the cafés and restaurants, which is the greater source of PNC, higher than the traffic source itself (Dennekamp, 2002).

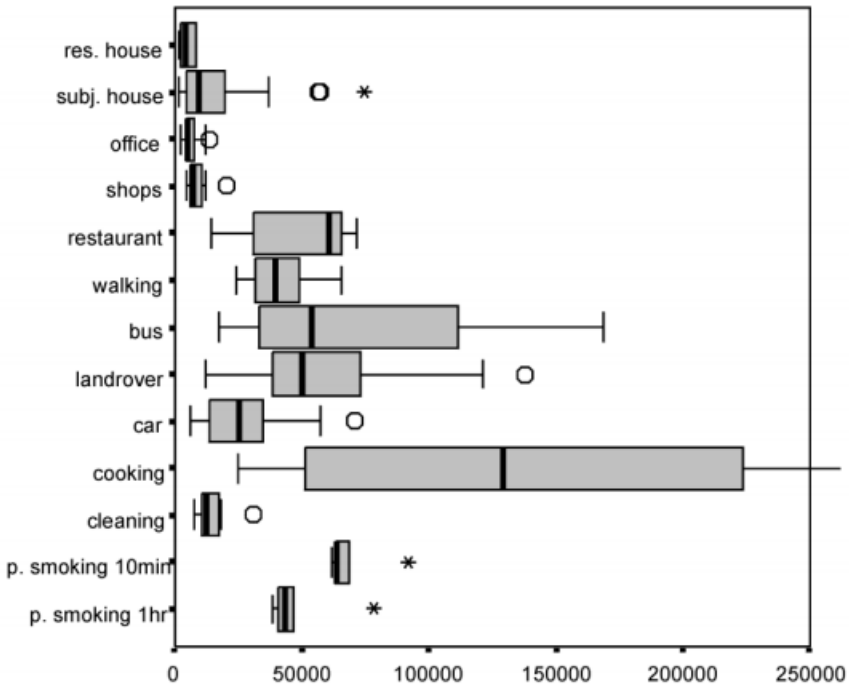


Figure 4. 4 Boxplot of particle number concentration (particles/cm^{-3}) for different microenvironments and activities

Source: Dennekamp, 2002

Exhibition Road has more cafes and restaurants along the road rather than The Cut and Upper Street, which can emit more PNC level. Moreover, Exhibition Road offers more

outside seats that allow people to smoke a cigarette, which can also contribute significantly to the PNC on the roadside environment (Dennekamp, 2002). In general, PNC level can also be influenced by the surrounding roads, but not to a significant degree (The Danish Ecological Council, 2014). Therefore, cooking and smoking activities are predicted to be the major part of the reason why PNC level surprisingly high on the Exhibition Road, whereas the traffic volume is very low.

The roadside increment data shows that the pollution from traffic on The Cut is still the lowest among the other sites. PNC level on Upper Street is the highest, but the roadside increment itself is just slightly different from the Exhibition Road. It probably caused by the meteorological factor on the third day (wind speed and direction) were sufficient to disperse pollutants quicker than on the previous two days.

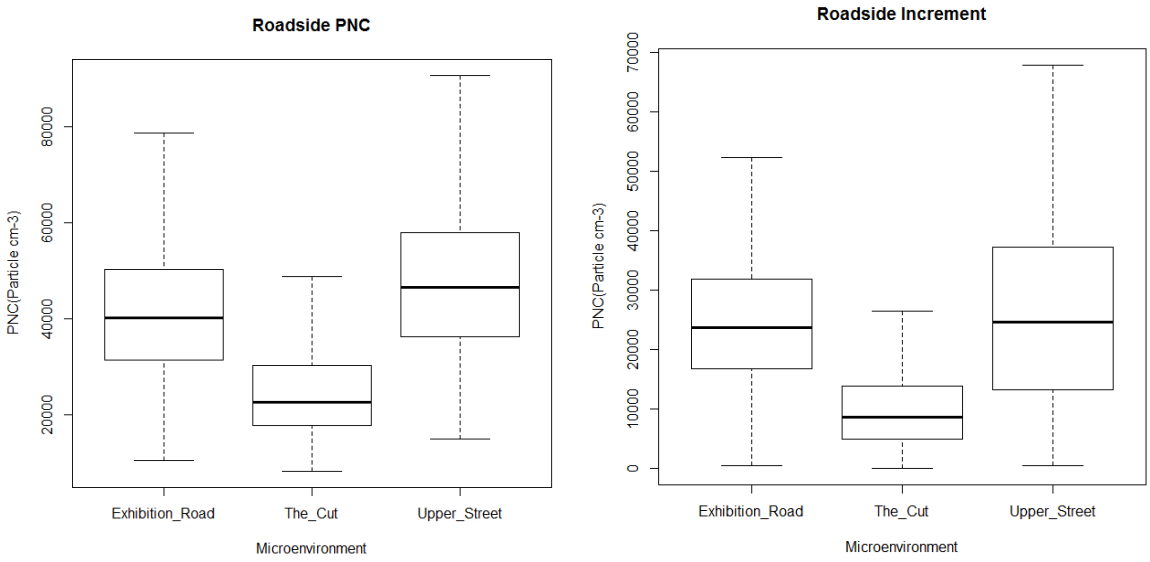


Figure 4. 5 Box Plot of Roadside and Roadside Increment (particles/cm^{-3})

Source: Own work

4.4 NOISE LEVEL DATA

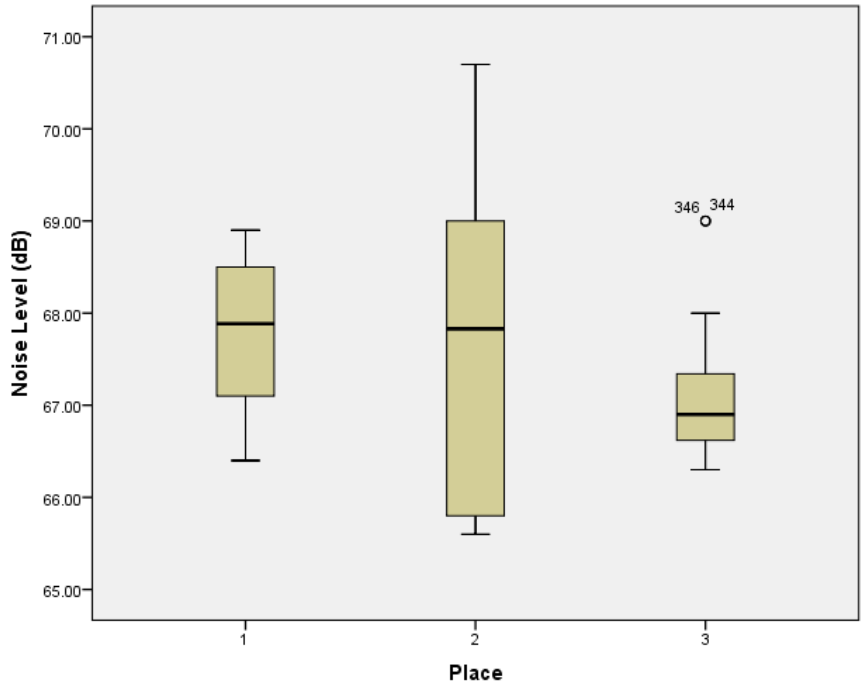
There are several sources of noise recorded in this measurement such as traffic noise, surrounding speech, footsteps, construction, music that mix into a soundscape. Traffic dominated by the noise level on The Cut. On Upper Street, the maximum noise level was caused by construction (observation) during the day and the traffic noise during the evening peak. However, data shows that the hourly mean in Exhibition Road at 14:00-15:00 was the

highest of all the sites, as well as, overall, the highest variance between the minimum and maximum level. This occurs because, through observation and video recording data, Exhibition Road is dominated by human noise (voices) close to the measurement equipment during those times.

Table 4. 3 Summary of Noise Levels

Time	Mean Leq (dB)			Max Leq (dB)			Min Leq (dB)		
	The Cut	Exhibition Road	Upper Street	The Cut	Exhibition Road	Upper Street	The Cut	Exhibition Road	Upper Street
11:00	66.6	66		84.2	82.5		52	66	
12:00	67.2	65.6	66.2		82.2	83.9		54.4	54.5
13:00	68	65.6	67.1	81.6	82.5	84.1	54.5	50.1	51
14:00	68.5	69	66.9	84.3	83	83.5	56.4	54.2	55.2
15:00	67.8	70.7	66.3	82.3	81.9	81	52.1	54.4	54
16:00		68.5	67		84.6	84.6		52.1	53.1
17:00	67.2	67.6	66.6	83.8	83.9	83.1	54.1	44	54.9
18:00	66.4	67.5	68	84.1	83.2	84.6	52.1	51.8	56.9
19:00	68.9	67	67.6	84.4	83.1	83.7	57.4	53.5	54.7
Average per day	67.58	67.50	66.96	83.53	82.99	83.56	54.09	53.39	54.29

Source: Own Work



1=The Cut; 2=Exhibition Road, 3=Upper Street

Figure 4. 6 Boxplot of Noise Level Data

Source: Own work

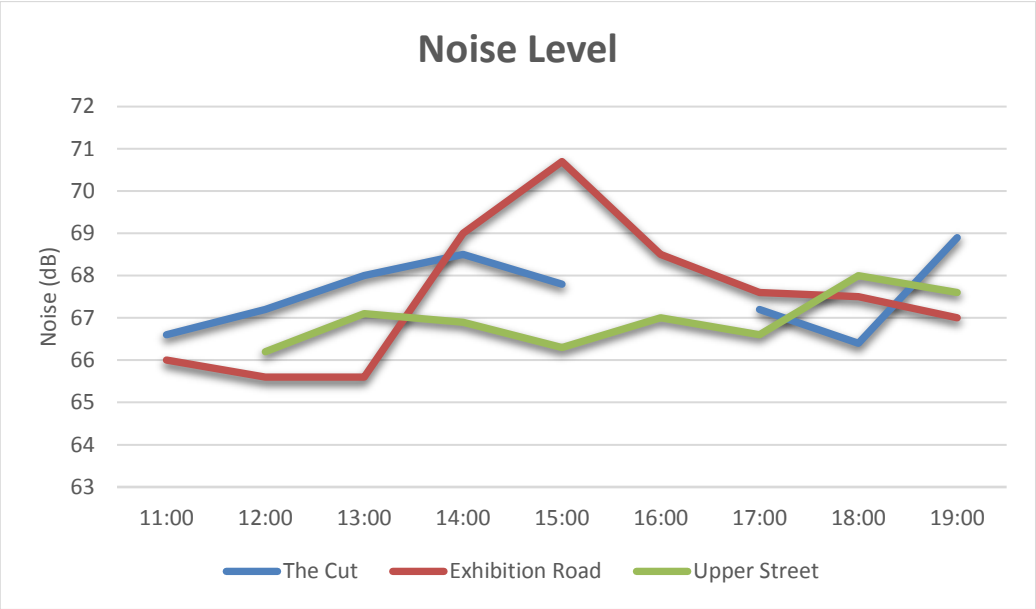


Figure 4. 7 Time Series of Noise Level

Source: Own work

4.5 DWELL TIME DATA

The Cut has the lowest average dwell time by 32.39 minutes, and then followed by Exhibition Road with 41.72 minutes. People tend to stay the longest in Upper Street, particularly in Radicals and Victuallers, which is a pub and restaurant. The second place people like to dwell longer is Fernandez and Wells, which acted mainly as a café until the evening (before 18:00) in the Exhibition road by 52.34 minutes. The shortest average dwell time is in Pret A Manger (The Cut) by only 25.31 minutes. Overall, the average dwell time people spent in all three places is 40.33 minutes. In addition, most of the people tend to stay about 30 minutes and 40 minutes (see Appendix 9).

Table 4. 4 Summary of Dwell Time Data

LOCATIONS	The Cut	Exhibition Road	Upper Street
Average Dwell Time/Place (07.00AM - 07PM)	28.97	39.87	44.02
At times when PNC data available	32.39	41.72	50.01
ESTABLISHMENTS	**Nero**	**Pret A Manger**	
Average Dwell Time per café/restaurant on The Cut	34.76	22.20	
At times when PNC data available	37.38	25.31	
ESTABLISHMENTS	**Fernandez and Wells**	**Roots and Bulbs Café**	
Average Dwell Time per café/restaurant on Exhibition Road	50.51	32.75	
At times when PNC data available	52.34	34.60	
ESTABLISHMENTS	**Costa**	**Tenshi**	**Radicals and Victuallers**
Average Dwell Time per café/restaurant on Upper Street	40.74	46.58	63.56
At times when PNC data available	46.37	45.43	63.56
OVERALL			
Average Dwell Time in All Places	37.24		
At times when PNC data available	40.33		

Source: Own work

Focusing on like for like comparison notice that the mean dwell times of Nero (The Cut), Pret a Manger (The Cut), Roots and Bulbs Café (Exhibition Road), and Costa (Upper Street) are significantly different ranging from 22.20 to 40.74 minutes. Therefore, further analysis tries to understand whether this was entirely due to the environmental variable using correlation and regression analysis. From the first observation, it shows that The Cut had the lowest mean PNC (Roadside increment), but the higher mean noise level. It also has the lowest mean dwell time. Conversely, Upper Street has the highest PNC level and the lowest mean noise level, yet had the highest dwell time. However, the comparisons are not so simple: Exhibition Road has high PNC, has the highest mean noise level, but in contrast, has high dwell time. It is hard to establish a clear pattern here, and so we examined the data at a more detailed level hour by hour using statistical analysis.

4.6 QUESTIONNAIRE DATA

The questionnaire was carried out with internet-based through online link printed in the paper. The limited number of customer captured in one day by using online survey method

become the restriction to see the pattern. There are 9 respondents in total; 2 participants in The Cut, 4 peoples in Exhibition Road, and 3 respondents in Upper Street. The analysis will show the relationship of air pollution to the dwell time and retail spend by analysing the variance of perception because it won't be amenable to statistical analysis.

1. Perceived Air Quality

People perceived air quality differently in Upper Street. About 33% of respondents perceived air quality awful, 33% respondent neutral, and 33% other stated fairly good (see Appendix 10). More people tend to perceived air quality to be not especially good on Upper Street. Meanwhile, in exhibition road, 50% respondents perceived air quality as neutral, and 25% mentioned it fairly good, 25% is excellent. From all the respondents, no one said the air quality was poor and tend to be good. On The Cut, 50% respondents perceived the air quality bad, and the 50% is good. It shows that people's perception of air quality is vary among individuals even to the similar environment.

2. Perceived Dustiness

In Upper Street, 67% respondent tend to perceive the air dustiness is neutral, and 33% evaluate it very dusty (see Appendix 11). None recognized the air in Upper Street clean. Otherwise, people's perceptions in Exhibition Road are varied, 50% tend to understand it clean, and even 25% perceive very clean, while 25% other tend to be neutral. None of the respondents recognized the air in Exhibition Road to be dusty. People in The Cut view differently, 50% clean and 50% duty.

3. Noise Level

People tend to recognize Upper Street to be noisy (33%), very noisy (33%), and neutral (33%) (see Appendix 12). It means respondents agree the noise level on Upper Street is not quiet. People also feels that the soundscape tend to be very unpleasant (33%), neutral (33%), and pleasant (33%) (see Appendix 13). From the observation, Upper Street is a noisy place which primary noise come from the vehicle and construction, which may able to explaining their judgment of soundscape and noise level.

On Exhibition Road, 50% respondent perceive neutral and 50% quiet. The perceived noise level in line with the soundscape evaluation, which indicates the place to be quiet (25%) and neutral (75%). None of the respondents perceived noise level and soundscape of the place to be noisy. Customers observed The Cut to be neutral (50%) and very noisy (50%). It doesn't match with their perception of soundscape quality, which tends to be pleasant (50%) and neutral (50%). The results indicate the inconsistency between noise level and soundscape perception, which probably caused by other factors.

4. Air Quality and Dwell Time

People's dwell times are vary according to their perception of air quality. About 11% respondents, who perceived excellent air quality, tend to stay longer (60-120 minutes) (see figure 4.8). Meanwhile, when the air is fairly good, their dwell times were shows, 22% spend more than 30 minutes, while 11% spend <30 minutes.

Neutral air quality perceptions show some pattern with spending morealso. About 22% who perceived neutral spend more time (45-60), and 11% spend less than 30 minutes. When 11% respondents think the air quality was poor, they spend less time (<30), in contrast, 11% respondents perceived very poor air quality, they tend to spend more time (60-120). It's hard to find the correlation between dwell time and air quality because several respondents who perceived the air quality as good spend less time whereas people who view air quality poor spent more time in those place. The data show no correlation between perceived air quality and customer dwell time, although the evidence is not clear and strong because of the limited respondents.

5. Noise and dwell time

Individuals who perceived it very noisy have various dwell time; 11% stayed longer (60-120), whereas 11% spend less than 30 minutes (see Figure 4.9). It also happens when participants perceived the noise level relatively quiet, they spend longer and less time. When they recognized it somewhat noisy, 11% respondents spend longer about 45-60 minutes. 44% people observed neutral have a various dwell time. Association between noise perception and dwell time 's hard to determine since the limited respondents participate in this study show no correlation between noise level and dwell time.

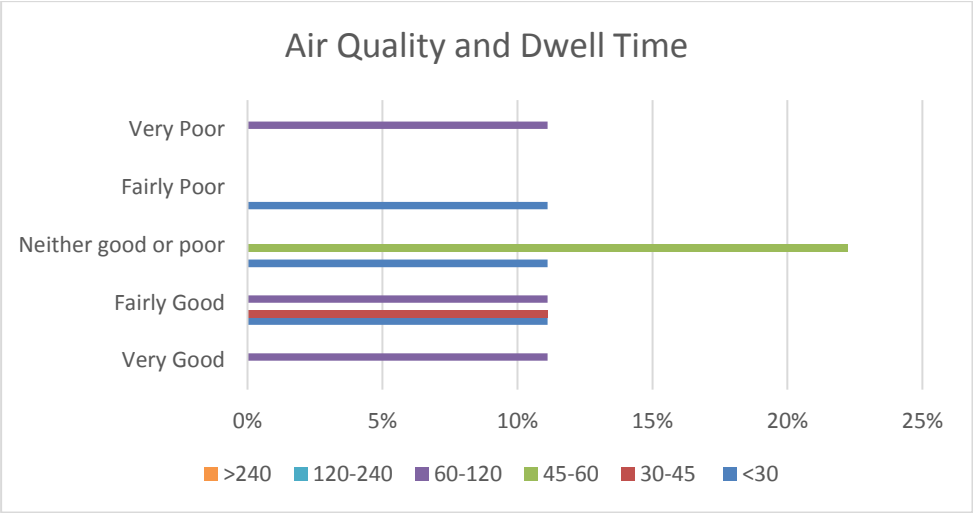


Figure 4. 8 Perceived air quality vs dwell Time

Source: own work

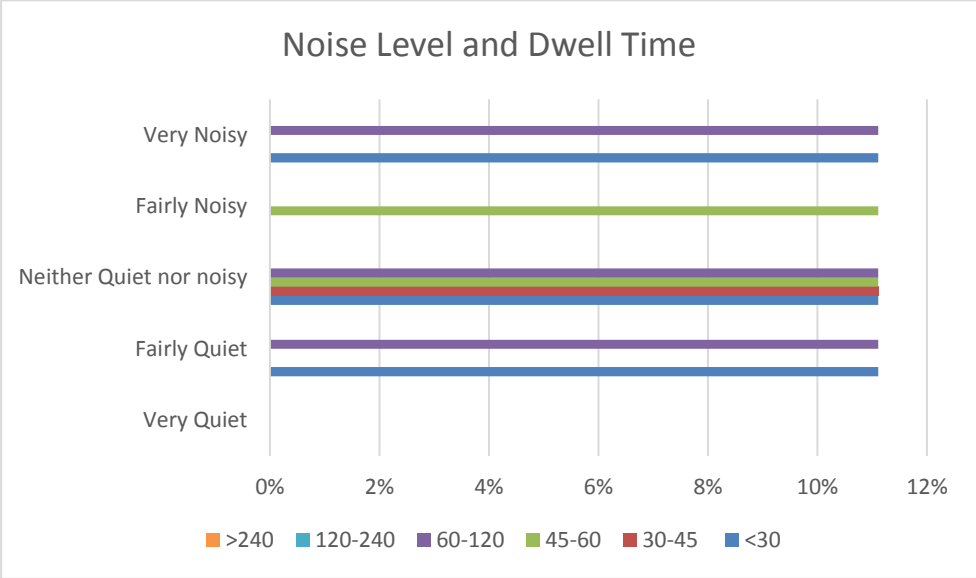


Figure 4. 9 Perceived Noise Level vs Dwell Time

Source: Own Work

6. Air Quality and Retail Spend

About 44% respondents, who recognized the air quality good and excellent, spend more money in those cafes/restaurants (see Figure 4.10). Neutral perception cause various result in customer spending, 22% spend more, whereas 11% spend less. There are two different results when they tend to recognize the air quality poor, 11% spend more, and 11% spend less. There are some unconnected results found in the relationship, although the trend

shows that good air quality perception tends to make people spend more money. The sample size is way too small to foresee the relationship.

7. Noise Level and Retail Spend

The graph shows that people tend to spend more when they perceived the air quality neutral (44%) and quiet (22%) (see Figure 4.11). If the noise level is observed noisy and very noisy, they tend to spent less about <5 compared to 5-10 pound sterling.

About 22% participants, who recognized the place quiet, spend more money (5-10 have). In contrast, 22% respondents who perceived the place noisy spend money less than 5 pounds. 11% respondents spend more when it's very loud, and 44% neutral respondents spend more money. The trend shows that customer who perceived the place noisy spend less money than who perceived not noisy.

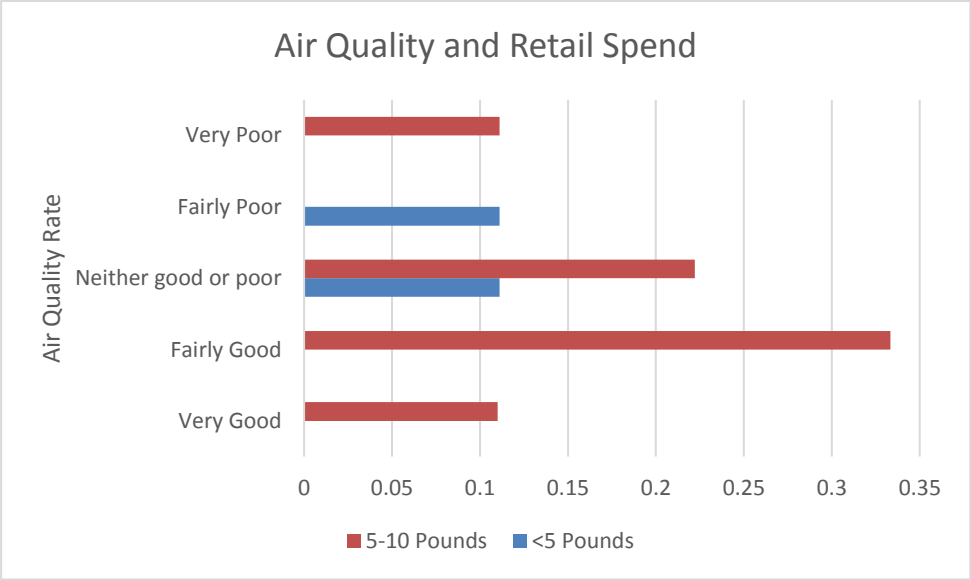


Figure 4. 10 Perceived air quality vs retail spend

Source: Own work

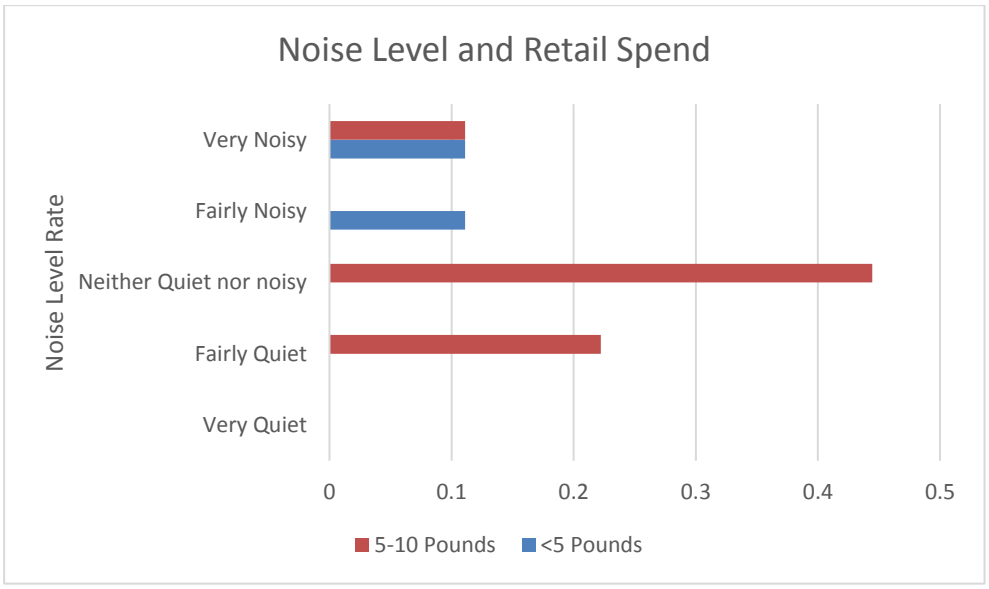


Figure 4. 11 Perceived Noise Level and Retail Spend

Source: Own works

8. Dwell Time and Retail Spend

About 11% respondents who dwell less than 30 minutes spend less money (<5 pounds), whereas 22% tend to spend more money (see Appendix 14). The graph also shows that 11% people who dwell more, spend less, and about 55% respondents that stay longer than 30 minutes spend more money about 5-10 pounds. It 's hard to justify the correlation between dwell time and retail spend since only a few respondents and variances can be investigated.

4.7 BIVARIATE CORRELATION ANALYSIS

Bivariate correlation analysis is conducted to find out whether there is a correlation between variables. It's the first phase to understand factors affecting people's dwell time in outside cafes and restaurants. It is stated before that there are a lot of factor influencing consumer behaviour and uses of public space. Therefore, it is important to identify which variables has contribution and level of contribution in driving customer dwell time. Since all the data are interval and ordinal, Pearson and Spearman correlation will be used.

Table 4. 5 Correlation Analysis for Dwell Time

Variables	Dwell Time	p-value
PNC Level	**0.161	0.002
Noise Level	-0.48	0.392
Group Size	**0.316	0.000
Temperature	**0.108	0.042
Humidity	**0.159	0.03
Children Presence	-0.004	0.941
Location	**0.248	0.000
Café/restaurant type	**0.178	0.001
PCU/minute	-0.052	0.326

*p<0.05; **p<0.01

Source: Own work

There is a weak yet significant correlation (see Appendix 17) between PNC level and dwell time (p=0.002), while for noise, the correlation is moderate (-0.48) at 60% significance level (see Appendix 18). Group size also shows moderate correlation for 0.316, and it's statistically significant with p-value=0.000 (see Appendix 19). Noise has the strongest correlation among other variables investigated and then followed by group size.

Temperature and humidity have a weak correlation (see Appendices 21,22) for 0.108 and 0.159, but both are insignificant level (p-value<0.01). This maybe because the temperature and humidity during those 3 days are quite similar without any rain. Children presence show very weak correlation to the dwell time almost at only in 6% significance level. Location and cafe/restaurant type have a weak association yet significant for 0.248 and 0.178. Passenger car unit also shows a very weak correlation at 62% significant level.

4.8 REGRESSION ANALYSIS

Bivariate correlation analysis helps to understand what factors are contributing most to the individual's dwell time. Therefore, to estimate the relationship, to get more powerful and accurate analysis, multiple regression will be applied. However, the impact of factors needs to be controlled to get a better understanding of the variation. In order to avoid

multicollinearity, some variables should be chosen correctly. Initial correlation analysis is conducted within independent factors. Temperature won't be used in this regression because according to the data and as the principal consideration, the temperature in those three days tend to be similar. Humidity as a part of weather condition won't be used because it has a very high standard error in the regression analysis. In the end, there will be 5 variables in total that will be applied to regression consist of PNC, group size, noise level, PCU/minute, and children presence.

Table 4. 6 Multiple Regression Analysis for Dwell Time

Factors	β	Standard Error	t-value	p-value
PNC (Particles/cm^{-3})	0.000	0.000	2.647	0.009
Noise Level	-1.244	1.230	-1.011	0.313
Group Size	17.138	2.436	7.034	0.000
PCU/minute	0.474	0.330	1.437	0.152
Children Presence	-17.359	8.961	-1.937	0.054

Source: Own work

PNC show the very weak coefficient correlation in affecting dwell time with b=0.000, t-value= 2.647, and t-value=0.009. It means that air pollution (in this case PNC) have an insignificant impact in influencing the people's dwell time in the café and restaurant. Meanwhile, noise level shows the negative correlation with b=-1.244, t-value=1.011 at 69% significant level. It means that when the level noise is lower, some people tend to dwell longer.

Group size is the strongest variables affecting people's dwell times, and it's statistically significant with b=17.138, t-value=7.034, p-value=0.000 with std. error = 2.436. It explains that customer who come in the number more than one will dwell longer probably because they will engage in social activities with others. PCU/minute shows the insignificant positive correlation with b=0.474 and t-value= 1.437, which mean the crowded the road, the longer people dwell. Children existing shows the negative correlation almost insignificant. The coefficient is b=-17.359 and t-value = -1.937, hence the standard error is high about 8.961. About 17% of people's dwell time can be accounted by all the factors mentioned in this regression.

It can be concluded that air pollution and noise is less significant in affecting people dwell time in street cafes/restaurants. Noise has a bigger effect than air pollution, even though it doesn't apply to the most case. In this survey, air pollution and noise only contribute to 3.8% people's dwell time data

4.9 DISCUSSION

Customer's perception is one of the behaviour in using a space, one of the responses to their surrounding environment. Therefore, the very weak significant correlation between air pollution and dwell time is highly related to people's perception of air quality. Meanwhile, need to be noted, perceptions of air quality are also affected by other factors such as socioeconomic, locations, health issue, media, visual evidence, etc.

Some studies have proved that identifying relationship between perceived and actual levels of pollutants has not been possible (Brody et al., 2004; Howel et al., 2002, Paas et al., 2016). Some may have success to find the relationship, but won't be reliable to compare to the high polluted air (Nikolopoulou, 2011). However, those previous studies investigated bigger PM such as $PM_{2.5}$ and PM_{10}. Research about the relationship between UFP and people's perception are still rare.

The very weak correlation between measured ultrafine particles and dwell time data found in this study supports the disconnected relationship between actual and perceived air pollution. The questionnaire result affirms the disconnection. It shows that people observed differently even in the same environment. The inconsistency apparently can be known on Exhibition Road, when people perception tends to be neutral and good, whereas the actual data show the high PNC.

This finding can be explained by the characteristic of that particles. UFP are identified as tiny particles, much smaller than $PM_{2.5}$ and PM_{10}. It is also more numerous and more toxic (Lonati et al., 2010; Dennekamp, 2002). Due to its characteristic, UFP are invisible and odourless (Brugge, 2013). All these criteria of UFP may make it hard to be sensed by human sensory, just like many air pollutants including $PM_{2.5}$ and PM_{10}. Since they are not able to sense it, they cannot perceive it, so that it won't significantly affecting their dwell time.

In outside environment, there are many other interferences that more able to be detected by human sensory. Also, in these studies, noise found to have a stronger influence than air pollution, hence statistically significant. Both statement and argument indicate that there are other greater factors in influencing dwell time than air pollution such as the sense of place (Brody, 2004) or acoustic occurrences (Paas et al., 2016).

Noise tend to have a stronger influence than air pollution. The studies show the negative correlation at 69% significance level. It confirms at certain circumstances, some customers feel annoyed from the traffic noise, the main source of noise from the street. Traffic noise irritates their dwell time behaviour (d'Astous, 2000) in the streets cafes and restaurants. However, it doesn't apply to all the customer. Some of them stay longer on the noisy street.

For that case, this phenomenon can be explained with the soundscape concept. In the Exhibition Road, where the highest average noise level found at the particular time, people tend to dwell longer. This possibly occurs because sound were dominated by surrounding speech tends to be more pleasant than traffic noise (Miller, 2013; Nilsson and Berglund, 2006; Guastavino, 2006; Carles et al., 1999). Surrounding speech until certain level can increase people excitement which leads to longer dwell time because human noise tends to be perceived eventful or exciting (Axelsson, 2010).

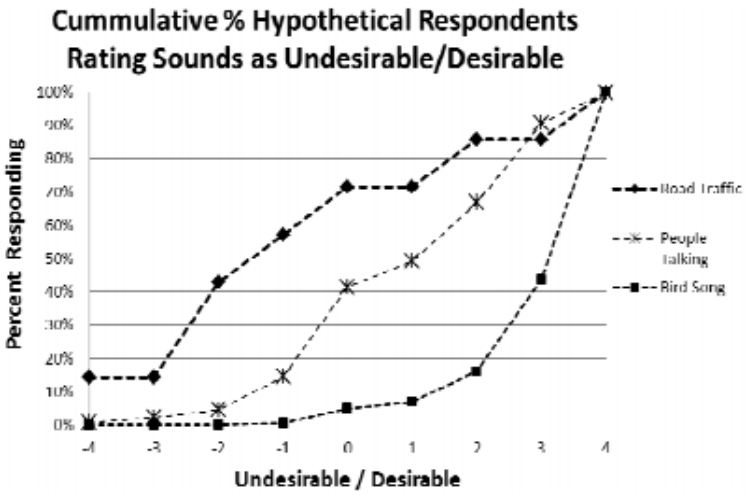


Figure 4. 12 Hypothetical respondent rating of three sounds

Source: Miller, 2013

Those soundscape perceptions can be matched with the questionnaire data. Some people on Upper Street tend to view the place to be noisy and the soundscape quality to be very unpleasant. It is in line with the number of traffic passing through the area as a source of the technological noise. Meanwhile, in Exhibition Road, none of the respondents perceived the noise level to be noisy and soundscape quality to be unpleasant. This is in contrast to the measured data while noise level tends to be high at the particular time, which majority come from a human voice, not the traffic sound. This indicates that people have tolerance to some source of sound.

Both air pollution and noise level as two of the environmental factors seem to have an insignificant influence on people's dwell time. This is supporting the Donovan et al. (1994) which find that the effect of environmental cues on retail activities is weak. It found that other factors such as group size affect more: the larger the group size, the longer they stay. This may be no surprise, because when people come together, social activities such as conversation can increase the dwell time.

The results on people's dwell time vs pollution seem to contradict H1: Dwell time in Upper Street and Exhibition Road are higher than dwell time in The Cut which is the lowest PNC level among others. The noisiest street for traffic noise – Upper Street- had some of the longest dwell times as well. The perceived data of air quality and dwell time (H2) also rejected because in some (small number) responses there is an opposite correlation occurs. Hypothesis 3 can not be tested because it doesn't have sufficient evidence in identifying the association. Comparison between perceived and measured (H4) doesn't show the compatibility: Exhibition Road has a high PNC level, hence neutral and good air quality perception. People tend to perceive noise in Exhibition Road to be neutral/ quiet, whereas the observation measures it relatively high.

Table 4. 7 Hypotheses Test

Hypotheses	**Results Test**
H1: If measured pollution (A) > measured pollution (B) → Dwell Time (A) < Dwell time (B)	Rejected
H2: If perceived pollution (A) > perceived pollution (B) → Dwell time (A) < Dwell time (B)	Rejected
H3: If pollution (A) > pollution (B) → retail spend per person (A) < retail spend per person (B)	-
H4: Perceived pollution is correlated with measured pollution	Incompatible

Source: Own work

CHAPTER 5: CONCLUSION

5.1 REFLECTION AND LIMITATIONS OF THE STUDY

The sample size in the online survey as part of qualitative data was small. These restrictions make it unable to foresee the relationship such a low response rate. This makes some hypotheses could not be explored at all or it won't a reliable test. For instance, there is no clear and sufficient evidence to draw any inferences to explain the air quality and noise impact to the customer's retail spend as well as the dwell time impact to the retail spend itself. Likewise perceived dwell time data, the small responses make it difficult to model the correlation since the pattern is not clear – although actual dwell time was recorded satisfactorily from the video recording.

Particle number concentrations or equal with ultrafine particles is the primary air pollution measured in this study. UFP is smaller than PM2.5 or PM10 hence more relevant to the adverse health effect by traffic activities. The results might be different if people perceived the larger particles, instead of UFP. However, previous research indicate that people do have problems recognizing all particles (Brody et al., 2004; Howel et al., 2002, Paas et al., 2016). Therefore, the small number of perceived air quality data won't be limitation added particularly to the challenges.

The measurement and survey were conducted on three different days, with supporting by 3 days of background pollution level. This help to get to know the true traffic impact to the air quality (Klose et al., 2009). However, observers have done the best to avoid bias mitigation by using roadside increment approach. Therefore, air pollution data through the measurements won't be a major issue in the results, although it may have had some minor effect.

5.2 CONCLUSION

The perceived results do not match the observed data regarding perceived air quality and dust, and also noise. Perceived air quality on Exhibition Road is least polluted and dusty. isIt contrasts to the actual data which shows the high pollution of UFP on that road. The Cut is the least polluted road, although, in some responses, air quality was perceived to be poor

and dusty. The results raise important question – why do perceptions not match observed data?

Previous research shows that people have trouble in perceiving air pollution including particulates matters (Brody et al., 2004; Howel et al., 2002, Paas et al., 2016). It maybe because they tend to perceived factors that stimulate the human sensory. They more rely on the sources of pollution and infer that pollution is present. This would explain the rank order in perceptions start from Upper Street as the worst, The Cut, and then Exhibition Road.

Another plausible reason may be the existence of cooking or food smell that can cover up the sense of air pollutant. Cooking emissions in Exhibition Road are a likely cause a higher UFP count. When on that street, human sensory maybe more aware of detecting the cooking smell rather than small particle. The customer is later on perceived the smell as a "good" thing. The smell will dominate the air and human sensory, which further may change the measured of "bad pollutants" become the perceived "good pollutants".

However, the perceived air pollution data do match with the prior expectations in this study: Air pollution on Upper Street > The Cut > Exhibition Road. In view of this, it could be worthwhile to explore the health implications of high levels of cooking emissions, whether the real impacts on people match the observation or the perception.

Similarly, in terms of noise perceptions, there is an incompatibility with the measured data. The noise on Exhibition Road includes a lot of speech, and that may explain why people perceive it neutral/fairly quiet whilst the measured sound level is actually relatively high - higher than Upper Street on some measures. This confirms the soundscape concept which classified human voice to be exciting and more pleasant than traffic noise in open public space (Miller, 2013; Nilsson and Berglund, 2006; Guastavino, 2006; Carles et al., 1999).

The results on dwell time vs pollution seem to contradict the initial hypothesis that reduced pollution would be associated with increased dwell time, both from the observed data and the (small sample) perceived data. PNC show very weak correlation – statistically significant - with dwell time. The noisiest street for traffic noise – Upper Street – had some of the longest dwell times.

The regression model gives an indication of why this could be the case: factors other than pollution seem to drive dwell time. Whilst the explanatory power of the model is not very strong, the most significant variable by far is group size, which has a positive association with dwell time – statistically significant: larger group tend to stay longer. Reflecting on the results, there may have been other social or behavioural factors – including the purpose of the visit to the cafe or the context that day (day off, working day, day as a tourist, etc.) that may have played a greater role in explaining dwell time that the environmental variables did. For example, it may be that the cafe visitors on Upper Street were meeting friends on a non-working day, whilst a majority of the visitors in Exhibition Road were tourist. This would need to be explored in the future using a larger sample survey of visitors.

5.3 OPPORTUNITIES FOR FURTHER RESEARCH

The findings in this research create opportunities for further studies. Research focusing on environmental impact to the health damage will be essential: Do people's perceptions of pollution, or the observed data, match the health damage caused by pollution – and where are the divergences?. Another study focusing the relationship related economic benefit and environment could be focused on how people perceived the streetscape environment and what is the best variables in the streetscape that can attract them to dwell longer and spend more money in that place?.

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APPENDICIES

APPENDIX 1: ONLINE SURVEY FORM ON THE CUT

Page I: Introduction

This survey is part of a research project seeking to understand how urban environmental quality influences the amount of time people spend in outside spaces.

This survey will take 10 - 15 minutes to complete. Your effort is much appreciated since the results will provide invaluable information to develop a sustainable urban environment. You are entitled to enter the prize-draw for £50 Amazon voucher after finishing the survey. Should you have any questions, please feel free to contact the researcher Martina Cecilia Adriana at ts15mca@leeds.ac.uk or the supervisor of this research Dr. John Nellthorp at J.Nellthorp@its.leeds.ac.uk.
This research is supported by Transport for London (TfL) and based at the University of Leeds. The data gathered includes noise and air pollution measurement and some video recording. All the data is gathered and held completely anonymously and individual people can not be identified in the data or the results. The data will be held securely on University servers in line with data protection laws.

Please read the following:

1. **All your information provided in this survey will be kept anonymous and confidential.**

2. Collected data will be stored properly and used in the dissertation and further research.

3. **No individual data will be displayed that identifies your own responses.**

4. You can terminate your participation at any time without prejudice by contacting the researcher by 31st July 2016.

☐ Please tick the following box if you agree with the above conditions and consent to begin the survey.

Page II: About you

1. What is your gender?
   - ☐ Female
   - ☐ Male
   - ☐ Prefer not to answer

2. What is your age?
   - ☐ Under 16
   - ☐ 16-25
   - ☐ 26-40
   - ☐ 41-55
   - ☐ 56 or older
3. Which of the following categories best describes your primary area of employment? (regardless of your actual position)
   - ☐ Employed for wages
   - ☐ Self-employed
   - ☐ Out of work and looking for work
   - ☐ Out of work but not currently looking for work
   - ☐ Homemaker
   - ☐ Carer (unpaid)
   - ☐ Student
   - ☐ Military
   - ☐ Retired
   - ☐ Unable to work

Page III: Activities

4. What café / restaurant did you visit in The Cut on the day you picked up the survey flyer? *you may answer more than one
   - ☐ Olivelli
   - ☐ Caffe Nero
   - ☐ Pret A Manger
   - ☐ Other. Please Specify _____
5. What was/were the purpose(s) of visiting the Café/Restaurant? *you may answer more than one
   - ☐ Rest and relaxation
   - ☐ Meeting relatives and friends
   - ☐ Professional reason
   - ☐ Vacation (tourist)
   - ☐ Other. Please Specify _____
6. When did you arrive at the Café or Restaurant? – give a approximate answer if you cannot remember exactly
   Start time: 07:00
   [ ]
7. Did you sit outside?
   - ☐ Yes
   - ☐ no

8. Roughly how long did you spend sitting outside the Café or Restaurant?
   - ☐ Less than 30 minutes
   - ☐ 30 - 45 minutes
   - ☐ 45 - 60 minutes
   - ☐ 1 - 2 hours
   - ☐ 2 - 3 hours
   - ☐ More than 3 hours
9. Please give your best estimate of the length of time you sat outside the Cafe or Restaurant:

   _____ hours _____ minutes

10. How many people in total were in your group in the cafe/restaurant?
    - ☐ 1
    - ☐ 2
    - ☐ 3
    - ☐ 4
    - ☐ More than 4
11. What did you do in the Café or Restaurant?
    - ☐ Drink only
    - ☐ Eat and drink
12. Were there any children in your group?
    - ☐ Yes. If so, how many of your group were children? ----------
    - ☐ No

Page IV: Environment Perceptions

13. How would you rate the temperature conditions during the time you sat outside?

	Cold	Cool	Neither Cool nor Warm	Warm	Hot
Weather Conditions	☐	☐	☐	☐	☐

14. With regard to weather conditions, did you feel comfortable during that time?
    - ☐ Yes
    - ☐ No
15. What is your opinion of the overall air quality during that time?

	Very good	Fairly good	Neither good nor poor	Fairly poor	Very poor
Cleanliness	☐	☐	☐	☐	☐

16. Would you say the air was clean or dusty at that time?

	Very clean	Fairly clean	Neither clean or dusty	Fairly dusty	Very dusty
Dustiness	☐	☐	☐	☐	☐

17. How would you describe the noise level during that time?

	Very quiet	Fairly quiet	Neither quiet nor noisy	Fairly noisy	Very noisy
Noise Level	☐	☐	☐	☐	☐

18. How would you describe the soundscape quality during that time? Soundscape means not only the sound level but also whether it contained pleasant sounds (e.g. birds, music you liked) or unpleasant sounds

	Very unpleasant	Unpleasant	Neither pleasant nor unpleasant	Pleasant	Very pleasant
Soundscape Quality	☐	☐		☐	☐

19. What did you find pleasant in soundscape environment during that time? *you may answer more than one
    - ☐ Street Music
    - ☐ Music from stores
    - ☐ Surrounding speech
    - ☐ Footsteps
    - ☐ Construction
    - ☐ Wind
    - ☐ Vehicle traffic
    - ☐ None of the above
    - ☐ Other. Please Specify _____
20. What did you find unpleasant in soundscape environment during that time? *you may answer more than one
    - ☐ Street Music
    - ☐ Music from stores
    - ☐ Surrounding speech
    - ☐ Footsteps
    - ☐ Construction
    - ☐ Wind
    - ☐ Vehicle Traffic

- ☐ None of the above
- ☐ Other. Please Specify

21. In general, would you stay longer in an outside Cafe or Restaurant if the environment (air quality, noise level, and soundscape) is improved?

	Definitely	Maybe	Maybe not	Definitely not
	☐	☐	☐	☐

Page V: Retail Spend

22. How much did your own food and drink cost in the Café or Restaurant? Please answer as best you can.
    - ☐ Less than £5
    - ☐ £5-£10
    - ☐ £11-£20
    - ☐ £21-£30
    - ☐ £31-£40
    - ☐ more than £40

    Please give an estimate of the total bill for your group: _____

23. If you would like to participate in prize draw, please type your email address here _____

APPENDIX 2: ONLINE SURVEY FORM ON EXHIBITION ROAD

Page I: Introduction

This survey is part of a research project seeking to understand how urban environmental quality influences the amount of time people spend in outside spaces.

This survey will take 10 - 15 minutes to complete. Your effort is much appreciated since the results will provide invaluable information to develop a sustainable urban environment. You are entitled to enter the prize-draw for £50 Amazon voucher after finishing the survey. Should you have any questions, please feel free to contact the researcher Martina Cecilia Adriana at ts15mca@leeds.ac.uk or the supervisor of this research Dr. John Nellthorp at J.Nellthorp@its.leeds.ac.uk.
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Please read the following:

1. **All your information provided in this survey will be kept anonymous and confidential.**

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3. **No individual data will be displayed that identifies your own responses.**

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   - ☐ Female
   - ☐ Male
   - ☐ Prefer not to answer

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   - ☐ Under 16
   - ☐ 16-25
   - ☐ 26-40
   - ☐ 41-55
   - ☐ 56 or older
3. Which of the following categories best describes your primary area of employment? (regardless of your actual position)
   - ☐ Employed for wages
   - ☐ Self-employed
   - ☐ Out of work and looking for work
   - ☐ Out of work but not currently looking for work
   - ☐ Homemaker
   - ☐ Carer (unpaid)
   - ☐ Student
   - ☐ Military
   - ☐ Retired
   - ☐ Unable to work

Page III: Activities

4. What café / restaurant did you visit in Exhibition Road on the day you picked up the survey flyer? *you may answer more than one
   - ☐ Roots and Bulbs Cafe
   - ☐ Fernandez and Wells
   - ☐ Cafe Cremerie (KC)
   - ☐ Comptoir Libanais
   - ☐ Casa Brindisa
   - ☐ Le Pain Quotidien
   - ☐ Other. Please Specify _____
5. What was/were the purpose(s) of visiting the Café/Restaurant? *you may answer more than one
   - ☐ Rest and relaxation
   - ☐ Meeting relatives and friends
   - ☐ Professional reason
   - ☐ Vacation (tourist)
   - ☐ Other. Please Specify _____
6. When did you arrive at the Café or Restaurant? – give a approximate answer if you cannot remember exactly
   Start time: 07:00
   
7. Did you sit outside?
   - ☐ Yes
   - ☐ no

8. Roughly how long did you spend sitting outside the Café or Restaurant?
   - ☐ Less than 30 minutes
   - ☐ 30 - 45 minutes
   - ☐ 45 - 60 minutes
   - ☐ 1 - 2 hours
   - ☐ 2 - 3 hours
   - ☐ More than 3 hours
9. Please give your best estimate of the length of time you sat outside the Cafe or Restaurant:

   _____ hours _____ minutes

10. How many people in total were in your group in the cafe/restaurant?
    - ☐ 1
    - ☐ 2
    - ☐ 3
    - ☐ 4
    - ☐ More than 4
11. What did you do in the Café or Restaurant?
    - ☐ Drink only
    - ☐ Eat and drink
12. Were there any children in your group?
    - ☐ Yes. If so, how many of your group were children? ----------
    - ☐ No

Page IV: Environment Perceptions

13. How would you rate the temperature conditions during the time you sat outside?

	Cold	Cool	Neither Cool nor Warm	Warm	Hot
Weather Conditions	☐	☐	☐	☐	☐

14. With regard to weather conditions, did you feel comfortable during that time?
    - ☐ Yes
    - ☐ No
15. What is your opinion of the overall air quality during that time?

	Very good	Fairly good	Neither good nor poor	Fairly poor	Very poor
Cleanliness	☐	☐	☐	☐	☐

16. Would you say the air was clean or dusty at that time?

	Very clean	Fairly clean	Neither clean or dusty	Fairly dusty	Very dusty
Dustiness	☐	☐	☐	☐	☐

17. How would you describe the noise level during that time?

	Very quiet	Fairly quiet	Neither quiet nor noisy	Fairly noisy	Very noisy
Noise Level	☐	☐	☐	☐	☐

18. How would you describe the soundscape quality during that time? Soundscape means not only the sound level but also whether it contained pleasant sounds (e.g. birds, music you liked) or unpleasant sounds

	Very unpleasant	Unpleasant	Neither pleasant nor unpleasant	Pleasant	Very pleasant
Soundscape Quality	☐	☐		☐	☐

19. What did you find pleasant in soundscape environment during that time? *you may answer more than one
    - ☐ Street Music
    - ☐ Music from stores
    - ☐ Surrounding speech
    - ☐ Footsteps
    - ☐ Construction
    - ☐ Wind
    - ☐ Vehicle traffic
    - ☐ None of the above
    - ☐ Other. Please Specify _____
20. What did you find unpleasant in soundscape environment during that time? *you may answer more than one
    - ☐ Street Music
    - ☐ Music from stores
    - ☐ Surrounding speech
    - ☐ Footsteps
    - ☐ Construction
    - ☐ Wind
    - ☐ Vehicle Traffic
    - ☐ None of the above
    - ☐ Other. Please Specify

21. In general, would you stay longer in an outside Cafe or Restaurant if the environment (air quality, noise level, and soundscape) is improved?

	Definitely	Maybe	Maybe not	Definitely not
	☐	☐	☐	☐

Page V: Retail Spend

22. How much did your own food and drink cost in the Café or Restaurant? Please answer as best you can.
    - ☐ Less than £5
    - ☐ £5-£10
    - ☐ £11-£20
    - ☐ £21-£30
    - ☐ £31-£40
    - ☐ more than £40

    Please give an estimate of the total bill for your group: _____

23. If you would like to participate in prize draw, please type your email address here _____

APPENDIX 3: ONLINE SURVEY FORM ON EXHIBITION ROAD

Page I: Introduction

This survey is part of a research project seeking to understand how urban environmental quality influences the amount of time people spend in outside spaces.

This survey will take 10 - 15 minutes to complete. Your effort is much appreciated since the results will provide invaluable information to develop a sustainable urban environment. You are entitled to enter the prize-draw for £50 Amazon voucher after finishing the survey. Should you have any questions, please feel free to contact the researcher Martina Cecilia Adriana at ts15mca@leeds.ac.uk or the supervisor of this research Dr. John Nellthorp at J.Nellthorp@its.leeds.ac.uk.
This research is supported by Transport for London (TfL) and based at the University of Leeds. The data gathered includes noise and air pollution measurement and some video recording. All the data is gathered and held completely anonymously and individual people can not be identified in the data or the results. The data will be held securely on University servers in line with data protection laws.

Please read the following:

1. **All your information provided in this survey will be kept anonymous and confidential.**

2. Collected data will be stored properly and used in the dissertation and further research.

3. **No individual data will be displayed that identifies your own responses.**

4. You can terminate your participation at any time without prejudice by contacting the researcher by 31st July 2016.

☐ Please tick the following box if you agree with the above conditions and consent to begin the survey.

Page II: About you

1. What is your gender?
   - ☐ Female
   - ☐ Male
   - ☐ Prefer not to answer

2. What is your age?
   - ☐ Under 16
   - ☐ 16-25
   - ☐ 26-40
   - ☐ 41-55
   - ☐ 56 or older
3. Which of the following categories best describes your primary area of employment? (regardless of your actual position)
   - ☐ Employed for wages
   - ☐ Self-employed
   - ☐ Out of work and looking for work
   - ☐ Out of work but not currently looking for work
   - ☐ Homemaker
   - ☐ Carer (unpaid)
   - ☐ Student
   - ☐ Military
   - ☐ Retired
   - ☐ Unable to work

Page III: Activities

4. What café / restaurant did you visit in Upper Street on the day you picked up the survey flyer? *you may answer more than one
   - ☐ Cabanas
   - ☐ Vivo
   - ☐ Costa
   - ☐ Other. Please Specify _____
5. What was/were the purpose(s) of visiting the Café/Restaurant? *you may answer more than one
   - ☐ Rest and relaxation
   - ☐ Meeting relatives and friends
   - ☐ Professional reason
   - ☐ Vacation (tourist)
   - ☐ Other. Please Specify _____
6. When did you arrive at the Café or Restaurant? – give a approximate answer if you cannot remember exactly
   Start time: 07:00
   
7. Did you sit outside?
   - ☐ Yes
   - ☐ no

8. Roughly how long did you spend sitting outside the Café or Restaurant?
   - ☐ Less than 30 minutes
   - ☐ 30 - 45 minutes

- ☐ 45 - 60 minutes
- ☐ 1 - 2 hours
- ☐ 2 - 3 hours
- ☐ More than 3 hours

9. Please give your best estimate of the length of time you sat outside the Cafe or Restaurant:

   _____ hours _____ minutes

10. How many people in total were in your group in the cafe/restaurant?
    - ☐ 1
    - ☐ 2
    - ☐ 3
    - ☐ 4
    - ☐ More than 4
11. What did you do in the Café or Restaurant?
    - ☐ Drink only
    - ☐ Eat and drink
12. Were there any children in your group?
    - ☐ Yes. If so, how many of your group were children? ----------
    - ☐ No

Page IV: Environment Perceptions

13. How would you rate the temperature conditions during the time you sat outside?

	Cold	Cool	Neither Cool nor Warm	Warm	Hot
Weather Conditions	☐	☐	☐	☐	☐

14. With regard to weather conditions, did you feel comfortable during that time?
    - ☐ Yes
    - ☐ No
15. What is your opinion of the overall air quality during that time?

	Very good	Fairly good	Neither good nor poor	Fairly poor	Very poor
Cleanliness	☐	☐	☐	☐	☐

16. Would you say the air was clean or dusty at that time?

	Very clean	Fairly clean	Neither clean or	Fairly dusty	Very dusty

			dusty		
Dustiness	☐	☐	☐	☐	☐

17. How would you describe the noise level during that time?

	Very quiet	Fairly quiet	Neither quiet nor noisy	Fairly noisy	Very noisy
Noise Level	☐	☐	☐	☐	☐

18. How would you describe the soundscape quality during that time? Soundscape means not only the sound level but also whether it contained pleasant sounds (e.g. birds, music you liked) or unpleasant sounds

	Very unpleasant	Unpleasant	Neither pleasant nor unpleasant	Pleasant	Very pleasant
Soundscape Quality	☐	☐		☐	☐

19. What did you find pleasant in soundscape environment during that time? *you may answer more than one
    - ☐ Street Music
    - ☐ Music from stores
    - ☐ Surrounding speech
    - ☐ Footsteps
    - ☐ Construction
    - ☐ Wind
    - ☐ Vehicle traffic
    - ☐ None of the above
    - ☐ Other. Please Specify _____
20. What did you find unpleasant in soundscape environment during that time? *you may answer more than one
    - ☐ Street Music
    - ☐ Music from stores
    - ☐ Surrounding speech
    - ☐ Footsteps
    - ☐ Construction
    - ☐ Wind
    - ☐ Vehicle Traffic
    - ☐ None of the above
    - ☐ Other. Please Specify

21. In general, would you stay longer in an outside Cafe or Restaurant if the environment (air quality, noise level, and soundscape) is improved?

	Definitely	Maybe	Maybe not	Definitely not
	☐	☐	☐	☐

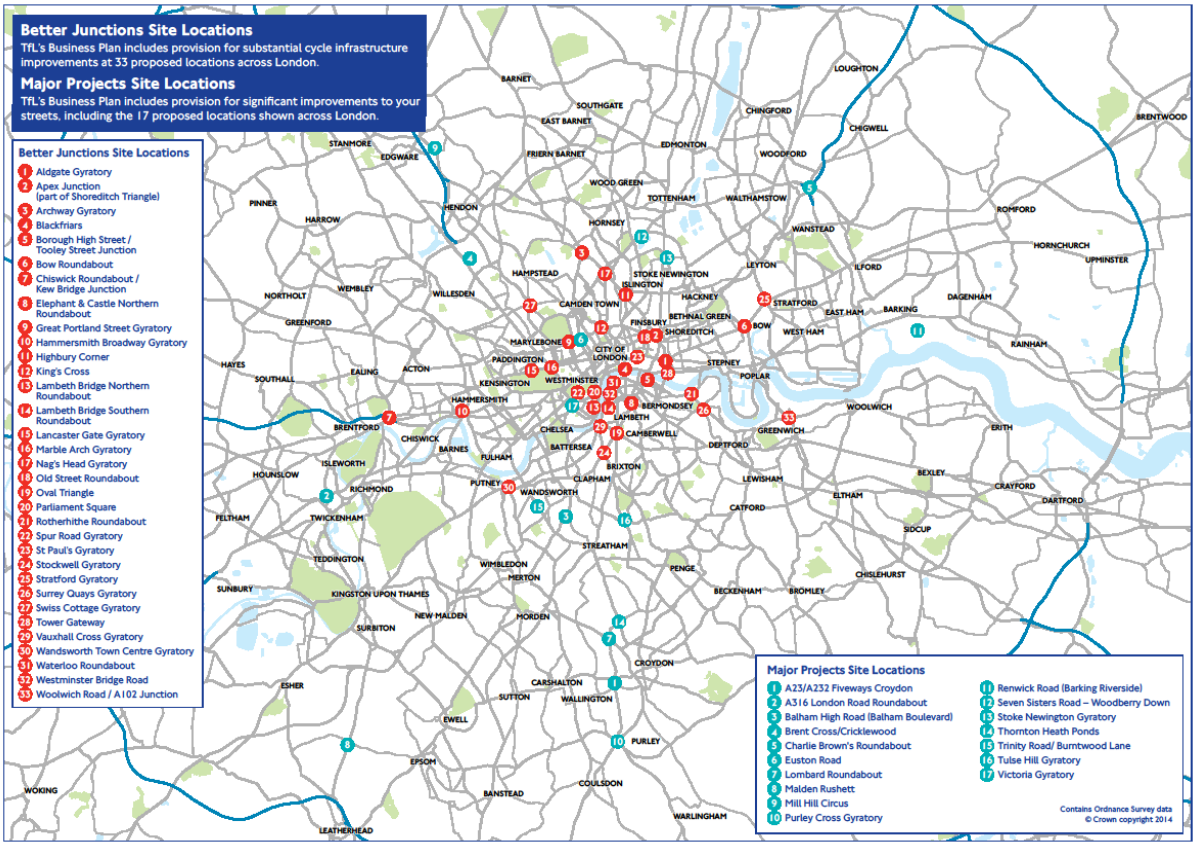
Page V: Retail Spend

22. How much did your own food and drink cost in the Café or Restaurant? Please answer as best you can.
    - ☐ Less than £5
    - ☐ £5-£10
    - ☐ £11-£20
    - ☐ £21-£30
    - ☐ £31-£40
    - ☐ more than £40

    Please give an estimate of the total bill for your group: _____

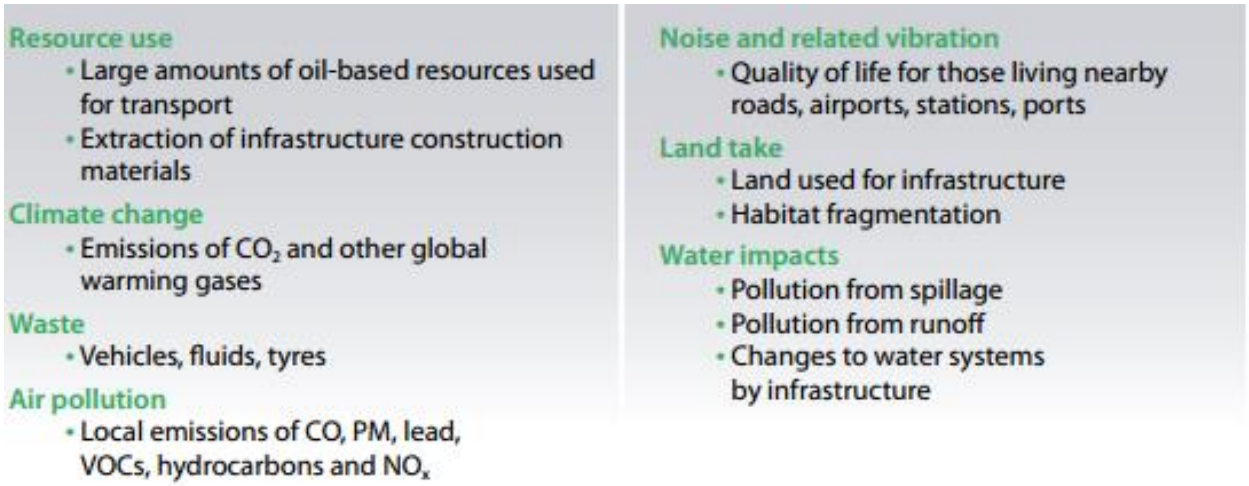
23. If you would like to participate in prize draw, please type your email address here _____

APPENDIX 4: ROAD MODERNISATION PLAN



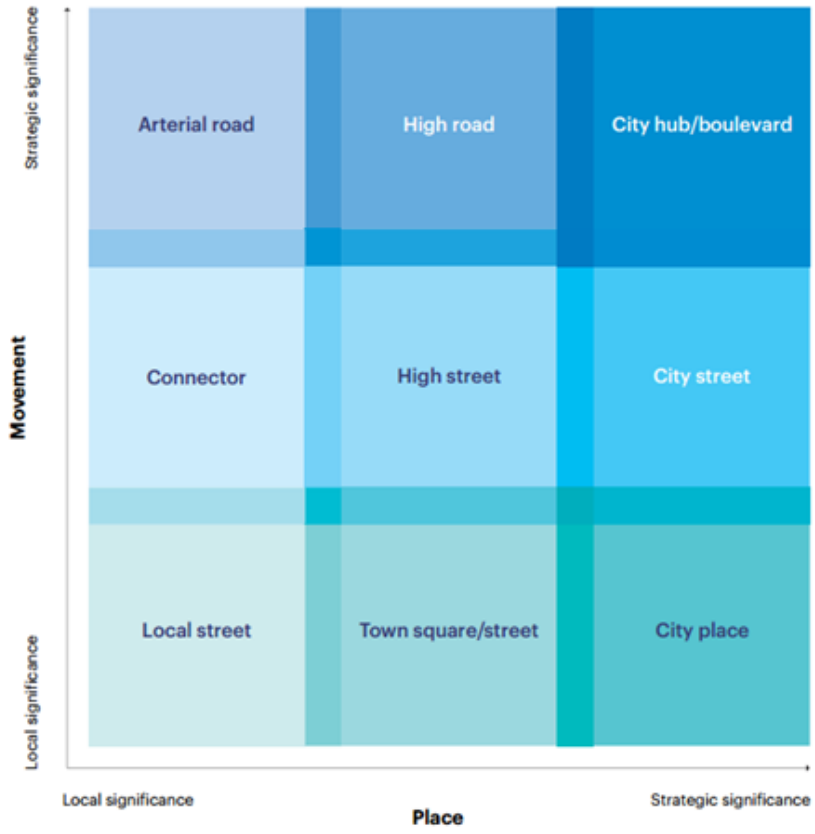
Source: TfL, 2014

APPENDIX 5: ENVIRONMENTAL IMPACT OF TRANSPORTATION



Source: Banister et al., 2000

APPENDIX 6: ROAD TASK FORCE STREET TYPES



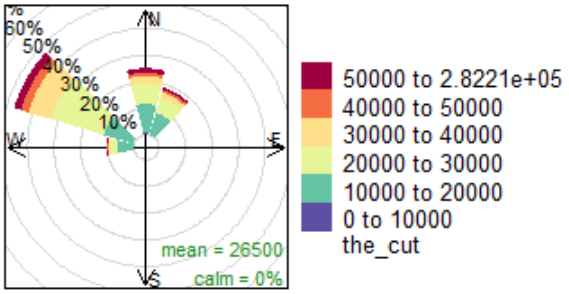
Source: TfL, 2015

APPENDIX 7: METEOROLOGICAL DATA ON 6-8 JULY 2016

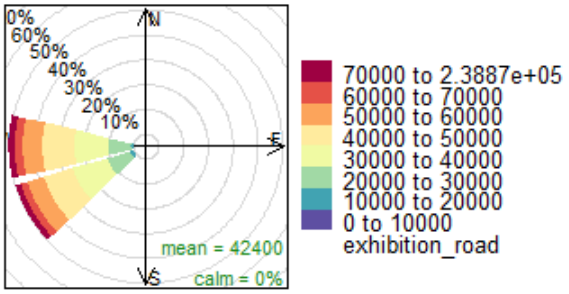
Place	Weather	Time													
		06:50	07:50	08:50	09:50	10:50	11:50	12:50	13:50	14:50	15:50	16:50	17:50	18:50	19:50
The Cut	Temperature (°C)	11	13	15	17	18	19	20	21	20	21	21	21	20	19
	Humidity	82%	77%	63%	49%	49%	46%	38%	40%	40%	40%	40%	40%	43%	49%
	Wind Speed (mph)	2	1	6	5	3	5	3	7	6	3	3	6	6	6
	Wind Direction	300	250	10	0	20	20	350	300	290	270	300	290	290	300
Exhibition Road	Temperature (°C)	15	16	17	19	20	20	20	22	22	23	22	22	21	21
	Humidity	72%	68%	64%	60%	56%	60%	56%	53%	53%	50%	53%	53%	60%	60%
	Wind Speed (mph)	7	6	7	8	9	8	8	12	12	8	10	9	9	9
	Wind Direction	220	220	220	230	250	240	270	260	260	230	260	250	240	250
Upper Street	Temperature (°C)	16	17	18	18	18	20	22	22	22	21	21	22	21	20
	Humidity	83%	83%	73%	78%	78%	69%	65%	57%	53%	57%	57%	53%	53%	60%
	Wind Speed (mph)	9	13	16	15	15	14	15	17	17	16	18	16	18	15
	Wind Direction	260	250	250	260	250	260	240	280	290	280	270	280	280	290

Source: Time and date website, 2016

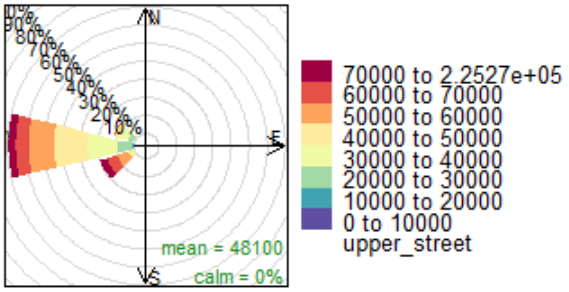
APPENDIX 8: WINDROSE CHART ON THREE LOCATIONS



Frequency of counts by wind direction (%)



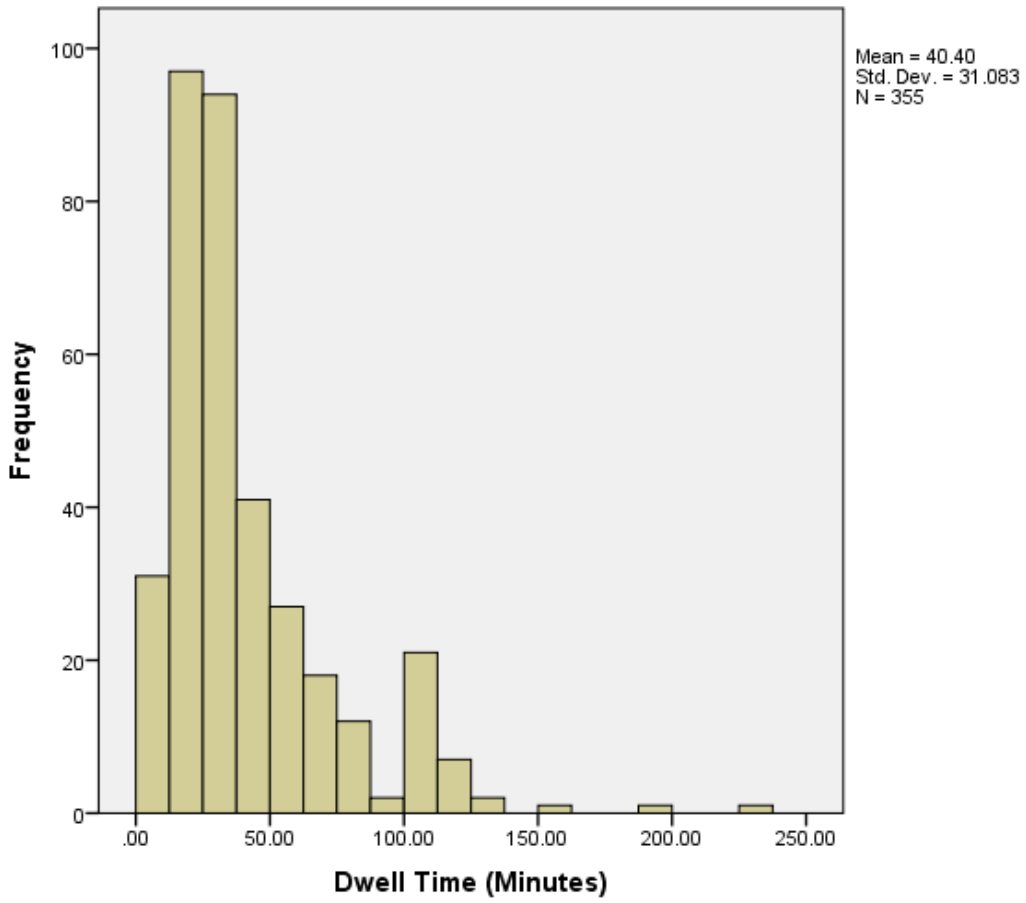
Frequency of counts by wind direction (%)



Frequency of counts by wind direction (%)

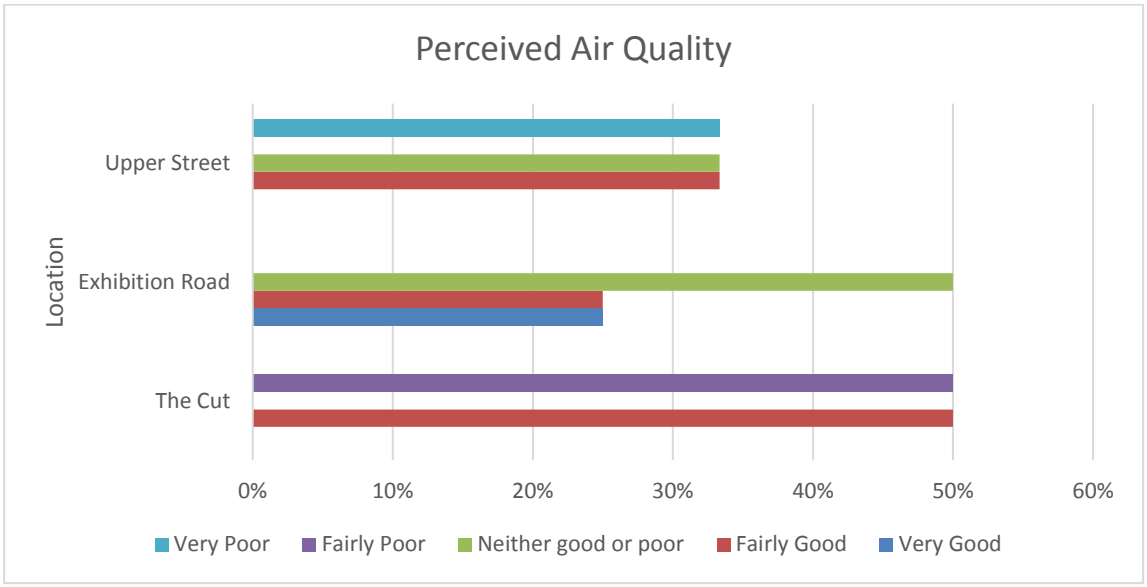
Source: own work

APPENDIX 9: HISTOGRAM OF DWELL TIME



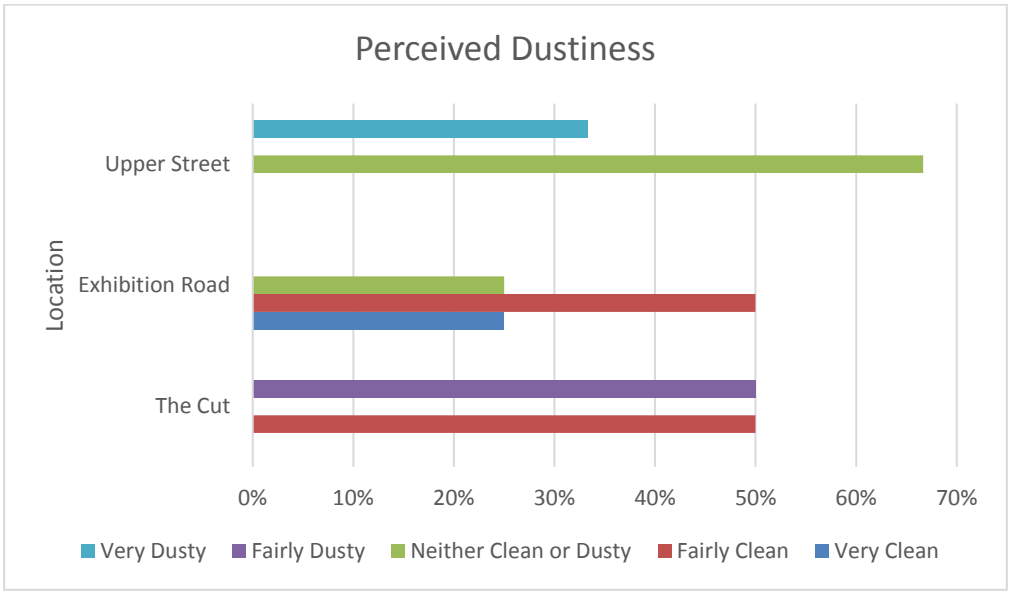
Source: Own work

APPENDIX 10: AIR QUALITY PERCEPTION



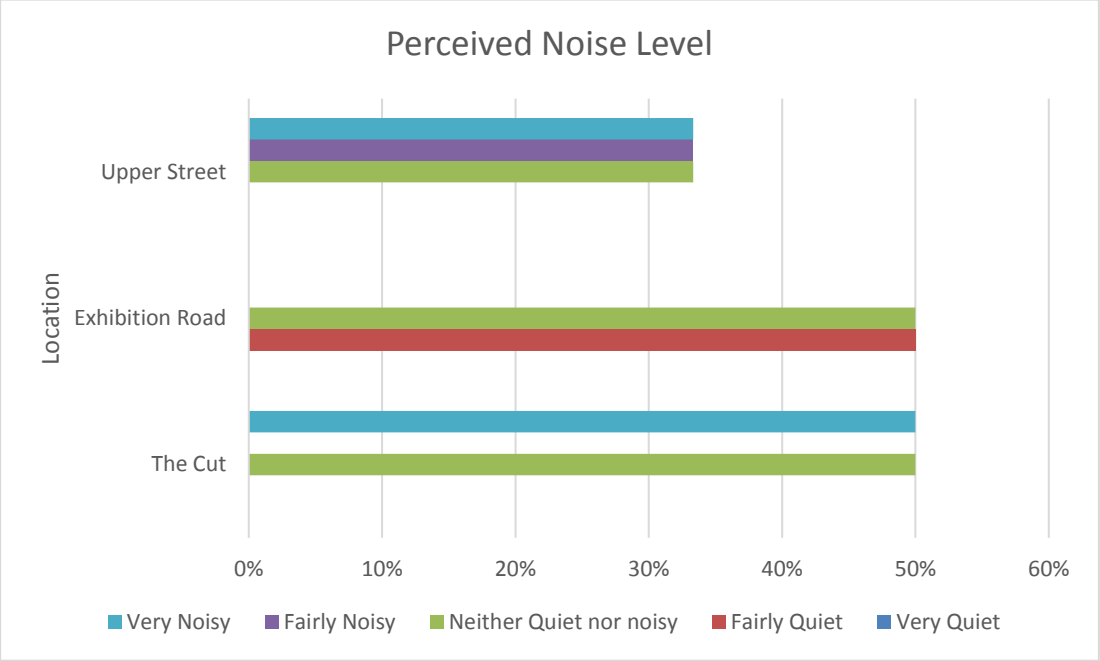
Source: own work

APPENDIX 11: DUSTINESS PERCEPTION



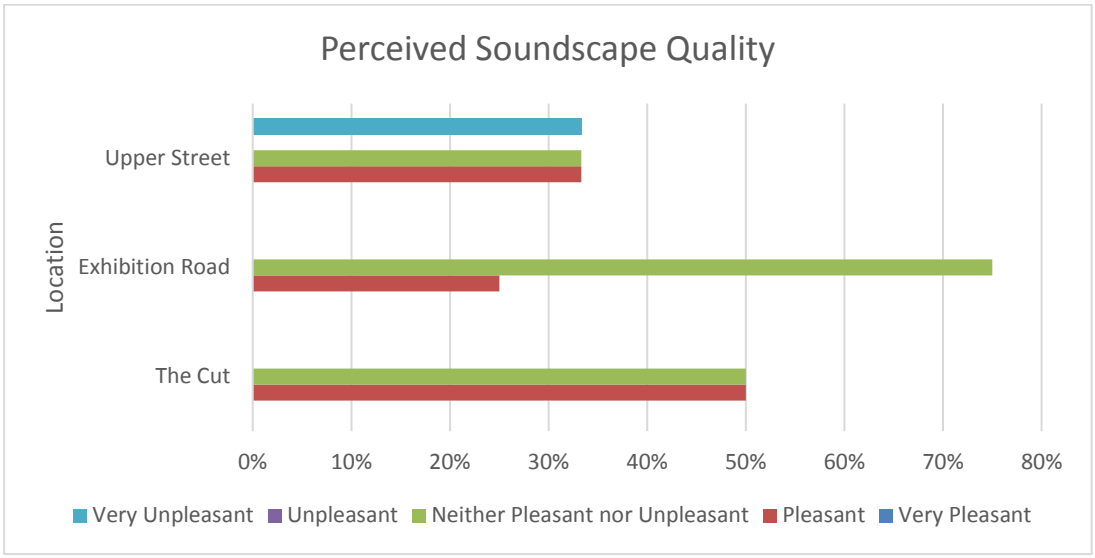
Source: own work

APPENDIX 12: NOISE LEVEL PERCEPTION



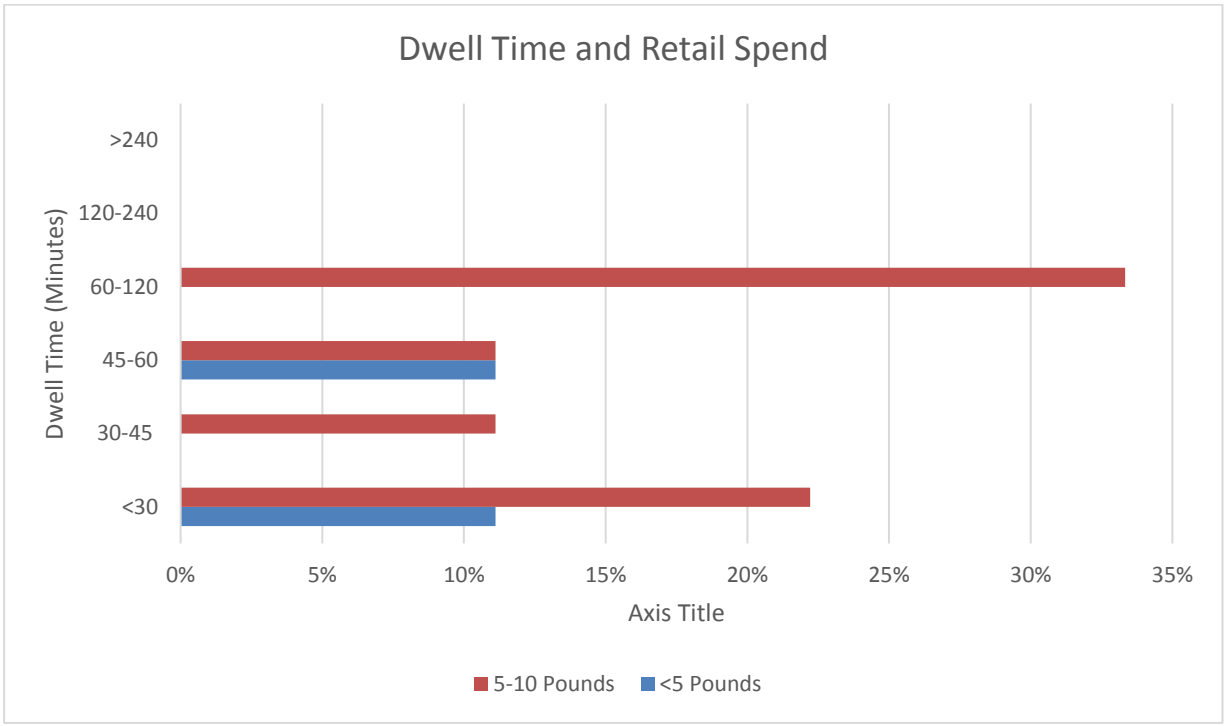
Source: Own work

APPENDIX 13: SOUNDSCAPE QUALITY PERCEPTION



Source: own work

APPENDIX 14: PERCEIVED DWELL TIME AND RETAIL SPEND



Source: own work

APPENDIX 15: COMPONENTS OF ENVIRONMENT

Category	Definition	Features
Ambient Factors	Background conditions that exist below the level of our immediate awareness	- Air Quality (temperature, humidity, circulation/ventilation) - Noise (level, pitch) - Scent - Cleanliness
Design Factors	Stimuli that exist at the forefront of our awareness	1. Aesthetic - Architecture - Colour - Scale - Materials - Texture, pattern - Accessories 2. Functional - Layout - Comfort - signage
Social factors	People in the environment	1. Other customers - Number - Appearance - Behaviour 2. Service personnel - Number - Appearance - Behaviour

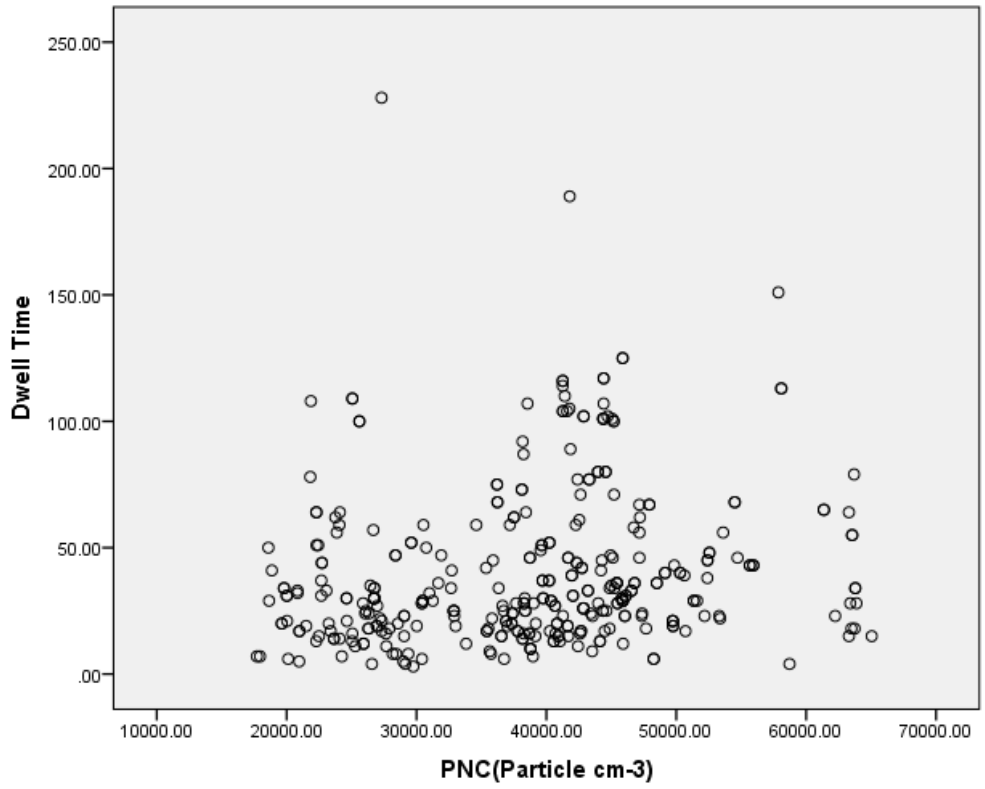
Source: Baker, 1986

APPENDIX 16: ATMOSPHERIC FACTORS

1. External Variables a. Exterior signs b. Entrances c. Exterior display windows d. Height of building e. Size of building f. Colour of building g. Surrounding stores h. Lawns and gardens i. Address and location j. Architectural area k. Surrounding area l. Parking availability m. Congestion and traffic n. Exterior walls	**2. General interior variables** a. Flooring and carpeting b. Colour schemes c. Lighting d. Music e. P.A. usage f. Scents g. Tobacco smoke h. Width of aisles i. Wall composition j. Paint and wallpaper k. Ceiling composition l. Merchandise m. Temperature n. Cleanliness
3. Layout and design variables a. Space design and allocation b. Placement of merchandise c. Grouping of merchandise d. Workstation placement e. Placement of equipment f. Placement of cash registers g. Waiting areas h. Waiting rooms i. Department locations j. Traffic flow k. Racks and cases l. Waiting ques m. Furniture n. Dead areas	**4. Point-of-purchase and decoration and variables** a. Point-of-purchase displays b. Signs and Cards c. Wall decorations d. Degrees and certificates e. Pictures f. Artwork g. Product displays h. Usage instructions i. Price displays j. Teletext

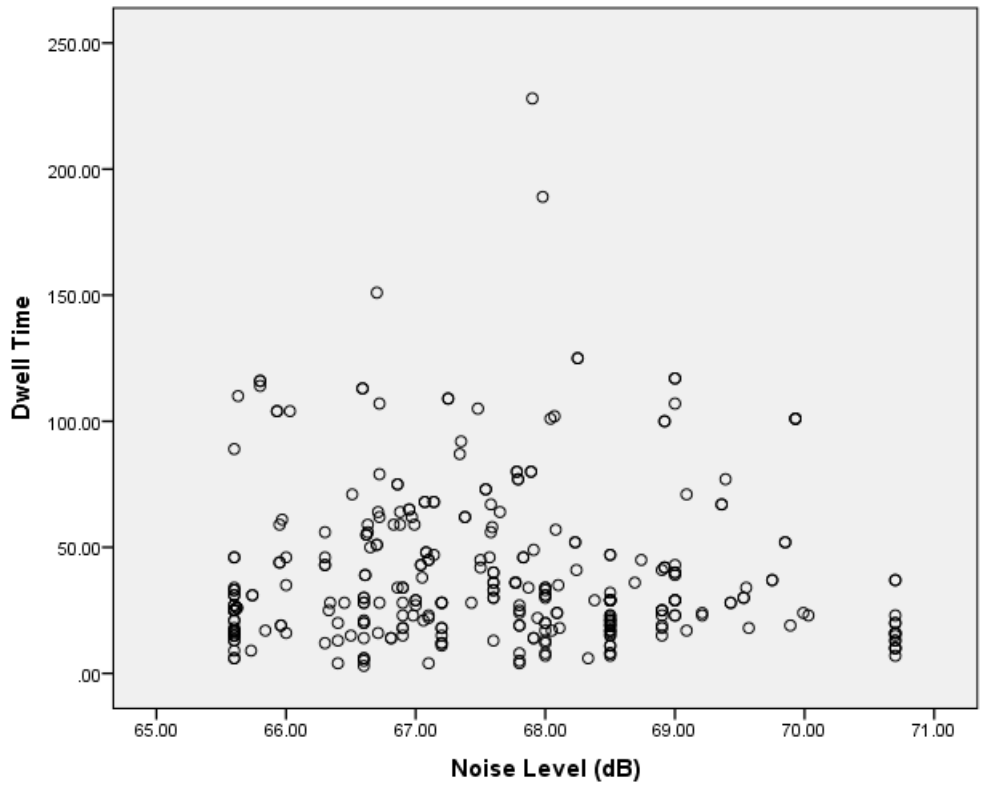
Source: Berman and Evans, 1989

APPENDIX 17: SCATTER PLOT OF PNC VS DWELL TIME



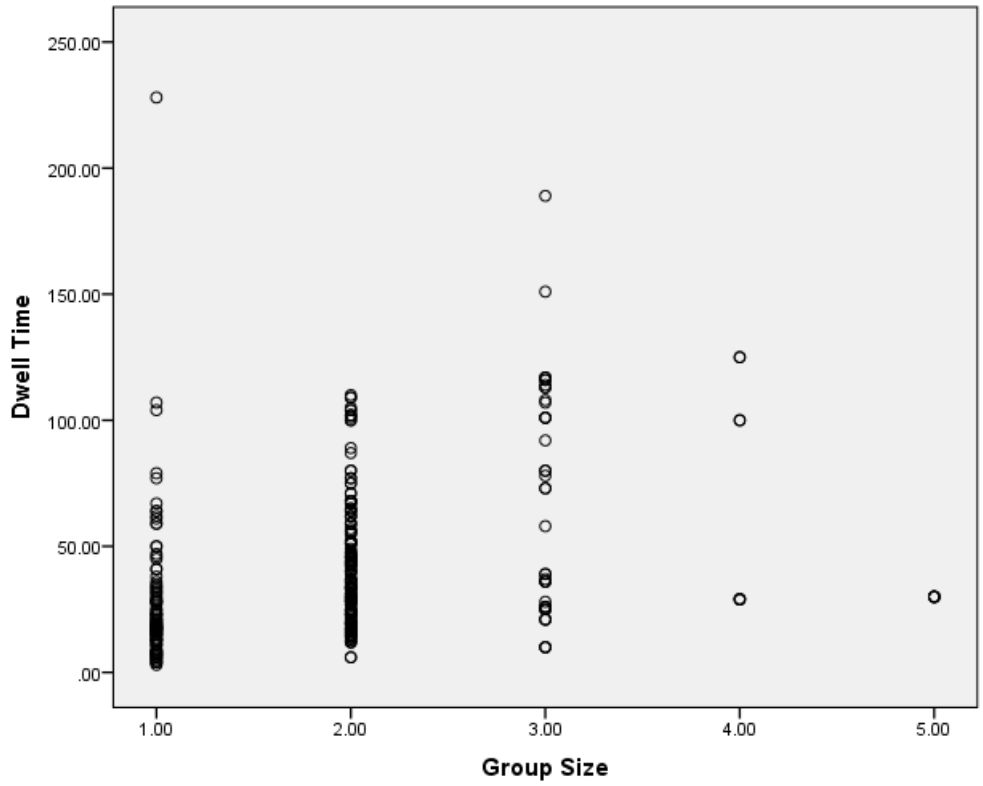
Source: Own work

APPENDIX 18: SCATTER PLOT OF NOISE LEVEL VS DWELL TIME



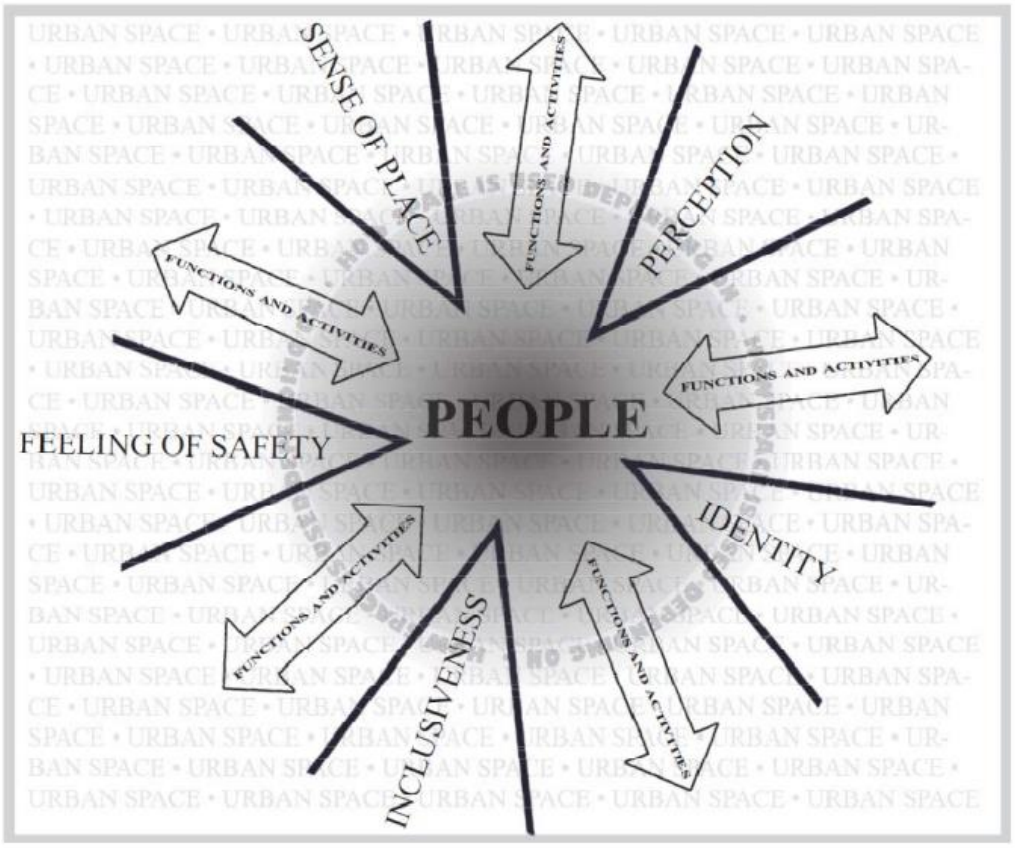
Source: own work

APPENDIX 19: SCATTER PLOT OF GROUP SIZE VS DWELL TIME



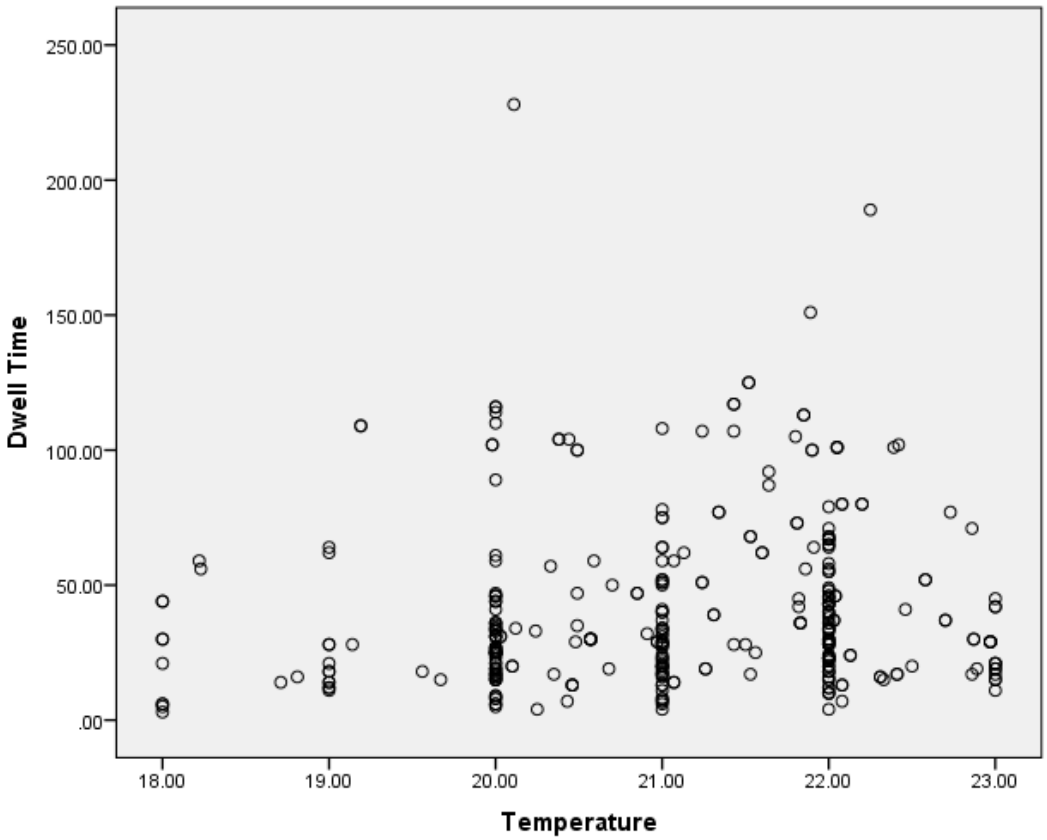
Source: own Works

APPENDIX 20: PRESENTATION OF THE USE OF SPACE



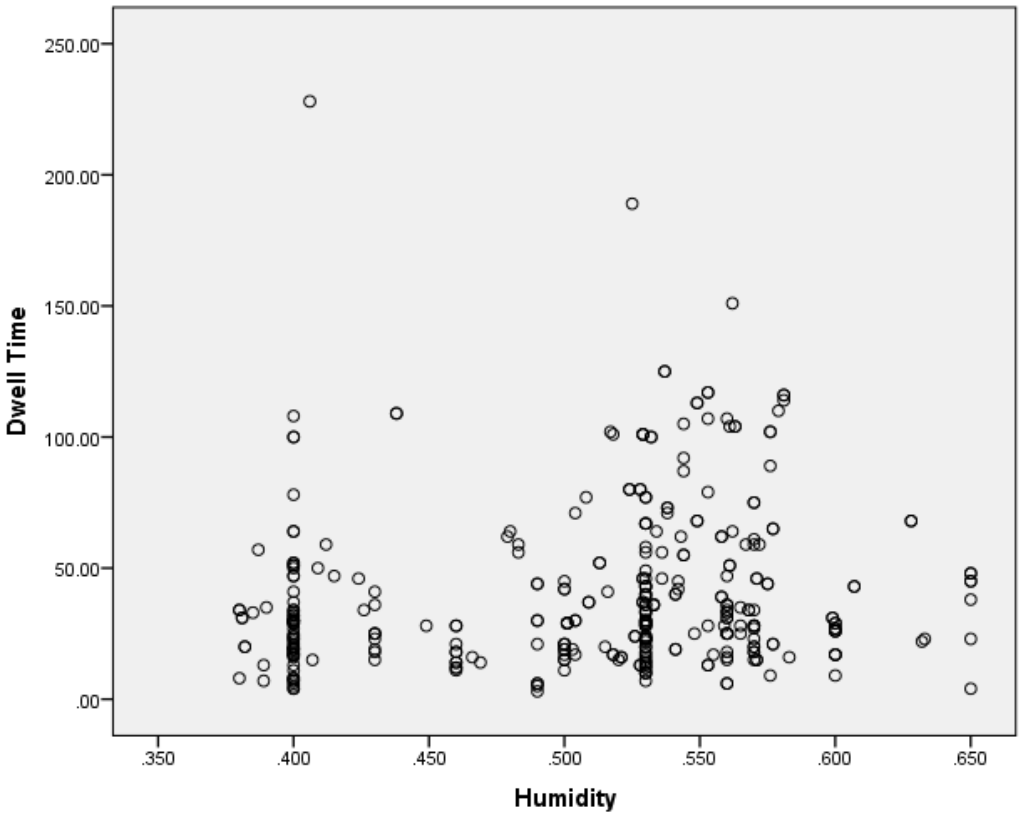
Source: Rasmussen et al., 2011

APPENDIX 21: SCATTER PLOT OF TEMPERATURE VS DWELL TIME



Source: Own work

APPENDIX 22: SCATTER PLOT OF HUMIDITY VS DWELL TIME



Source: own work