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by Hoi Ng

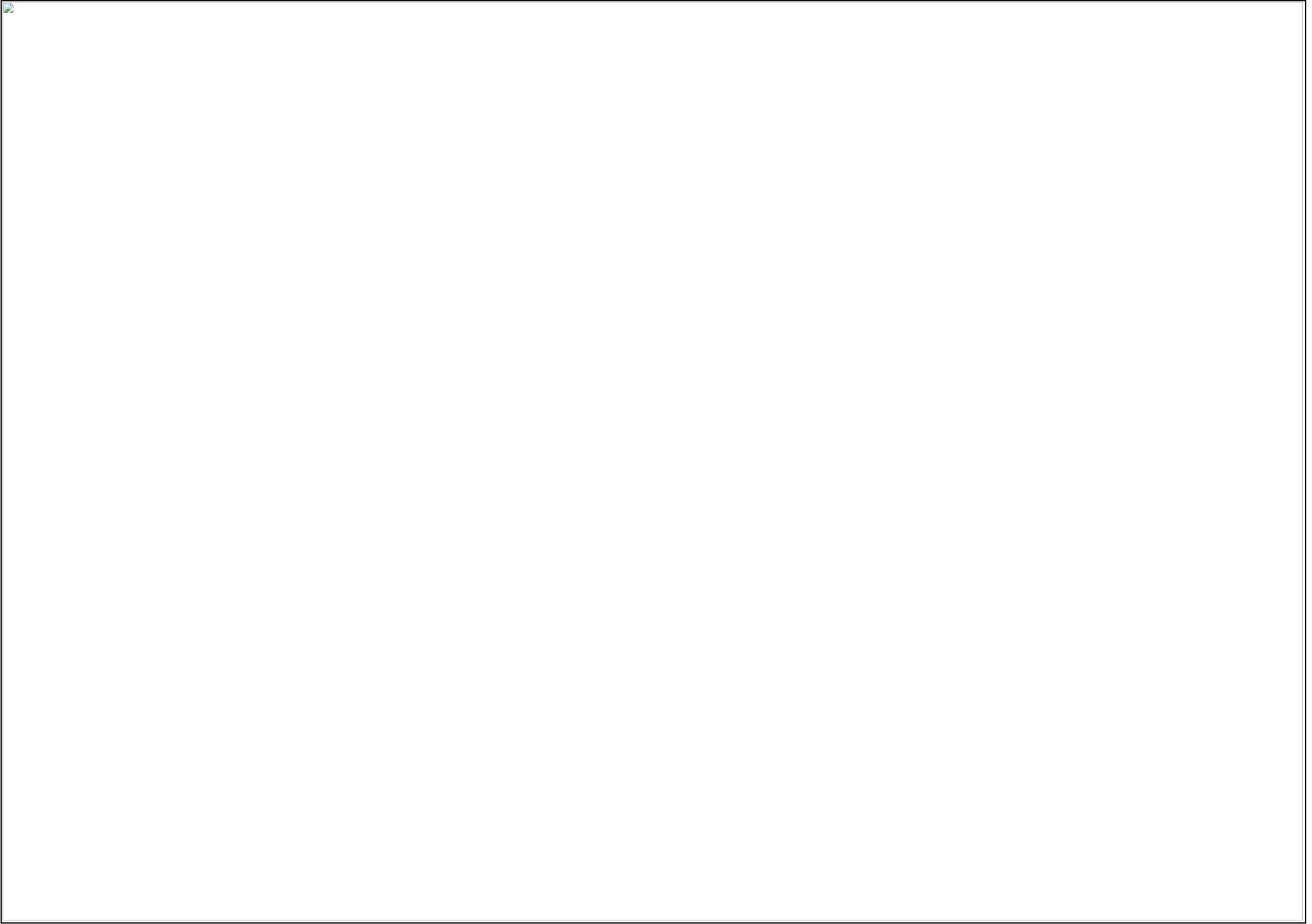
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UNIVERSITY COLLEGE LONDON
FACULTY OF THE BUILT ENVIRONMENT
BARTLETT SCHOOL OF PLANNING

MAJOR PROJECT:

'How does enriching a tertiary network contribute to improving pedestrian safety and security, and thus promote walking in dense metropolitan areas?'

Hoi Lun Helen Ng,
Msc Urban Design and City Planning
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Being a Major Project in MSc Urban Design and City Planning submitted to the faculty of The Built Environment as part of the requirements for the award of the MSc Urban Design and City Planning at University College London, I declare that this project is entirely my own work and that ideas, data and images, as well as direct quotations, drawn from elsewhere are identified and referenced.

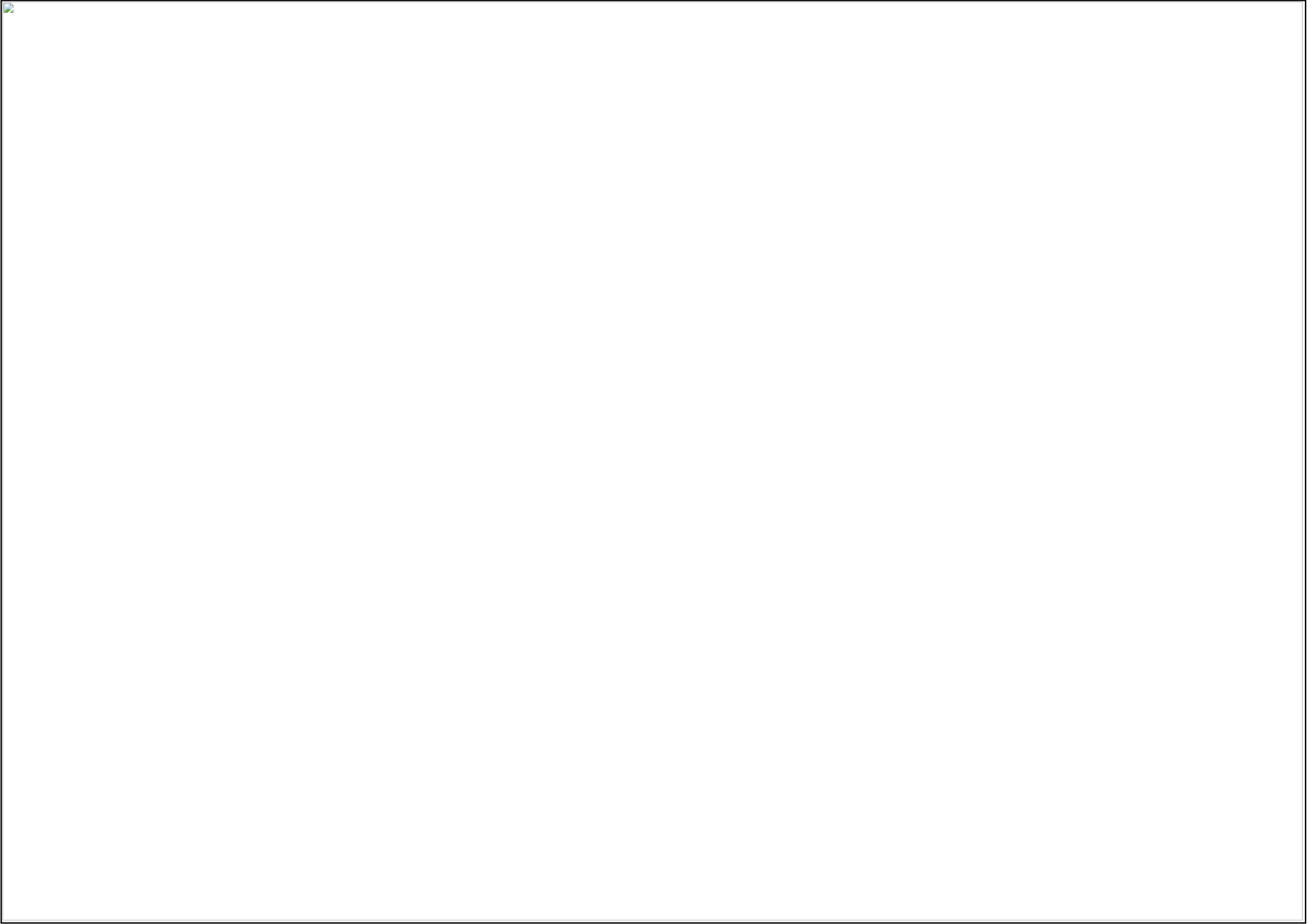


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Abstract

This is a research project on pedestrian safety – both road safety and personal security. It has recognised potential of tertiary networks as an alternative solution in promoting pedestrian safety, bringing people away from traffic through animated routes. It has adopted a systematic approach in understanding pedestrian needs and behaviour, identifying mitigation methods and potential challenges, such as conflicts between different street functions.

A toolkit consisting a framework, action objectives, application guidelines and interventions are developed and tested against the literature review and case-study findings. The methodical application has allowed for a clear establishment of tertiary network, linking key destinations, catering different users need. The study area chosen is an office-dominant location. The sensitive site analysis has introduced a site-specific approach, building on the distinctively different character of the site during different days of week, proposing different interventions and route enhancements for weekdays and weekends. During weekdays, the key focus is on road safety, by introducing pedestrianisation on streets with high pedestrian flow, and intersection managements that offer safer crossing and movement through the site. During weekends, the emphasis lies on personal security, which aims to retain and attract people to the area through route animations, provision of gathering space and introduction of activities. The application of toolkit has demonstrated its flexibility and ability to be used across different type and scale of projects within dense metropolitan areas.

Acknowledgements

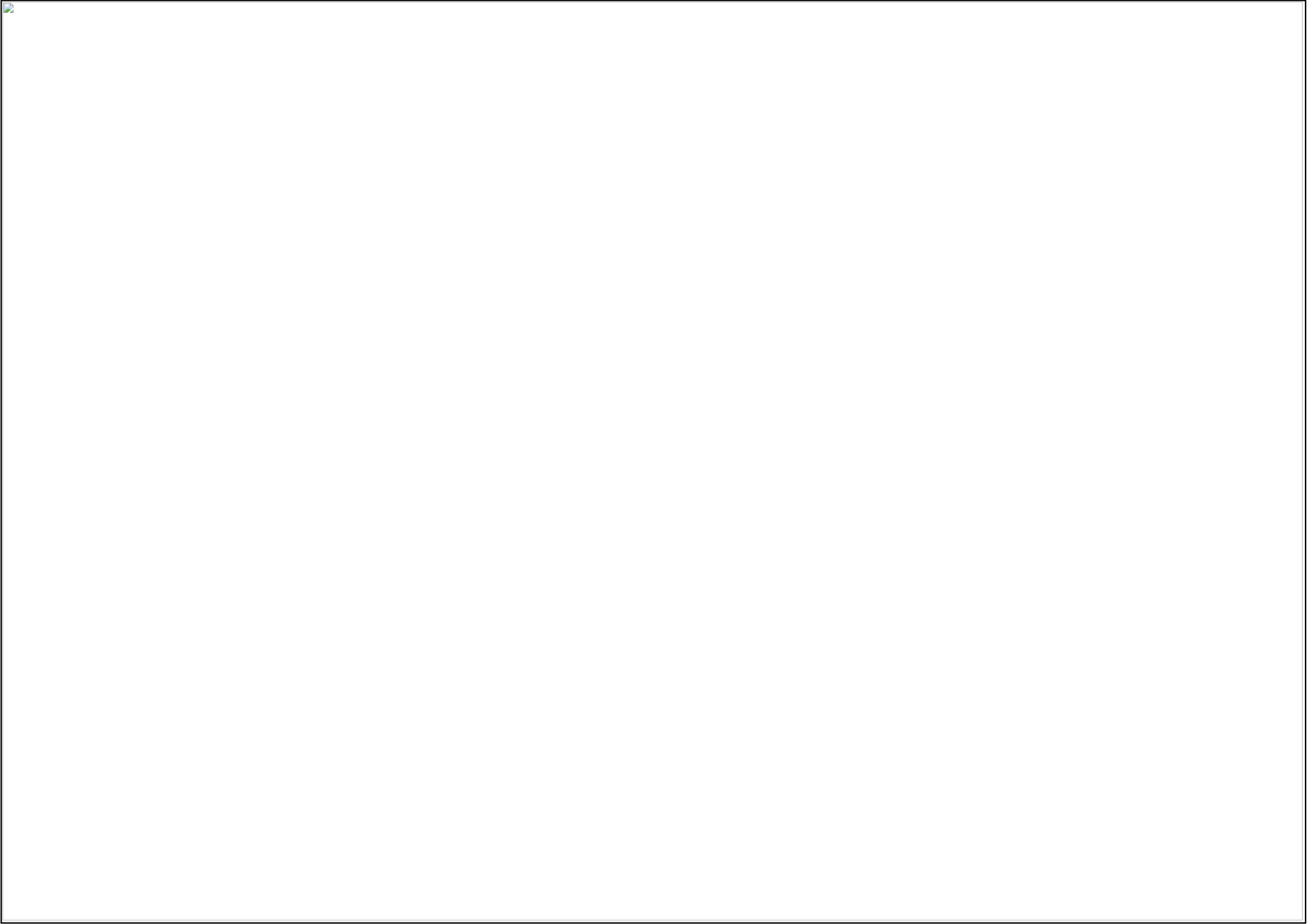
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Last but not least, I would like to thank my parents for their endless support and encouragement throughout my study.

Finally, I would love to express my deepest gratitude to everyone in the Bartlett School of Planning, for the greatest 4 years of university.



Introduction

Research Question

'How does enriching a tertiary network contribute to improving pedestrian safety and security, and thus promote walking in dense metropolitan areas?'

Secondary Questions

- How does activating a tertiary network activate the area, i.e. drawing in new users?
- How does the network accommodate different levels of activities, particularly on the balance of movement and activities?

Objectives



To encourage developments that prioritise pedestrians.



To maximise the use of spaces in dense metropolitan areas.



To create a network that supports different level of activities, balancing different pedestrian needs.



To provide alternatives to the ordinary road safety measures.



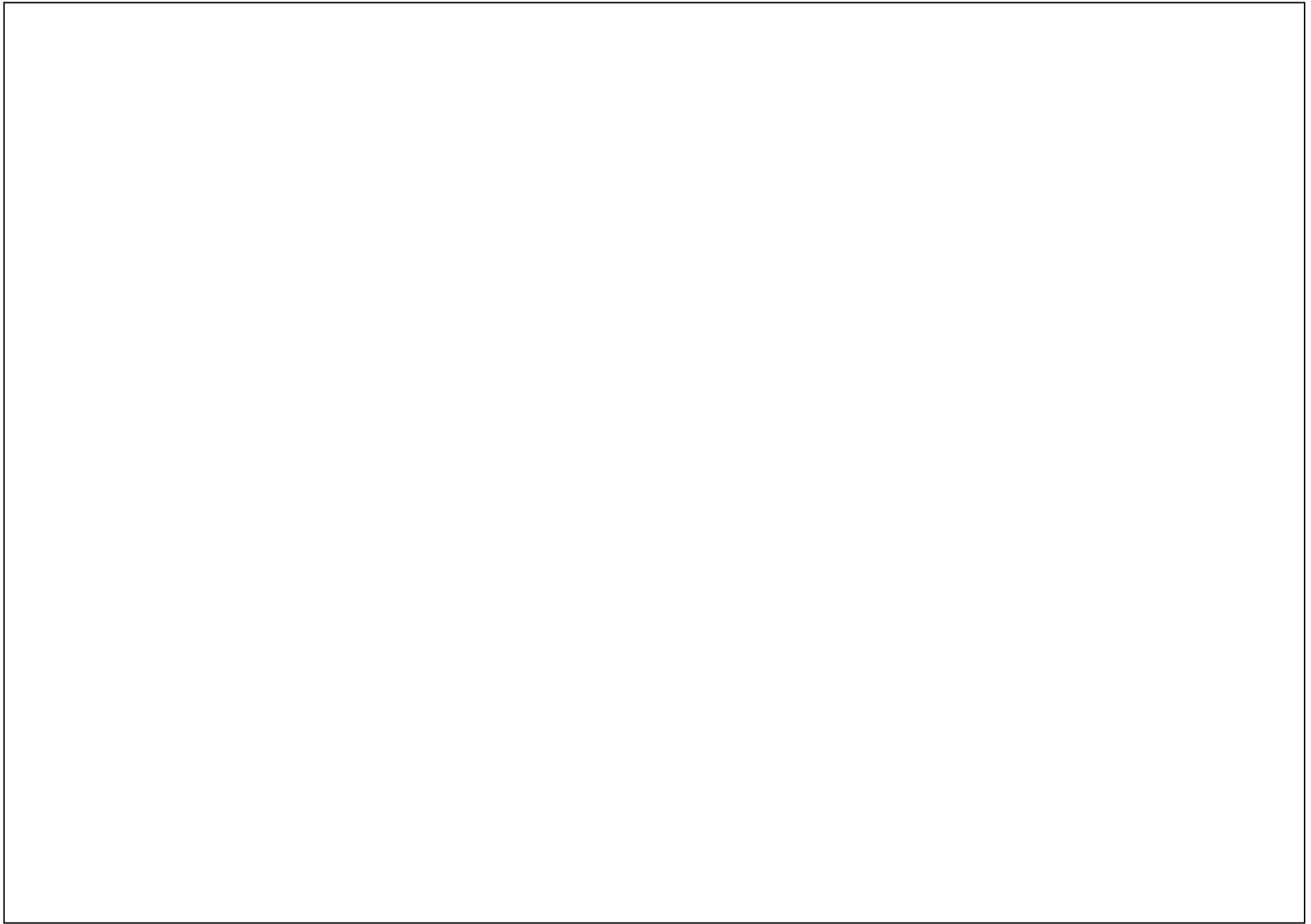
To establish principles and a toolkit, with enhancements upon reflection on the application.

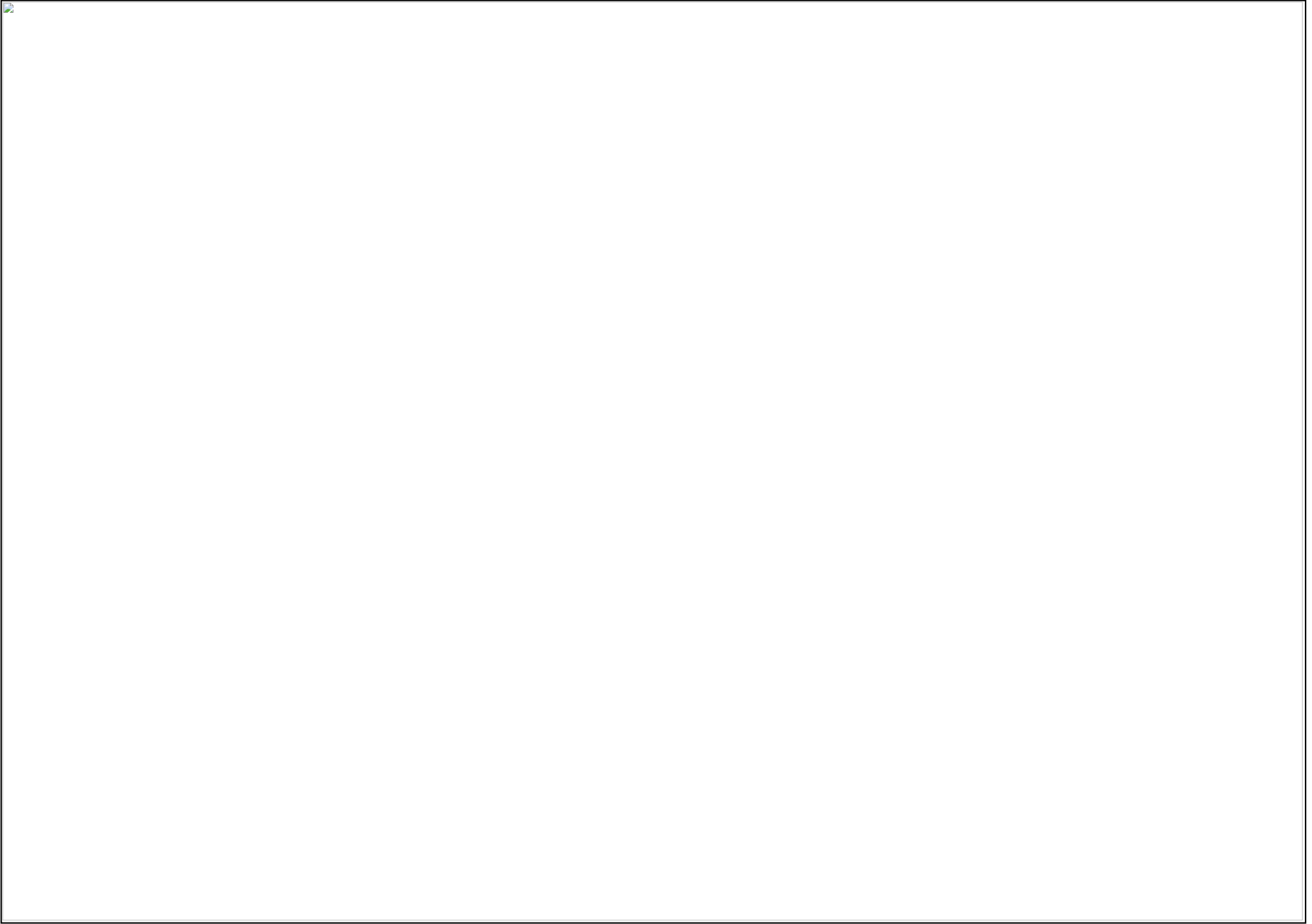
Contributions to practice

There has been a rising trend of prioritising pedestrians in new developments, with multiple local authorities in the UK promoting car-free developments. This research can provide insight to the potential of reconfiguring existing routes into a network with pedestrian priority through intensification and increased animation. In the application part of the research, it has realised the potential of altering use of the network at different times of day and week. This is particularly applicable to developments that involves office blocks. This research attempt to provide a toolkit that is appropriate for various scales and type of developments in dense metropolitan areas, ranging from redevelopments of several blocks to an area-wide strategy. It is applicable for both urban designers and planning authorities.

Ethics Statement

It is believed that the research does not contain ethical risk as it will not require contact with any vulnerable groups, nor data collection related to them.





Literature Review - Context : Pedestrian Mobility

The increase in traffic flow and priority towards transport system has shown negative impacts on pedestrian mobility, particularly to vulnerable users with reliance on walking, e.g. elderly and low-income populations. (Manaugh and El-Geneidy, 2011)

It is prominent to promote pedestrian mobility since the freedom of "walking and looking around" is an essential component of quality of life. Also, walking:

- is convenient and fast for short journeys
- improves accessibility to local amenities and jobs
- is as an activity with its own appeal
- promotes health, independence and life satisfaction

(Anciaes, 2011; Buchanan and Crowther 1963, Warburton et al., 2006)

Needs and behaviours vary according to pedestrian profiles, such as age, familiarity of the environment, individual or group travel, entry and exit location to the network, time of day, etc.

Pedestrian Behaviour

Pedestrian behaviour is complicated. Compare to other road users (e.g. motorized vehicles), they do not have to follow fixed movement lines. This freedom in movement suggest that designs should allow for 'randomness' (Bezbradica and Ruskin, 2019). Wide-ranging research has attempted to understand pedestrian dynamics, predominantly on self-organisation patterns and interaction of pedestrian flows (Augustijn et al, 2009; Bezbradica and Ruskin, 2014; Couzin and Krause, 2003). Others classified pedestrian motion through physical model types (Seyfried et al, 2011) and some represented individual movement as superposition of pedestrian interactions (Moussaïd et al, 2011). More recently, geo-spatial intelligence made understanding pedestrian behaviour trends more plausible. (Laurier E et al, 2015)

Pedestrian Need

Walkable streets are places where people find their basic needs met. In the literature, numerous pedestrian needs have been identified. Some suggest 'needs' are structured with a hierarchy, with the seminal work by Maslow (1943), but some believe 'needs' interacts, and sometimes specific needs would conflict with collective needs (Methorst et al, 2010).

Below is a summary of the most common needs and design features identified in the literature :

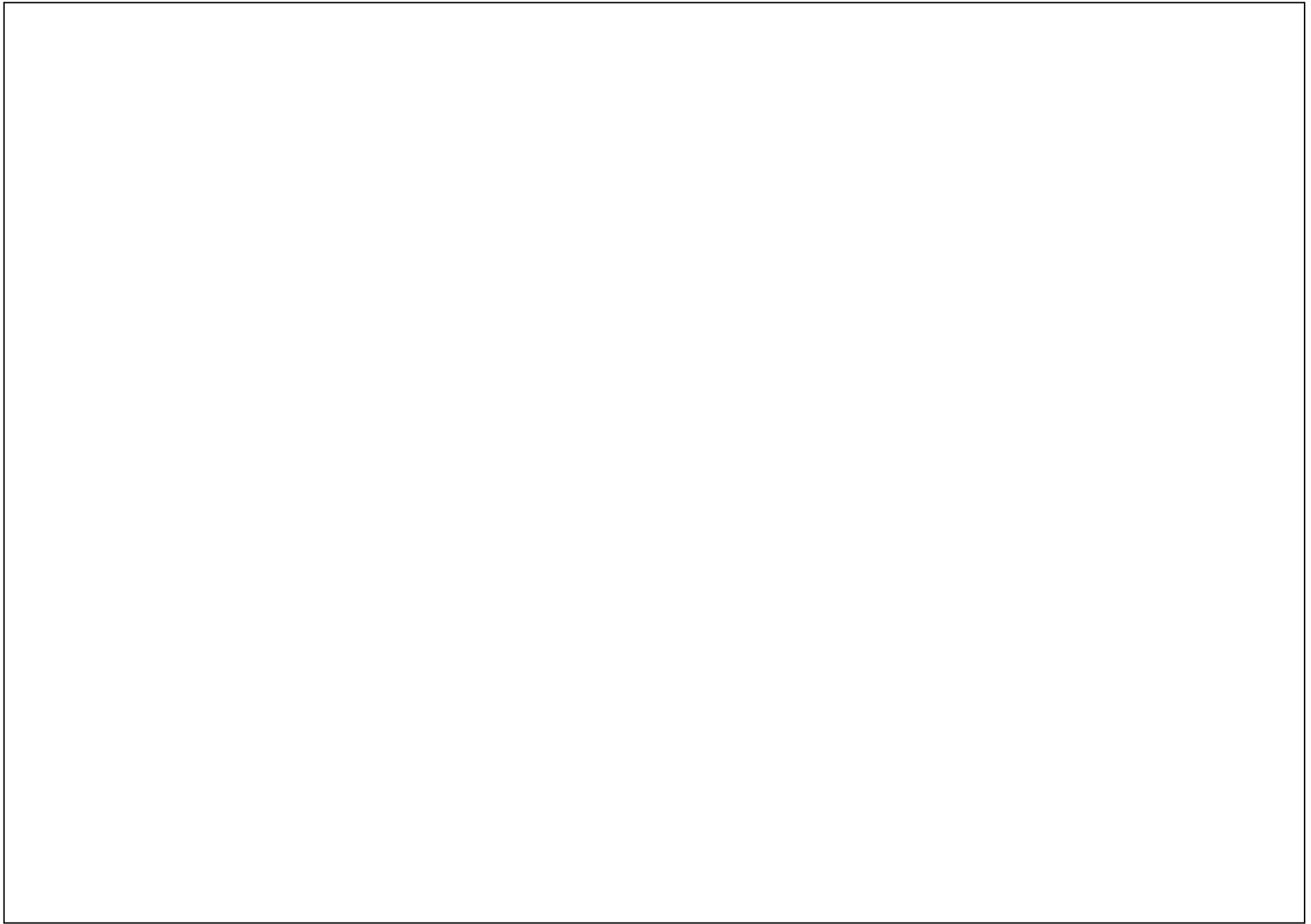
| Perception/ Precondition | Appearance | Activity | Movement |
|--|---|---|--|
| <ul style="list-style-type: none"> • Safety • Legibility • Health • Protection against pollution • Weather Protection • Familiarity • Welcome | <ul style="list-style-type: none"> • Aesthetic • Attractiveness • Self-identification • Terminating vistas • Cleanliness • Presence of green • Maintenance | <ul style="list-style-type: none"> • Usability • Vitality • Comfort • Social Value • Social contacts and Relations • Variety • Efficiency • Crowd management • Flexibility • Proximity to green space | <ul style="list-style-type: none"> • Mobility • Connectivity • Convenience • Accessibility • Chaining of trips • Walking distances • Ease of navigation |

Figure 03: Pedestrian Needs (Burden, 1999; Methorst, 2007; Methorst et al, 2010; Rauhala, 2007; Risser & Chaloupka, 2009)

| Footpath | Carriageway |
|--|---|
| <ul style="list-style-type: none"> • Footpath width • Street furniture • Lightings • Meeting points • Art • Shades • Amenities • Traffic calming measures • Surface Evenness • Pavement materials • Landscaping | <ul style="list-style-type: none"> • Carriageway width • Number of lanes • Crossing Types <ul style="list-style-type: none"> • Puffin , Zebra, Pelican, Toucan • Unsignalised • Pedestrian Subway, Bridge • Crossing placement • Speed Control |

Figure 04: Design Features (Hodgson et al, 2004; Rodriguez et al., 2015; Welle et al., 2015)

With the broken-window theory, specific requirements identified in tertiary routes is the level of use, perceived safety, surveillance and absence of signs of neglects (Monahan and Gemmell, 2016).



Literature Review - Mitigation: Safety Measures

In order to encourage use of tertiary networks, safety issues should be addressed. Safety in this research is classified as traffic-related safety and personal security. There are multiple ways of improving pedestrian safety in the literature with seminal work such as 'Defensible Space' (Newman, 1973) and 'Design Out Crime' (Design Council, 2015). In this report, intersection management, reclaiming road space and lighting strategy would be prioritised. Other key interventions, e.g. traffic calming measures, speed control, surveillance and land use redistribution, are noted but would not be the key focus of this research.

Intersection/ Crossing Management

This section is applicable to where the tertiary streets intersect with the secondary or primary routes, and routes with vehicular access.

Pedestrian crossings play an important role in encouraging walking (Department for Transport, 2006). In an area with mixed land use, there are high levels of pedestrian crossing activities. It is prominent to understand the pedestrian decision-making manner and interaction with road crossing, e.g. gap acceptance theory (Oxley et al, 2005). Two main types of crossing behaviour include (Martin, 2006):

- predictable: those who follow the safety procedure;
- unpredictable: those who cross without waiting for the signal, crossing between parked cars, not using nearby crossing, or run across the road without looking properly.

The latter is a detrimental factor of vehicle-pedestrian collisions. Although it is impossible to control pedestrian behaviour, this research aims to find solutions to account for such unpredictable pedestrian behaviour.

Formal pedestrian crossings usually locate at an intersection, where different user mix compete for time and space. They are also locations where collisions are more likely to occur. There are different forms of intersections, ranging from complex junctions, to driveways, to the meeting of two paths. Key examples include signalised and non-signalised crossing, T-junctions, four-way intersections and roundabouts. The general consensus is that the fewer intersection conflict points, the safer the intersections.

Studies have shown opportunities for intersections as major nodes, meeting points, and new public spaces. They are a form of extended streets. When designing intersection, simplicity, compactness, and low speed are favoured. Major intersections crossing improvement includes: curb extension, changing alignments, daylighting corners, re-location and redirecting traffic where necessary (NACTO, 2013).

Reclaiming Road Space

With the growing focus on sustainable travel modes and the shifting away from automobiles, there is huge potential in reclaiming road space for pedestrian use. This could be dealt with at different scales, from parklets to complete pedestrianisation. The rise of 'superblock' theory, where it reclaims streets from vehicles and transform them into walkable public space, sheds insights on the potential of pedestrianising tertiary routes, re-routing traffics to the 'main roads' surrounding the blocks, allowing limited or no vehicular access within (Vivanco and Escudero, 2018).



Figure 09: Diagram showing superblock concept (Bcnecologia.net, n.d.)

Widening sidewalks could encourage pedestrian use, improve flow, provide more space for amenities, and allow for easier street-crossing. It not only improves safety and calm traffic, but also poses potential to revitalise the economy and vitality of the street (Lowber, 2015). This could be achieved by increasing setbacks of new developments, redistributing roadbed geometries and reduction in number of lanes. One common example is to reclaim space from parking lanes, introducing temporary uses, outdoor seating, and parklets.

Sidewalk widening is subject to various limitations, particularly with existing street widths, and presence of parking lanes. It is crucial to understand the vehicular use of space and pedestrian patterns in order to determine the need of sidewalk widening (PPS, 2008).

| | With Heavy Vehicles And Public Service Vehicle Access | Car And Light Vehicles Only | Single Carriageway Roads (Two-Way Operation) |
|------------------------------|---|-----------------------------|--|
| Desirable Minimum (m) | 3.25 | 2.75 | 5.5 |
| Absolute Minimum (m) | 3.0 | 2.5 | / |

Figure 10: Recommended lane width minimums (Department for Transport, 2009)

Alternatively, complete pedestrianisation could lessen collisions by 50% or more (Elvik et al., 2009). With little or no car use, creates optimal conditions for pedestrian's free movement and road safety. It also offers aesthetic, economic, and social benefits, enhancing access to retail and improves air quality. Such approach is more substantial, feasibility is highly dependent on the transport network.

With limited spaces in dense cities, both widening sidewalk and complete pedestrianisation could be introduced on a temporary basis depending on the need and existing pedestrian patterns. This allows for flexibility and maximisation of different uses at different times of day and week. The scale of road reclamation should also be determined by the amount of existing public space and land use in the surrounding area.

Literature Review - Mitigation: Safety Measures

Lighting

Pedestrians are less attracted to areas where there are dark spots. The potential of being victimised keeps many pedestrians from travelling through an area at night, or even daytime where daylight is insufficient. Hence, lighting is crucial to the success of an area. It promotes safety and security, reduces both daytime and night-time crime, complemented by other safety measures. For road safety, it allows motorists to detect pedestrians, vice versa. For security, it allows detection of passers-bys and increase chance of identifying wrongdoers (Electricity Council, 1984).

In commercial districts, level of lighting should be dealt with more carefully, particularly around ground level (FHWA,2006). Pedestrian requires three sources of lighting – overall street lighting, low placement lighting, and light emitted from active frontages. It is recommended to have grazing light directly above ground, which ensures the lighting does not disturb pedestrian's view onto the ground and into distance (Brandt and Geissmar-Brandt, 2007). Alternatively, for narrow space, direct light towards the wall of building is suggested, where intruder could be seen directly, or as a silhouette (ILE, 2005). Lighting around cross-walks or raised channel islands are also required for road safety.

With technological advancements, lighting can contribute to much more than security and safety use, providing orientation and recreational uses. Recently, there has been more attempts in using lighting as a mean of urban design, providing alternative solutions to urban challenges (Bevolo and Rosenius, 2014). See case studies for more .

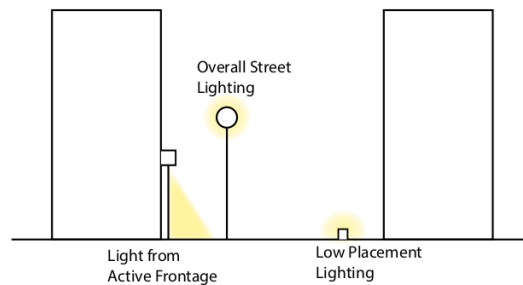


Figure 11 : Key source of lighting on streets

Literature Review - The Challenge

Balancing Conflict Between Different Uses

Streets are multi-functional, providing functions such as (City of London, 2010):

- Circulation for pedestrians, cyclists and vehicles;
- Transit access;
- Access to buildings,
- Utilities route;
- Storage space;
- Public space for human interaction e.g. parades, gathering, chance encounters;

A street should be designed to accommodate various functions. However, limited literature has covered how to design for competing street uses. Seminal concept is 'Link and Place' by Peter Jones, where 'link' refers to streets as a conduit for through movement, and 'place' as a destination on its own, where activities occur (Jones et al, 2008).

The two key street function as places and channels of movements, compete and complement each other correspondingly.

In public spaces, there are often desire lines through spaces where most movements happen. Within the movement network, majority of users would pass straight through, with limited users stopping and engaging directly with the space (Carmona, 2019).

At the same time, public realm on streets are designed to encourage activities to take place within it, accommodating a range of users, creating visual interest and encouraging social interaction (City of London, 2010). Nonetheless, promoting pedestrian activities would increase conflict of footway pressures. Pedestrian congestions are one of the biggest concern in street designs, particularly where the footway is narrow or with intrusive street furniture (Jones et al, 2007b). As a result, this leads to two types of conflicts – competition on footway (e.g. between street sellers and people in a hurry), and compatibility constraints, where even with sufficient space, some street uses might not be able to coexist comfortably (e.g. fast traffic and pavement cafés) (Jones et al, 2007a).

That being said, high level of through-movement would generally stimulate high levels of activities, with the highest activities occurring in the gaps between dominant lines of movement, and hence, being drawn to the key amenities nearby (Carmona, 2019).

To strike a balance, sensitive planning is essential when designing spaces, especially when introducing active use. Street capacity, functions and space required are derived from factors such as (Carmona,2019; Jones, 2008):

- Length of street segments: opportunities to locate street design elements at different points along the street.
- Surrounding land use : character of area
- Width of street between buildings
- Timing of provision: time of day, day of week, season

Sensitive planning requires identification of various street users' need, assessing the total space requirements for all type of activities on a street segment. Most times, there are 'minimum' and 'desirable' level of Link and Place street space provision, allocated based on needs (Figure 12). This allows for flexibility to reduce space requirements for particular street design feature (e.g. larger/smaller benches) and the possibility of using the same space – simultaneously (e.g. shared space) or at different time periods (e.g. temporary market stalls during lunchtime, loading during off-peak hours) – to accommodate multiple needs.

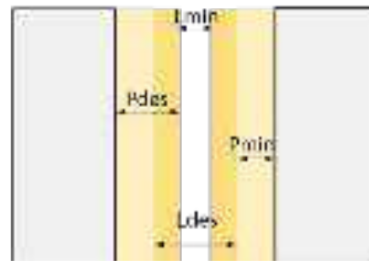
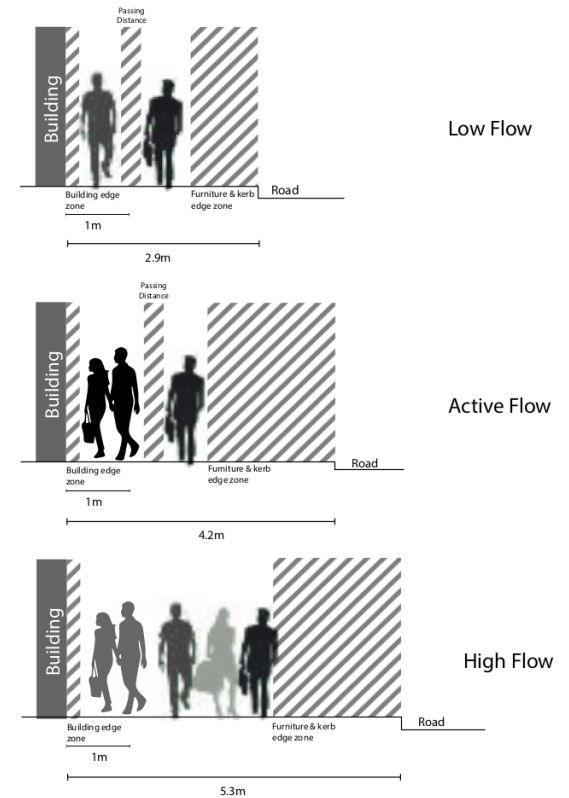


Figure 12: Minimum and Desirable Width for link and place (Adopted Jones, 2008)

Balance and layout of the street design depends on the relative link and place status of the street segment, land use characteristics, transport modal priorities and physical space available. Amount of space allocated to different uses varies, even if their status are the same, as there are multiple factors.

Below are the recommended street widths for different pedestrian flow by Transport for London (2010).



| | With large furniture (e.g. guard rails, cycle parking, pedestrian crossing) | Without furniture | |
|----------------------------------|--|-------------------------------|--------|
| | | High Street/ tourist areas | Others |
| Low flow (<600pph) | 2.9m | 2.6m | 2m |
| Active Flow (600 – 1200 pph) | 4.2m | 3.3m | 2.2m |
| High Flow (>1200 pph) | 5.3m | 3.3m | 3.3m |

Figure 13: Footway widths for different levels of flow (Transport for London, 2010)

Measuring Success

The success of public spaces are determined by multiple factors. Synthesising from the literature, below are the key indicators to the success of spaces (Carmona, 2019; Mehta, 2014; Urban Design London, 2017):

1. Flexibility

Spaces that can adapt to different users and activities, at different times of day, week or year; whilst being able to adapt to changes in needs and circumstances.

2. Right mix of uses and activities

Uses and activities that complement each other, with efficient use of land resources.

3. Engagement and Sociability

Background activity level, spaces with active uses, and different interactions – planned and spontaneous encounters.

4. Fit for purpose

Uses and activities are accommodated at the right capacity.

5. Allow easy movement

How people get around and how development is connected to the surrounding area.

6. Comfortability

Environment for people to feel safe and relax.

7. Attractiveness

Appearance and type of activities offered that is appealing and appreciated.

8. Distinctiveness

Having a unique, positive identity and sense of place.

9. Sensitiveness

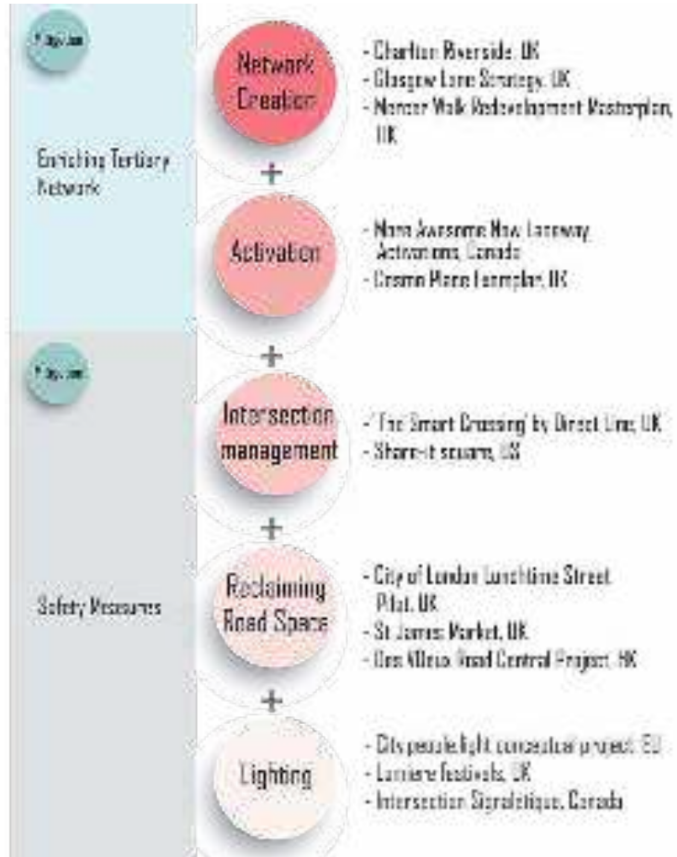
Response to local needs and context.

10. Stakeholder engagement

Involvement of local community and businesses throughout different stages of development – planning, installations, maintenance, etc.

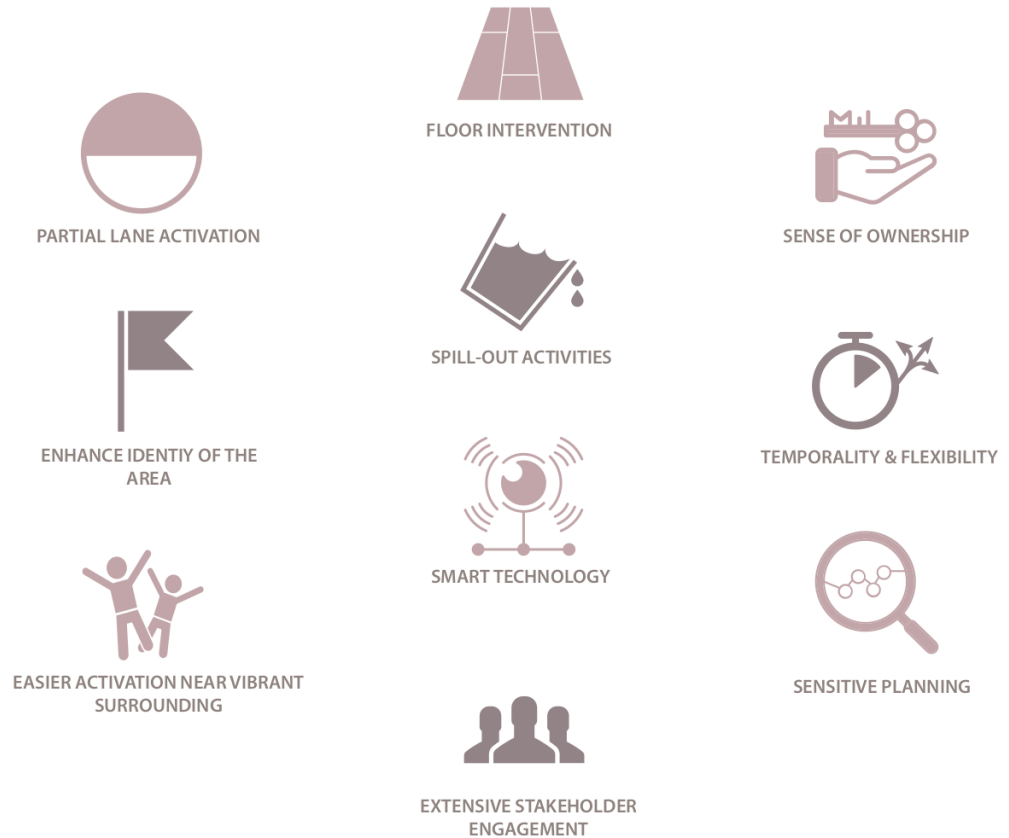
The above would inform the design process and evaluation of the project.

Case-studies



Recurring Themes

Below are the recurring themes synthesized from the case studies:



Case-studies

Charlton Riverside Movement Network (SPD), UK



Summary

A supplementary network of streets and public space linking major nodes through existing, new or recovered historic routes, amplifying the primary routes.

Intervention

- shared surface/ pedestrian priority zones
- 20mph speed limit in secondary/ tertiary routes
- permeable block structure design
- provision of green infrastructure

Lessons Learnt



- Green infrastructures can link and form routes e.g. tree-lined streets.
- Key attributes to the design : characterful, legible, safe, permeable.
- Secondary and tertiary routes could be used as linear public space.
- New routes could be created to support and link existing routes.
- Variety of route options between key destinations.

Glasgow Lane Strategy, UK



Summary

Comprehensive strategy for maximising use of city centre lanes through creation of attractive and active lanes, fostering a thriving civic life and promoting economic growth, inclusion and sustainability.

Intervention

- public-private partnership
- surveying local groups
- space for artist (due to strong art scene in Glasgow)
- multiple action projects e.g. heritage and visitor attraction

Lessons Learnt



- Specific attention has been drawn to where the primary/ secondary routes and lanes intersect. The surface design, hard/soft landscaping draw users' attention to the adjacent lanes and encourage use.
- Proximity to secondary/primary routes could help define hierarchy of tertiary routes.
- Character zones could be identified to support street network design, targeting different users.

Mercer Walk Redevelopment Masterplan, UK



Summary

Layout reconfiguration of a site that was only accessible from one side with uninviting street frontage. Proposal incorporated a new pedestrian route through site, with additional retail frontages.

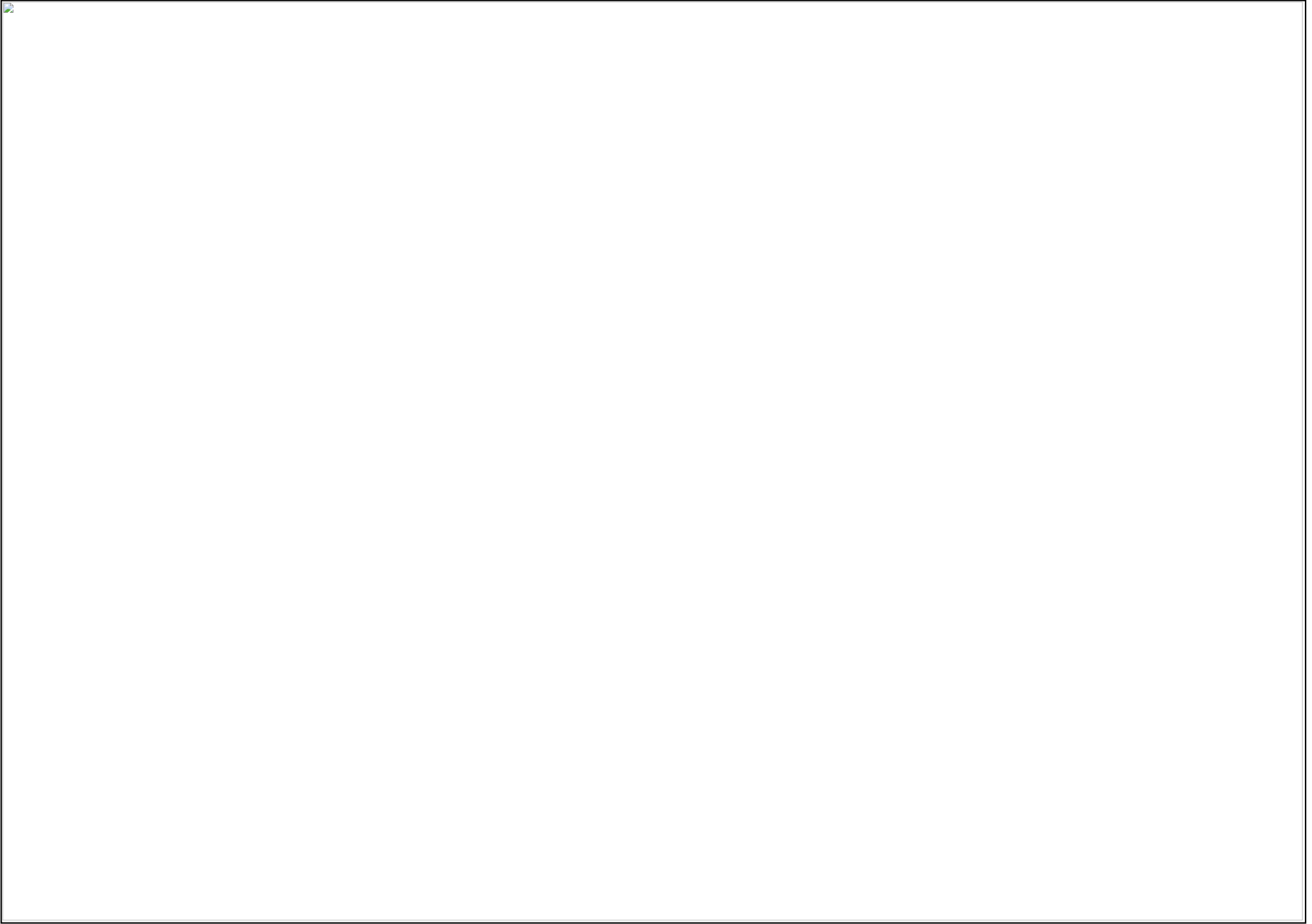
Intervention

- new pedestrian route
- new active frontage
- new public square

Lessons Learnt



- The development demolished and reconfigured a few buildings, without demolition of the whole site.
- Movable street furniture could allow for interactive public spaces.
- The new connection adjoins the wider area, to a further destination.



Case-studies

'The Smart Crossing' by Direct Line, UK



Summary

Responsive road crossing that differentiates between vehicles, pedestrians and cyclists automatically, aimed at reducing traffic and pedestrian accidents.

Intervention

- smart technology: LED road surface, sensor & signals
- visualisation

Lessons Learnt



- Adaptive technologies could be used to address unpredictable pedestrian behaviour.
- Unlocked potential of projection on road space, e.g. advertisement, wayfinding.
- Colours and visualisation could catch attention of pedestrians, raising awareness when crossing roads.

Share-it-square scheme, US



Summary

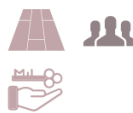
A community-initiated project that transformed an intersection to a community crossroad.

The intersection has attracted families to live around it, with adults bringing their child to the intersection, and spill-out of activities to the rest of the streets and the wider community.

Intervention

- painting on road surface
- street furniture e.g. kiosks and lending library

Lessons Learnt



- Designs should cater local needs, involving locals at different stages of improvement projects.
- Paintings can allow people to express their identity, and develop sense of ownership.
- Such intervention can encourage community-building, almost creating an outdoor living-room.
- These spaces encourage exchange of ideas, objects and culture.

Case-studies

City of London Lunchtime Street Pilot, UK



Summary

An event that removes traffic from a street over lunchtime, allowing people to enjoy their lunch in a safer and more pleasant environment.

Intervention

- pedestrianisation
- surveys
- stakeholder engagement

Lessons Learnt

- Effects on and perceptions of local communities are studied prior the event, understanding the peak times with highest pedestrian concentration
- Diversion of daytime traffic to make space for street activities is plausible.
- Workers enjoy to have lunch outdoor if pleasant environment is provided
- Retailers support street closures for vending purposes, as they boost economic activities in the area.

St James Market, Piccadilly Circus, UK



Summary

Redevelopment of two buildings with extension of public realm improvements beyond site, introducing a new public square and pedestrianised routes.

Intervention

- pedestrianisation
- street furniture
- new public square & active frontage
- public realm improvements

Lessons Learnt

- Vehicle access could be restricted in certain areas
- Building lines could be reconfigured to increase public realm and active frontages
- Change in pavement material can change the character of the area and attract more pedestrians.

Des VDeux Road Central Project, Hong Kong

Summary

A proposal that promotes walkability and liveability, including a shared space, widened pavement for pedestrian and event use, removal of barrier between pedestrians and trams, etc. . One-day trail proved possibility.

Intervention

- pedestrianisation
- street furniture
- public realm & green infrastructure improvements
- smart technology

Lessons Learnt

- The key is to enhance pedestrian experience and rigorous street management.
- Connecting the site to the surrounding point of interest would facilitate a formation of neighbourhood, improving attractiveness of the routes.
- Understanding the history and context of the site is vital to its success. It helps formulate the rationale of the proposal and development of a clear design concept.

City.people.light conceptual project – Speaker’s Corner



Summary

A conceptual project exploring the opportunity to merge lighting design with mobile media, utilizing public lighting installations as gathering points to stimulate socialisation.

Intervention

- smart technology

Lessons Learnt

- Integrating smart technology into lighting could empower people to interact with the environment, creating a new culture of urban socialisation.
- Lighting can encourage ‘play’ and transform the area as a destination.



Lumiere Festivals, UK



Summary

A light festival that exhibits interactive installations, involving local and international artist, reimagining familiar buildings and public spaces.

Intervention

- lighting as art
- smart technology
- stakeholder engagement

Lessons Learnt

- Lighting can engage people, provide opportunities for social activities at night that is family-friendly.
- Lighting can provide a transformation effect and enhance the character of the area.
- Temporary installations can be remained permanent



Intersection Signalétique, Canada



Summary

A project exploring the potential of light projection on pavements to create signage and express identity with the urban landscape.

Intervention

- smart technology
- interactive elements

Lessons Learnt

- Lighting can act as a wayfinding system.
- This can encourage people to explore the nearby area at night.
- Demonstrated potential of floor interventions (e.g. interactive floor, floor graphics) to improve pedestrian mobility and safety.



Summary of Literature Review and Case Study

Summary below helped identifying key interventions required to create a network that is safe for pedestrians, reflected in the toolkit.



Figure 14: Summary Diagram of Literature Review and Case Study



Toolkit - Framework

The toolkit is divided into 4 parts - the missing link, the balance of activities, the 6 steps and site selection attributes, supported by 4 key action objectives. All materials are derived from the literature review and case studies findings.



Figure 16: Toolkit concept

Toolkit - The Missing Link

Below are the 'missing links' that could facilitate the formation of a tertiary network. They have been classified to four categories with reference to the literature review, catering different pedestrian needs. Note 'links' here are referred to interventions.

Perception/
Precondition



Security Lighting

Improvement of existing level of lighting, including introduction of low-placement lighting, and direct light towards wall of building in narrow spaces.



Curb Extension

A traffic calming measure that provides additional pedestrian space with potential provision of street furniture, most applicable to roads with street parking.



Stakeholder Engagement

This includes initial local surveys, and input from the local community, businesses, artists, etc. Hence contributing to better maintenance and management of the intervention.

Appearance



Pedestrianising Routes

Temporary or permanent intervention depending on existing level of use by both vehicles and pedestrians, and the possibility of re-routing.



Joining primary/ secondary routes

This includes pavement material coordination, opening up of activities, and increasing walkability between routes.



Green Infrastructures

This includes tree of trees, landscaping, rain gardens, planter boxes, etc. subject to the pavement width. This could provide aesthetic and environmental benefits, with traffic-calming effect.

Activity



Intersecting Gathering Space

Intersections as communal gathering spaces, with creative interventions by local communities, and communal facilities, eg. bike shelves, depending on local needs. Not ideal in areas with high volume of traffic.



Interactive Lighting

Lighting as a mean for social interaction and recreation purpose, allowing people to control lighting with their mobile device, and interactive pens.



Installations

This includes art installations, play elements, planters, etc. Consider temporary or permanent, depending upon performance and feasibility. Ideal to encourage local participation in the creation process.

Movement



Block layout Reconfiguration

Creation of new routes through large blocks, with potential additional active frontages and public square within.



Smart Crossing

Adaptation of crossing using sensors to detect different movement activities (pedestrian, cyclist, vehicles).



Widening Sidewalk

Removal of street parking and restriction of lanes.

Figure 17: The Missing Link

Toolkit - Application Guidelines

Balance of activities

Based on the literature review, street as places and channel of movement often compete and complement each other. It is important to strike a balance between them when activating the network. A series of pedestrian needs obtained from the literature review are identified, understanding the conflicts and the commons for both.

Below is a diagram showing the correlation between the indicators and level of activities, along with the corresponding interventions. For instance, the higher the link status, the lower the level of activities, vice versa. Variety of uses are also shown in relation to the length of street segments.

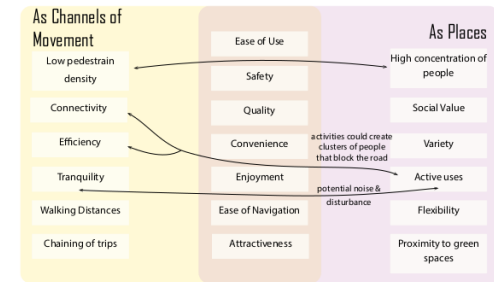
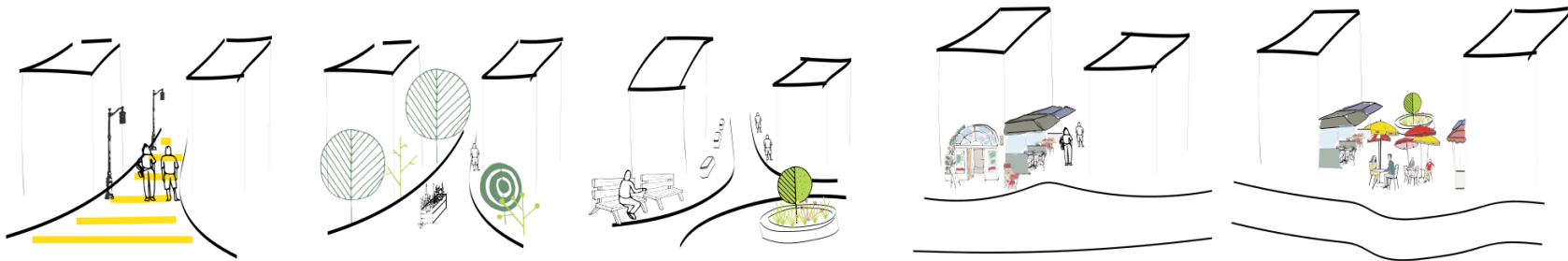
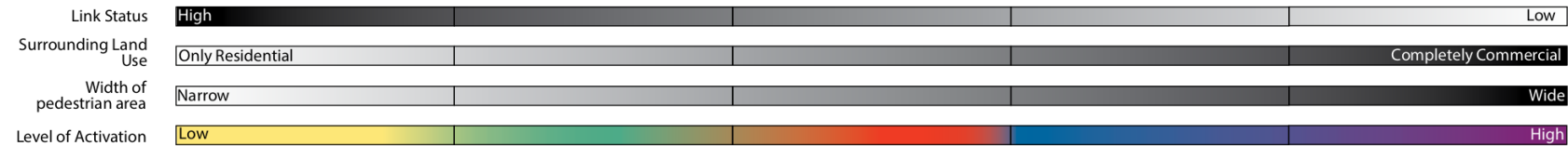


Figure 18: Desired Attributes for street as channels of movement and places.

Indicators



Interventions

Public Realm Improvements Green Infrastructure Street Furniture Active Frontages on one side Active Frontages on both sides

Indicators

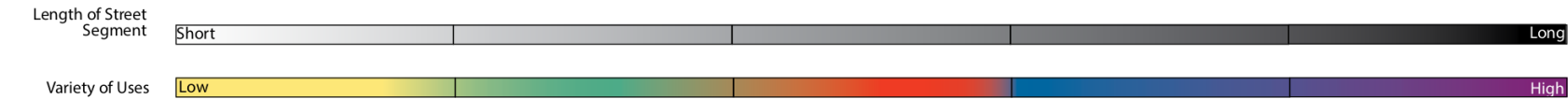


Figure 19: Balance of Activities

Toolkit - Application Guidelines

The 6 Steps

When applying the toolkit, these six key steps should be followed :

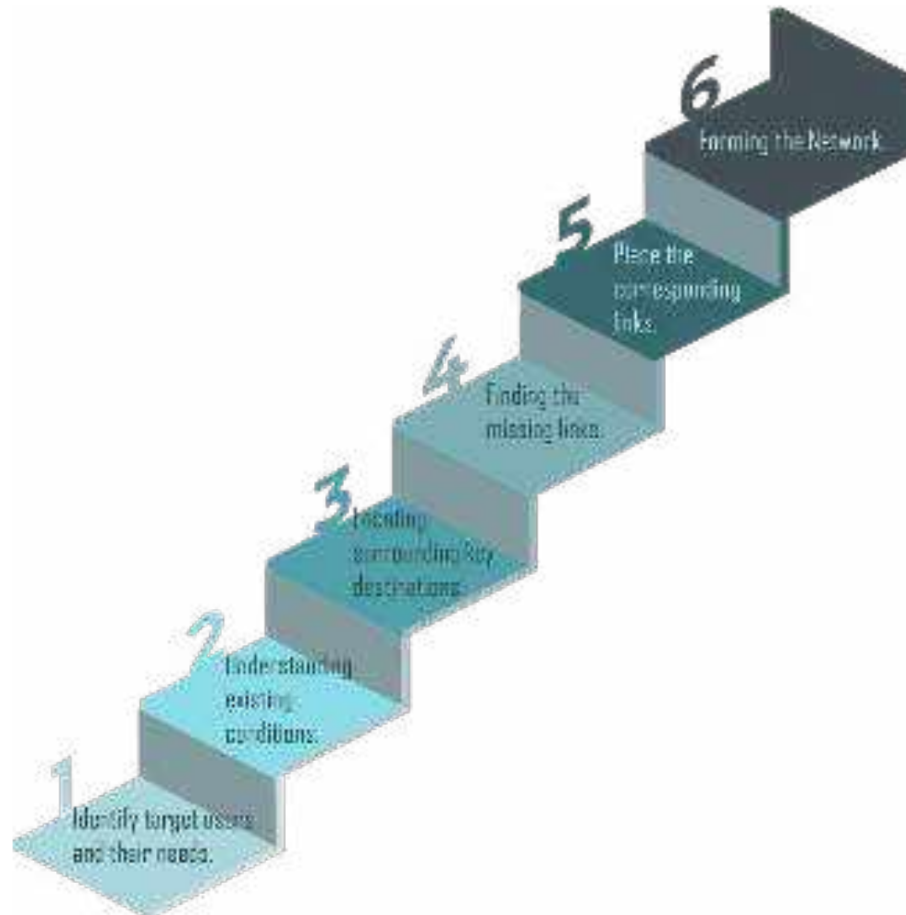


Figure 20: Toolkit Application Procedure

Site Selection Attributes

Below is a list of site selection attributes, of which the toolkit is targeted at. By choosing a site with most requirements fulfilled, the more effective it would be to test the toolkit.

1. High density mixed-use area
2. Presence of large urban blocks
3. Sufficient existing tertiary routes, potentially some with low footfall
4. Records of pedestrian collision
5. Presence of different street hierarchies
6. New infrastructure developments nearby/ on-site
7. Poor public realm and maintenance



Introducing the Site

Character of Area

The area is a worker-centric location. Surrounding facilities serve a tight convenience-driven catchment. Visitor behaviour is characterised by high weekday frequency and relatively low retail spending.

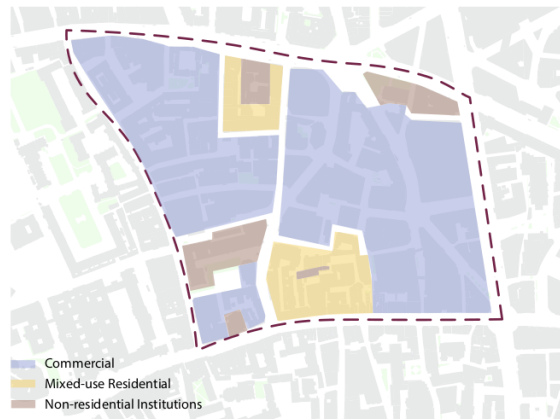


Figure 25: Land Use

In a retail study (Colliers International, 2017), only 9% of the respondent has visited the area during the weekend, predominantly for work/business or eating/drinking purpose as well.

High proportion of people are unlikely to recommend the area due to it being a place of work. The area would need significant development in order to create an evening and weekend destination.

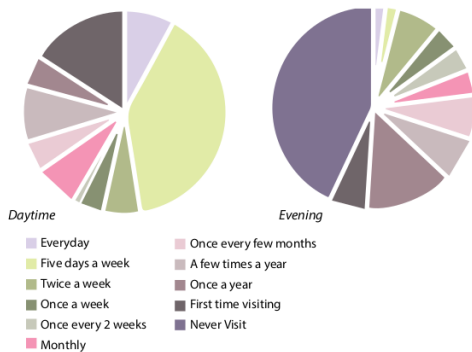


Figure 26: Frequency of Visit (Colliers International, 2017)

Retail offer - A 7-day economy?

Retail offer in the study area is predominantly food and beverage. Due to the worker-centric nature, it is difficult to adopt a 7-day economy. In the diagram below, the darker the colour represents the earlier the opening and close time, vice versa. During weekdays, stores tend to open and close early, some tend to open during lunch hours only, with a few exceptions of bars opening till late. It is deduced that the opening times pattern is designed in relation to the office workers. With 66 retail store on-site, only **22% opens during the evenings**(7pm onwards), and **27% opens during the weekend**. It is believed that this is a major factor contributing to the distinctively different character of the area during weekdays and weekends.



Figure 27: Opening hours during weekdays

Figure 28: Opening hours during weekends

General observation of pedestrian flow

Pedestrian flow during weekdays and weekends are observed in the same sample areas. Generally, there is significantly higher flow during weekdays, especially during morning when workers are arriving to work, and lunchtime. Although there is no clear barriers, there is huge distinction between the office and residential areas, people tend to hang around in the public spaces near big developments, rather than the intimate residential areas. There is one exception where a large flow of pedestrian is observed during weekends, which is as part of a walking tour.



Figure 29: Photos showing pedestrian flow on-site during weekdays and weekends

1 Identifying Target Users and Their Needs

Target Users

A study has shown that 53% of people visit the area because of business, with most people visiting 5 times a week (Colliers International, 2017).

Survey has also shown that more high quality shops, local events and attractions could make people visit the area more often both during weekdays and weekends.

Based on the analysis, target users of the proposal are derived.

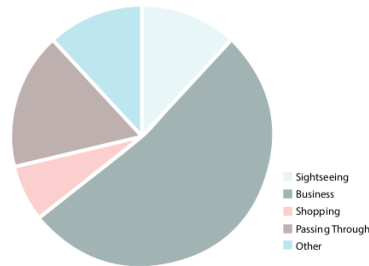


Figure 30: Purpose of Visit

Demographics



Workers

- 61% aged between 22-39
- 63% men, 37% women
- 28% black, Asian, or minority ethnic origin

(City of London Corporation, 2019)



Residents

- Relatively young population, ~75% aged between 15-44
- Mainly single residents/ childless couples
- Highest proportion of privately-rented residential within City of London

(ONS, 2011)



Tourists/Visitors

- Potentially people who are passing through, and decided to stay for longer, or the nearby tourists, e.g. those who are visiting the Temple Church/ St Paul's Cathedral.

User-specific needs & potential

On-site observation has shown that numerous workers would pop out of their office during working hours, most are seen to be standing around or sitting on the edge of buildings, additional seating in the area would be beneficial.

There are 352 housing units in the study area, residents are not very visible in the population. Apart from Shoe Lane library being a community gathering spot, no outdoor community facilities are observed in the area. There is potential in creating relationships between the residents and workers, offering something different to the residents during the weekends.

This category is the least observed on-site at the moment, one of the key objective is for the activated tertiary network to retain and draw people in the area, especially during the weekends, where there is minimal active usage on-site.

Accommodating Growth

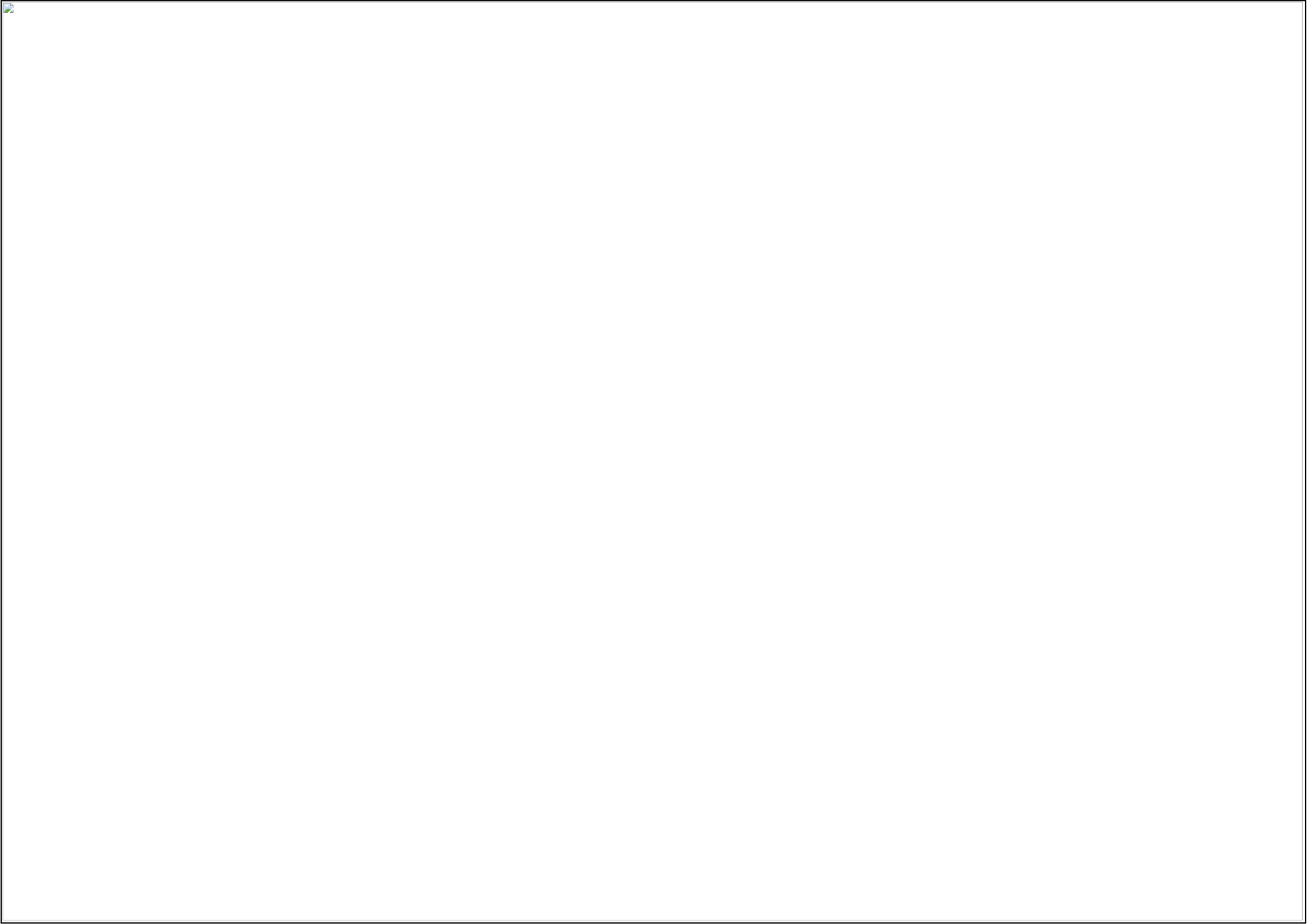
With the development of c.97,000 sqm pipeline of offices in the area, it is estimated to have an increase in daily population from 10,697 to 89,035 up to 2036. In addition, the new crossrail development in Farringdon would bring in a huge influx of people from all over England, 7-days a week.

Beyond Pedestrian Environment

Throughout the analysis, it is evident that the target users, not only desire to have better pedestrian environment, but also activities and facilities that attract them. Otherwise, there is no other reason for them to visit the area, if not necessary.

As part of the 'Lunchtime Street' campaign, surveys were conducted on, key interventions businesses anticipate (ACN, 2019):

- City Sports Day
- Performing Arts – busking, magic,
- Food Stall
- Themed events – health and well-being, charity
- Lunch Seating, picnic blankets and deck chairs
- Greening – temporary parklets, potted plants.
- Fitness classes during lunchtimes
- Meditation sessions
- Collaboration with local schools and charity



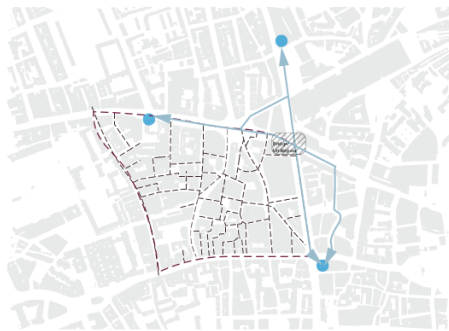
3 Locating surrounding Key Destinations

Transit Nodes

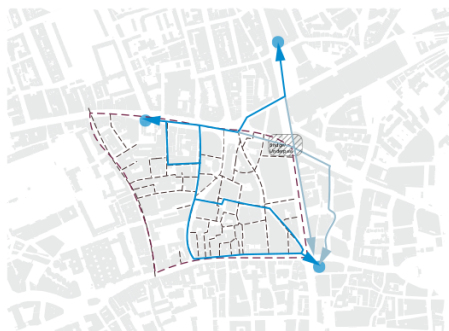
Key Destinations



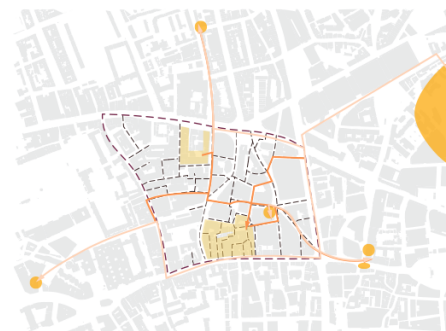
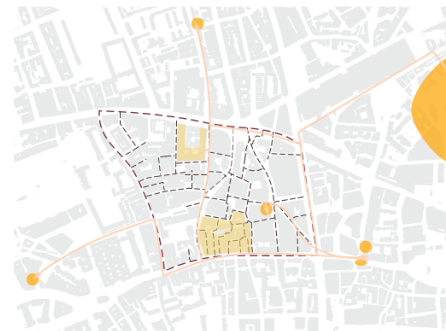
Existing Routes



Proposed & Existing Routes



Community Facilities



Point of Interests

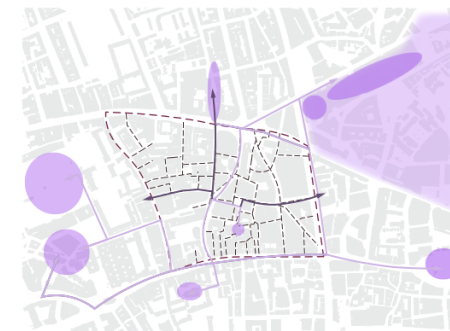
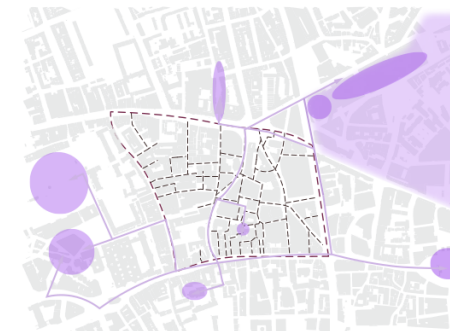


Figure 33: Diagrams indicating different key destinations and corresponding routes

3 Suggested Network based on key destinations

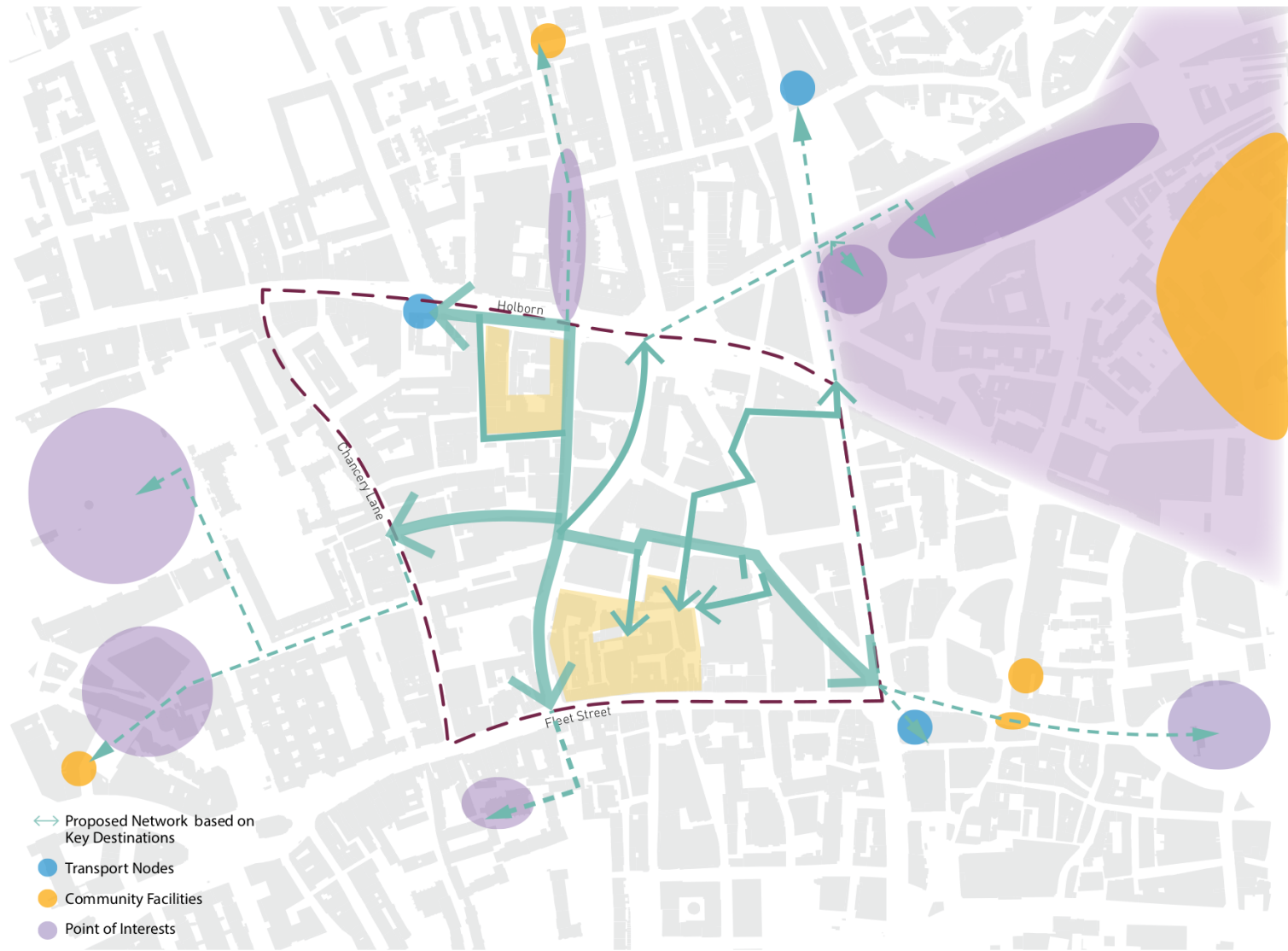


Figure 34: Proposed Network Based on Key Destinations



5 Placing the corresponding Links

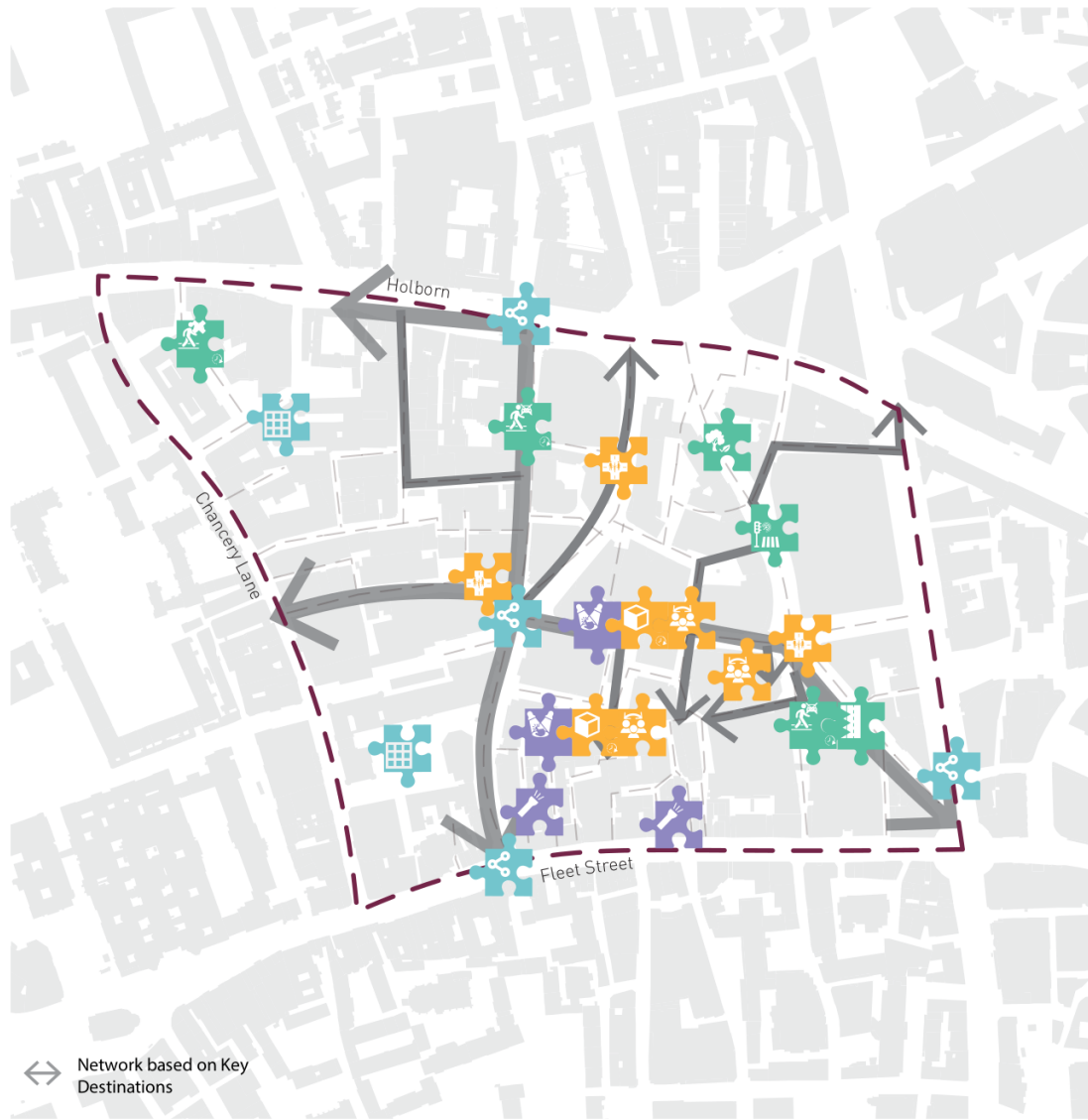














Figure 37: Proposed 'Links' Map

| | | | |
|-----------------------------|---|---|---|
| Perception/ Precondition |  Security Lighting |  Curb Extension |  Stakeholder Engagement |
| Appearance |  Pedestrianising Routes |  Joining primary/ secondary route |  Green Infrastructures |
| Activity |  Intersecting Gathering Space |  Interactive Lighting |  Installations |
| Movement |  Block Layout Reconfiguration |  Smart Crossing |  Widening Sidewalk |

6 Forming the network

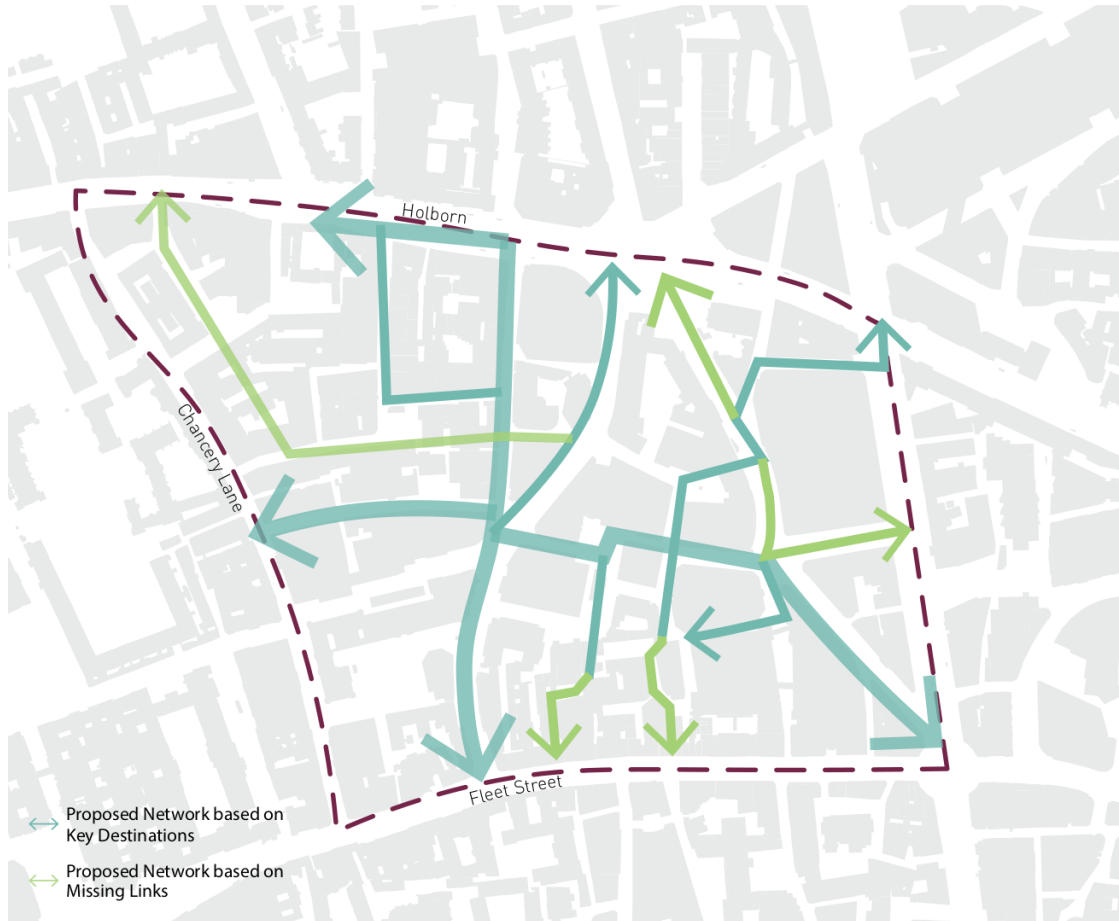
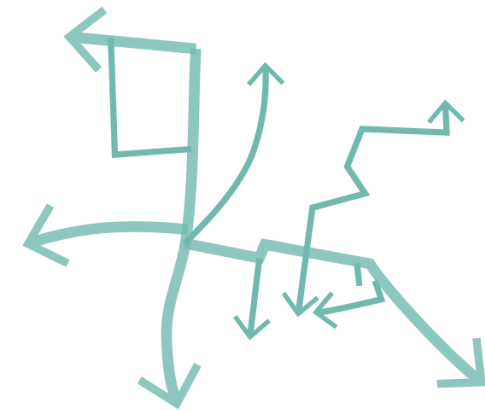


Figure 38: Proposed Network



Proposed network based on Key Destinations

+



The Missing Link

Site Specific Approach

With understanding of the site, it is noticed that the site performs distinctly different during weekdays and weekends. In order to create a network based on its context and local needs, the project aims to test the toolkit at different scenarios – weekday and weekends.

Weekdays

During weekdays, there is a strong need in accommodating the high pedestrian flow (particularly in the morning and lunchtime); meanwhile, balancing with the high traffic volume passing through an important junction. Hence, the design proposal should be focussed on pedestrian safety and comfort.

Weekends

During weekends, there is very low pedestrian flow, leaving an empty canvas in such strategic location, with tourist attractions nearby and well-connected transport links. Although the residential population is small, there is huge opportunity in allowing them to 'reclaim' their own space from the workers. Design proposals for the weekend should be centred around activation elements.

Both design proposals have the same goal of providing a pleasant environment for pedestrians, giving them priority to roam around and perform different activities. In line with findings in the case-study review, the idea of temporality and flexibility is key to the success of this proposal. The ideal outcome is to create a network that is used daily.

The following proposals will follow the flow of: overall improvements, weekday and weekend interventions.

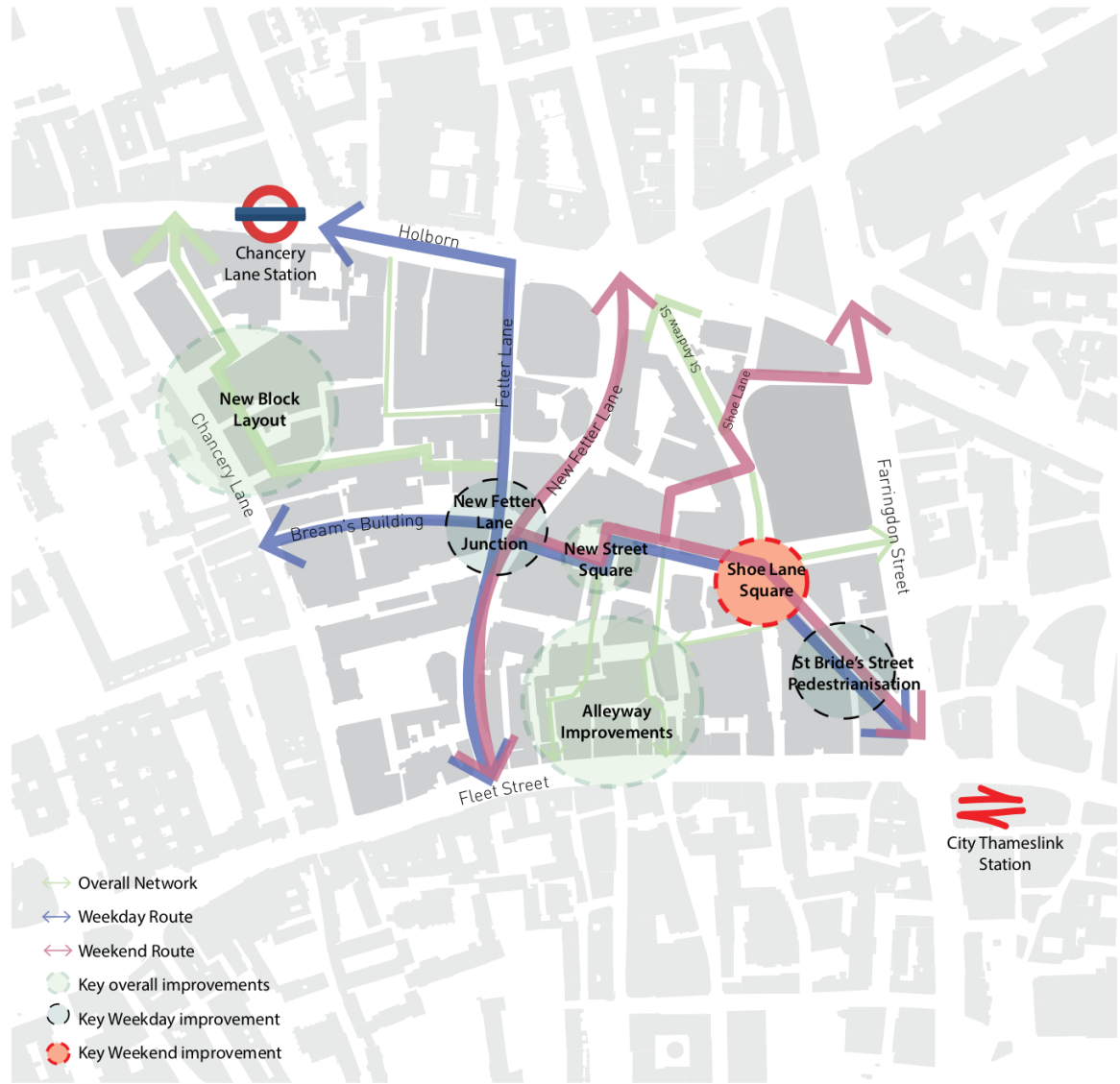
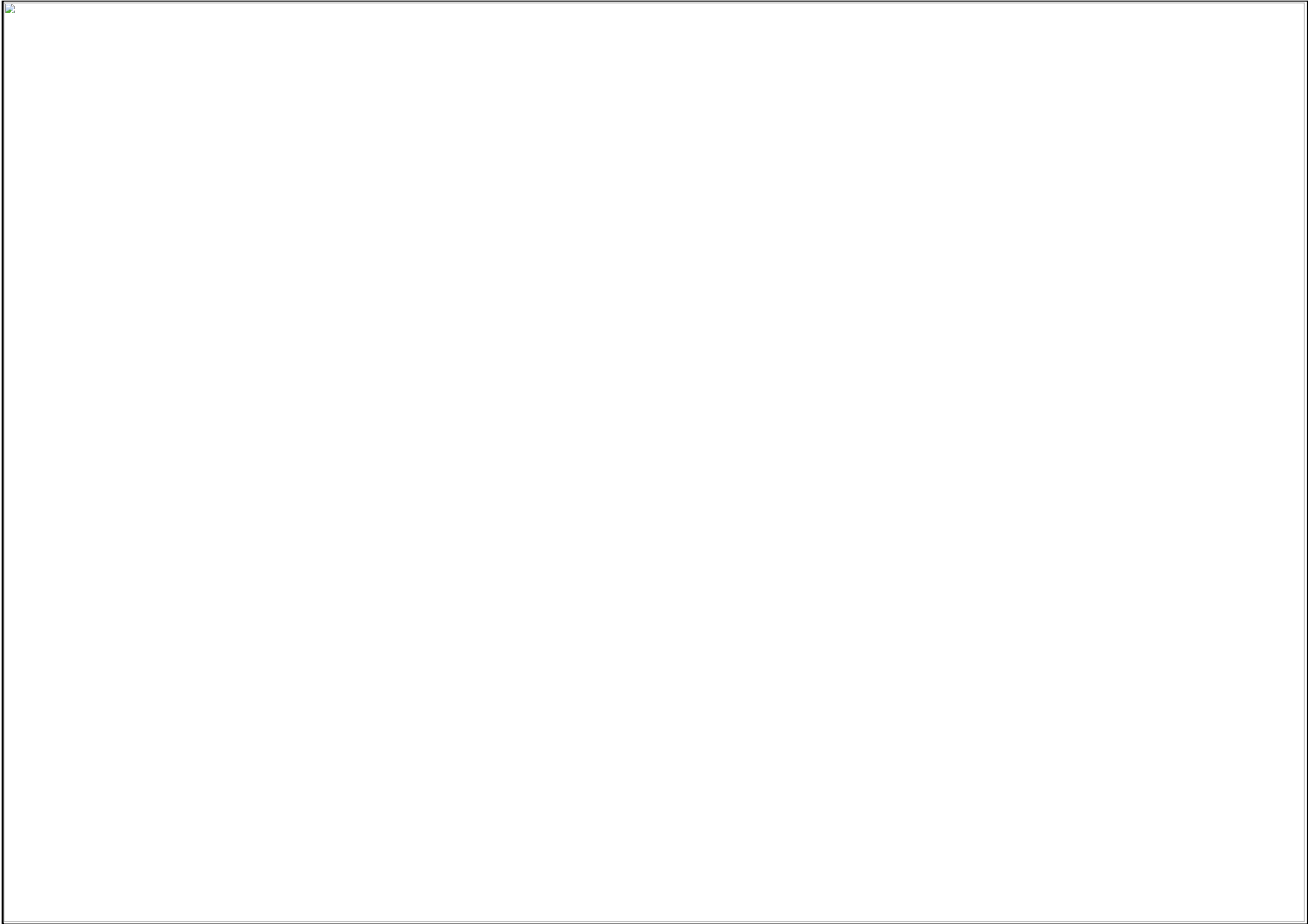


Figure 39: Overall Strategy



Application - Block Layout Reconfiguration



This link would be applied to the northeast part of the study area. The original site layout has segregated the part highlighted in red from the rest of the site, as there is no route through from Southampton Buildings to Cursitor Street. With the constraint of listed buildings (brown), a proposal has been made to break up the block and create new routes through it. This intervention has resulted in two new routes through site, an additional public space and active frontages.

The proposed site would retain the original building use as offices and mixed ground floor use.

Block Layout Reconfiguration

Original Site Layout



Figure 41: Impermeable route from point A to B.

Proposed Site Layout

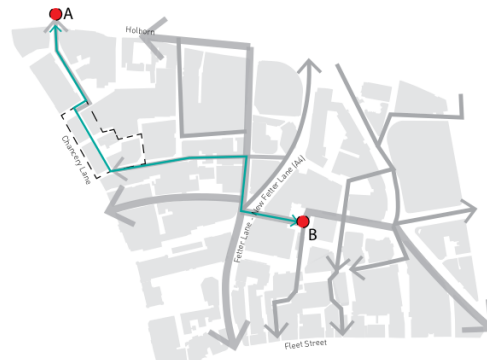


Figure 42: Proposed new route from A to B.

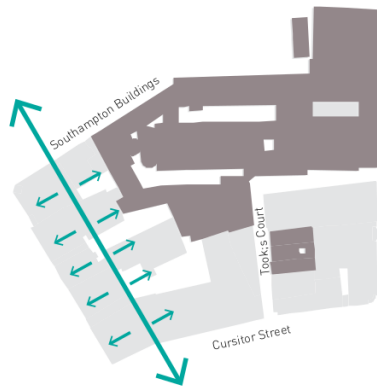


Figure 43: Suggested intervention of breaking down the block.

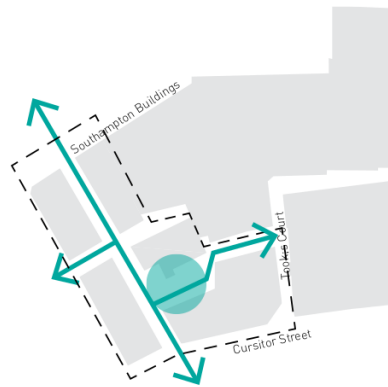


Figure 44: Proposed new connections.

| | | |
|--------------------------|-------------------|-------------|
| Link Status | High | Low |
| Surrounding Land Use | Office/Industrial | Residential |
| Width of pedestrian area | Wide | Narrow |
| Level of Activation | High | Low |
| Length of Street Segment | Short | Long |
| Variety of Uses | High | Low |



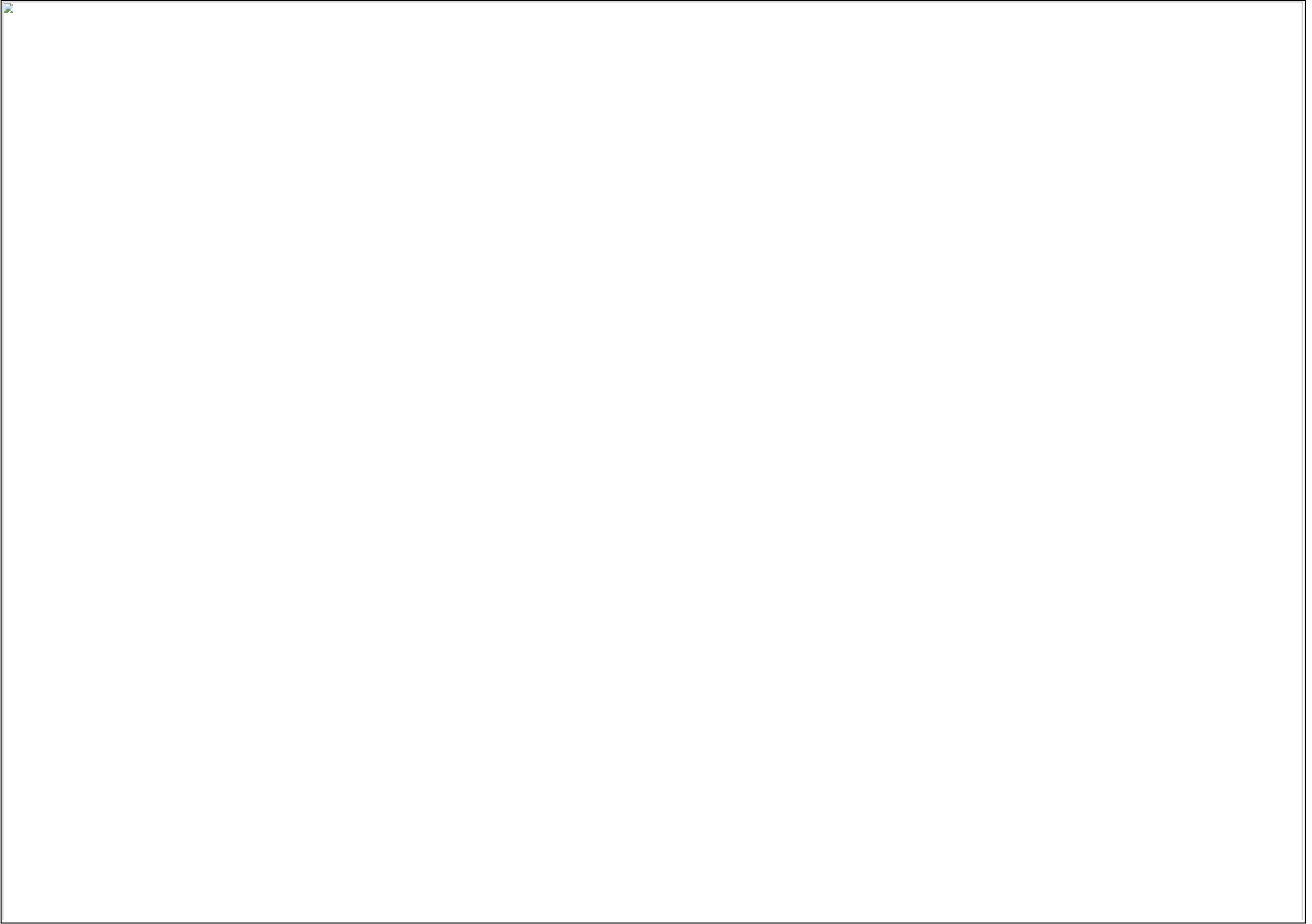
Figure 45: Artist Impression of the new route.

Application - Block Layout Reconfiguration

Opportunities for additional active frontage and animation arise, below is the proposed use of the new public space.



Figure 46: Artist Impression of new public space



Application - Weekday Improvements



Application - Pedestrianisation : St Bride's Street



Pedestrianising Routes

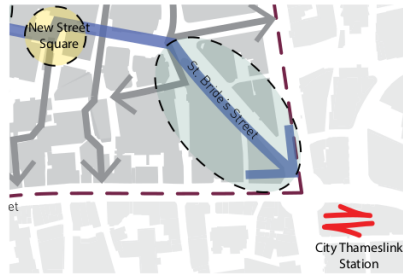


Figure 52: Intervention Location

This route is chosen to be pedestrianised as there is high volume of pedestrian flow both in the morning and lunchtime, mostly to commute to the City Thameslink Station. It is also a popular spot for lunch. This proposal allows for flexibility in use of the street, including route for commuting, lunchtime street markets, and service vehicles and emergency use.

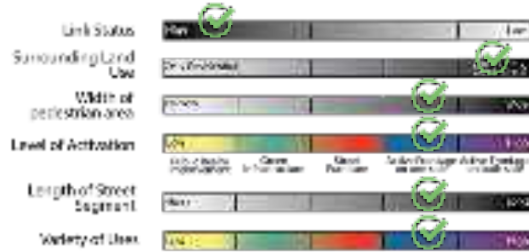


Figure 54: St Bride's Street during lunchtime



Figure 53: St Bride's Street during morning rush hour

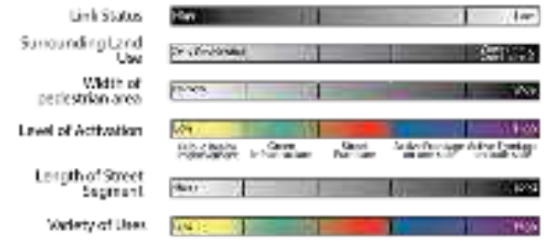
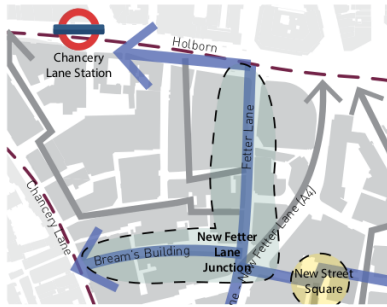


Figure 55: St Bride's Street during non-restricted hours with vehicular access

Application - Pedestrianisation : St Bride's Street



Application - Pedestrianisation & Smart Crossing : New Fetter Lane Junction



Application - Pedestrianisation & Smart Crossing : New Fetter Lane Junction



Pedestrianising Routes & Smart Crossing

The New Fetter Lane Junction serves a significant role as a movement corridor within the study area, locating along an A-road. To form a network, it is prominent to manage this intersection properly. It is proposed to convert the 3-point junction into a crossing, prioritising pedestrian and lowering the chance of collisions. In addition, smart crossing with sensors alerts both pedestrians and motorists in case of unpredictable danger. Pedestrianisation of the route has also allow for more animation and activities in the area, especially being in close proximity to New Street Square.

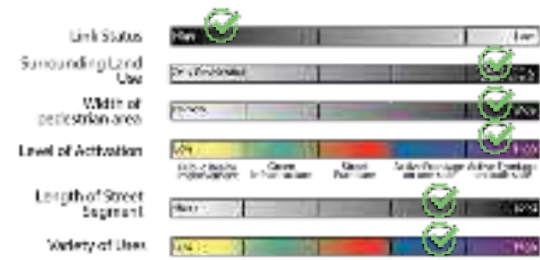


Figure 62: New Fetter Lane Junction Impression

Application - Weekend Improvements



Application - Activity Route

During the weekends, the study area has very limited pedestrian flow, leaving significant amount of street space empty. This project aims to utilise the existing street space, with appropriate level of animation, forming a weekend activity route, linking nearby destinations, attracting a new group of users to the area.

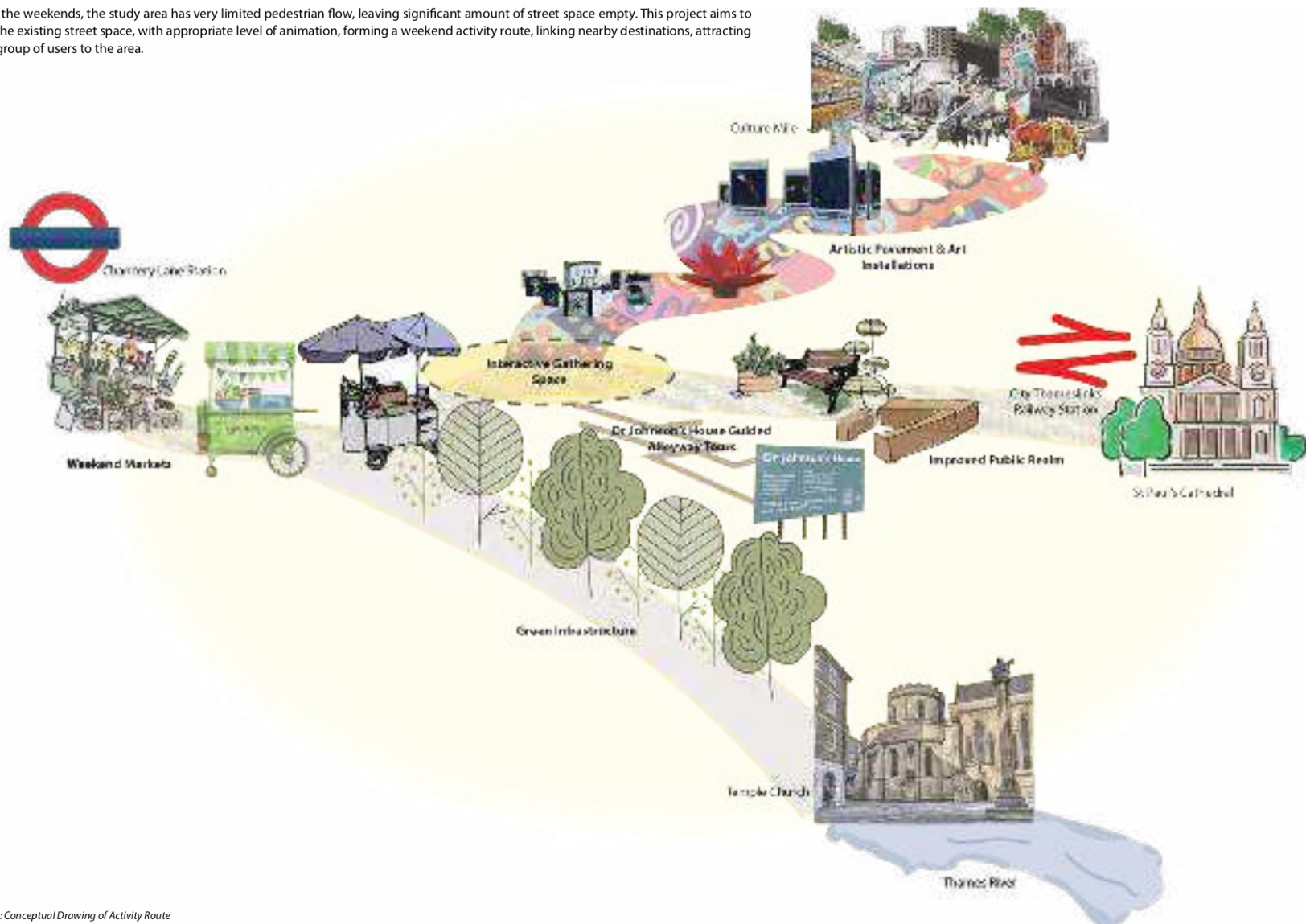


Figure 64: Conceptual Drawing of Activity Route

Application - Intersecting Gathering Space : Shoe Lane Square



Intersecting Gathering Space & Stakeholder Engagement

There are two general type of communities in the area - office and residential. Within the study area, there is only one designated community gathering space i.e. Shoe Lane Library (yellow). The intersection locates immediately outside the library, linking 5 different routes, making it a prime location to bring people together, especially during weekends.

This could allow for stakeholder engagement, creating sense of ownership. In addition, it could draw more people to the area during weekends.



Figure 65: Relationship between different communities in relation to Shoe Lane Square

| | | |
|--------------------------|--------------------------------------|-------------------------------------|
| Link Status | High | Low |
| Surrounding Land Use | Office/Commercial | Community |
| Width of pedestrian area | Wide | Narrow |
| Level of Activation | High (Public Space, High Population) | Low (Private Space, Low Population) |
| Length of Street Segment | Short | Long |
| Variety of Uses | High | Low |



Shoe Lane Library



Community Events Poster in Shoe Lane Library



Space outside Shoe Lane Library - proposed site of intervention

Application - Intersecting Gathering Space : Shoe Lane Square

With the office community dominating the area most times during weekdays, residents and the wider community could reclaim the space - organise community events or utilise the space creatively.

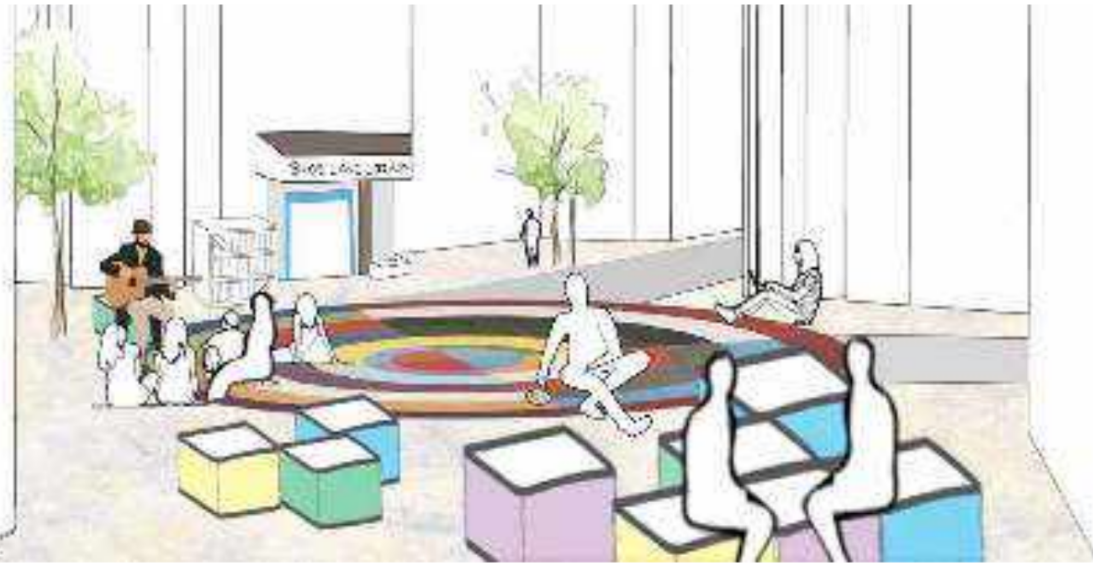


Figure 66: Shoe Lane Square during weekends



Figure 67: Shoe Lane Square during weekdays






It is understood that it locates at a junction where cars can pass by. During the weekends, there are very low vehicle flow on-site. Temporary traffic re-routing could be explored when events are being held.

The street furniture is designed to be moveable, during weekdays, they could be moved to the side of the square.





Evaluation

To understand the effectiveness of this research, hypothetical results are evaluated against the project objectives, toolkit action objectives and evaluation criteria set out in the literature review. Each criteria would be rated from 1-5, with [1] being not likely, and [5] being with strong probability.

Project Objectives

| | 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|---|
|  To encourage developments that prioritise pedestrians. | ● | ● | ● | ● | ● |
|  To maximise the use of spaces in dense metropolitan areas. | ● | ● | ● | ● | ● |
|  To create a network that supports different level of activities, balancing different pedestrian needs. | ● | ● | ● | ● | ● |
|  To provide alternatives to the ordinary road safety measures. | ● | ● | ● | ● | ● |
|  To establish principles and a toolkit, with enhancements upon reflection on the application. | ● | ● | ● | ● | ● |

Toolkit Action Objectives

| | 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|---|
|  To improve connectivity. | ● | ● | ● | ● | ● |
|  To improve road-side safety. | ● | ● | ● | ● | ● |
|  To improve personal security. | ● | ● | ● | ● | ● |
|  To improve sense of a wherewithal. | ● | ● | ● | ● | ● |

Evaluation Criteria

| | 1 | 2 | 3 | 4 | 5 |
|----------------------------------|---|---|---|---|---|
| Flexibility | ● | ● | ● | ● | ● |
| Right mix of uses and activities | ● | ● | ● | ● | ● |
| Engagement and Sociability | ● | ● | ● | ● | ● |
| Fit for purpose | ● | ● | ● | ● | ● |
| Allow easy movement | ● | ● | ● | ● | ● |
| Comfortability | ● | ● | ● | ● | ● |
| Attractiveness | ● | ● | ● | ● | ● |
| Distinctiveness | ● | ● | ● | ● | ● |
| Sensitiveness | ● | ● | ● | ● | ● |
| Stakeholder engagement | ● | ● | ● | ● | ● |

In general, the toolkit is has been proven to be successful in creating a tertiary network, being in line with the above criteria. It demonstrated the possibility of multifunctional routes and balance of activities, with a key focus on being sensitive to local context and needs. The elaboration of the toolkit into three elements : overall, weekday and weekend improvements has shown flexibility of the network and catered for all target users (workers, residents and visitors). Needs identified earlier e.g. additional seating, opportunities of interaction between workers and residents, and a network that retains and draw people to the area, are also reflected.

Limitations & Future Research

Nonetheless, the research findings have to be seen in light of some limitations:

- Interventions e.g. pedestrianisation and smart crossing, requires knowledge on transport planning and smart technology. They have not been reviewed against professional knowledge, and are proposed with assumption of being practical.
- Due to project nature, evaluation could not be reflected against actual results, rather, speculative assumptions are made. Also, pedestrian behaviour is unpredictable and cannot be controlled, hence, outcome of pedestrian safety cannot be guaranteed.
- Site chosen has an abundance of routes that are already linked, the concept of creating new routes have not been explored extensively.

Hence, for future research, it would be advantageous to explore the following:

- Technicality on pedestrianisation and smart crossing
- Prospect in recreating a fine grain network in a coarse-grain city through route creations
- Methods to monitor and act on pedestrian behaviour
- Appropriate management style of the network

More radically, the possibility of prioritising pedestrian in the core of cities, reclaiming space for pedestrian and removing unnecessary traffic lanes. Finally, the weekday-weekend approach has posed an inspiration on developing a design toolkit for a 7-day economy in an office-dominant location.

Conclusion

This research has explored the potential of tertiary network in promoting pedestrian safety.

The literature review developed understanding on pedestrian behaviour and needs, giving context to elements required to create a tertiary network and promoting pedestrian safety. It identified strong correlation between pedestrian safety and pedestrian environment (Jacobs, 1961; Newman, 1973) and the need to balance different street functions (Carmona, 2019).

Case studies then realised the suggested interventions, emphasising flexibility, and linkage with primary and secondary routes. Key concepts include floor interventions, creative elements and smart technology.

As a result, a toolkit is extracted from the synthesized information, including a framework, action objectives, key interventions (missing links) and application guidelines. The systematic methodology has allowed for clear establishment of a tertiary network. In addition, the sensitive approach, through in-depth site analysis, has assisted in developing a site-specific approach, with an overall improvement and different approaches during weekdays and weekends.

The toolkit application has tested the ideas set out in the case-study and literature review and demonstrated its flexibility and ability to be applied to different circumstances. It has presented an alternative solution to pedestrian safety, investigating from pedestrian's perspective, responding to the recent shift in focus from motorised transport to sustainable transport modes and the need to maximise use of space in dense metropolitan cities.

There are two broad types of approach in tackling pedestrian safety, forming the basis for the application. One associating with traffic, which aims to bring traffic away from people, through intersection management and pedestrianisation, reclaiming pedestrian priority, providing opportunity for additional animations. Alternatively, tackling personal security, it aims to reduce people's fear of crime, through appropriate level of animation and lighting. Increasing activities enhances surveillance and vitality, making pedestrian feel safe to walk through the area.

Lastly, it is realised that creation of tertiary networks requires integration with the wider network and different street hierarchies, linking to various destinations, providing purpose to visit.

To conclude, the research has successfully met its research objective, contributing to the wider research on pedestrian priority. Future research is desired.

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Appendix I - Project Timeline

| CATEGORY | TASK | START | END | Review | Deadlines | Column1 |
|-----------------------------|--------------------------------------|------------|------------|------------|------------|--|
| Concept Dev. | Initial Research | 01/01/2019 | 15/03/2019 | | 03/01/2019 | Initial Research Summary Submission |
| | Identify Urban Problem & Opportunity | 01/01/2019 | 05/02/2019 | | 18/01/2019 | Final Research Summary Submission |
| | Potential Intervention | 06/02/2019 | 26/02/2019 | | | |
| | Case Studies | 26/02/2019 | 15/03/2019 | | | |
| Final Proposal | Context for project | 01/04/2019 | 15/04/2019 | | 04/04/2019 | Research Proposal Submission |
| | Key literatures | 15/04/2019 | 22/04/2019 | | 16/04/2019 | Meeting 1: Review Research Proposal |
| | Identify potential site | 20/05/2019 | 05/06/2019 | | | |
| | Framework for project | 15/04/2019 | 01/05/2019 | | | |
| Background Research | Literature Review | 01/05/2019 | 25/05/2019 | 10/07/2019 | 14/05/2019 | Meeting 2: Review Background Research and prepare for Workshop 1 |
| | Case Studies Review | 25/05/2019 | 01/06/2019 | 15/07/2019 | | |
| | Summary | 01/06/2019 | 05/06/2019 | | 18/06/2019 | Meeting 3: Review of application and development of toolkit |
| Toolkit Development | Synthesis Background Information | 05/06/2019 | 08/06/2019 | | 05/06/2019 | Workshop 1 : Research |
| | Brainstorming | 08/06/2019 | 15/06/2019 | | | |
| | Design | 15/06/2019 | 30/06/2019 | 18/07/2019 | 04/07/2019 | Workshop 2: Application |
| Toolkit Application | Site Analysis | 20/06/2019 | 15/07/2019 | 26/07/2019 | | |
| | Application | 30/06/2019 | 25/07/2019 | 01/08/2019 | 19/07/2019 | Final Draft Submission |
| | Site-Specific Approach | 25/07/2019 | 05/08/2019 | 01/08/2019 | 29/07/2019 | Last supervisor meeting |
| Evaluation | Meeting Objectives | 21/08/2019 | 25/08/2019 | 27/08/2019 | | |
| | Limitation | 21/08/2019 | 25/08/2019 | 27/08/2019 | | |
| | Future Research | 21/08/2019 | 25/08/2019 | 27/08/2019 | | |
| 02/09/2019 Final Submission | | | | | | |



Appendix 2 - Risk Assessment Form

| | | | |
|--------------------------------|--|----|--|
| WORKING WITH THE PUBLIC | Will people working on site be at risk? | NO | If 'No' move to next hazard. If 'Yes' see space below to identify and assess any risks. |
| e.g. staff, contractors | Examples of risk: drowning, tripping, repetitive strain, musculoskeletal, risk of high pressure hot oil. | | |

CONTROL MEASURES - Indicate which procedures are in place to control the identified risk:

- Risk working on or near water will be controlled
- Sufficient information is understood at work to be able to take the appropriate control measures
- All participants are properly supervised
- Participants who are not fully competent e.g. temporary staff, will be given additional training
- All boats are equipped with an alternative means of propulsion e.g. outboard
- Participants have received any appropriate instruction
- OTHER CONTROL MEASURES: please specify any other control measures that have been implemented

| | | | |
|--|--|----|--|
| GENERAL HANDLING | Do all activities take place? | NO | If 'No' move to next hazard. If 'Yes' see space below to identify and assess any risks. |
| e.g. staff, visitors, moving large equipment, participant safety | Examples of risk: falls, lower back, lifting, high pressure hot oil? | | |

CONTROL MEASURES - Indicate which procedures are in place to control the identified risk:

- The relevant safety arrangements for lifting are followed
- The equipment that is used is all in the appropriate condition
- All participants are fully competent to lift, secure, move, store, lift or use the relevant equipment
- All participants are given the relevant safety instruction
- All participants are given the relevant safety instruction
- OTHER CONTROL MEASURES: please specify any other control measures that have been implemented

| | | | |
|---|--|--|--|
| ILL HEALTH | The possibility of ill health always represents a safety hazard. Use space below to identify and assess any risks associated with this hazard. | | |
| e.g. asthma, hay fever, pollen, dust, food, animal contact, disease, or infection | Examples of risk: injury, infection, illness, or the risk of a medical visit? | | |

CONTROL MEASURES - Indicate which procedures are in place to control the identified risk:

- An appropriate number of trained individuals (including any support staff) are present
- All participants have had the necessary instruction/competence for any activity
- Participants have been advised of the specific demands of the trip and are deemed to be physically fit
- Participants have been adequately advised on harmful plants, animals and substances they may encounter
- Participants who require medication have advised the leader of the activity of their condition for their needs
- OTHER CONTROL MEASURES: please specify any other control measures that have been implemented

| | | | | |
|----------------------|---|-----|----|--|
| INACCESSIBLE | Will anyone be needed? | NO | NO | If 'No' move to next hazard. If 'Yes' see space below to identify and assess any risks. |
| e.g. staff, visitors | Completed the activity with no need for rescue, recovery or towing? | YES | X | Examples of risk: falls, high pressure hot oil, high pressure hot oil? |

CONTROL MEASURES - Indicate which procedures are in place to control the identified risk:

- A suitable support team is present
- The vehicle will be used from a suitable location
- All participants are properly trained in compliance with relevant national regulations
- Drivers comply with MCA Policy on Drivers' Highways and on other roads
- Drivers have been trained and hold the appropriate licence
- There will be more than one driver to perform the task if required
- All participants are given the relevant safety instruction
- OTHER CONTROL MEASURES: please specify any other control measures that have been implemented

| | | | |
|--------------------------------|--|----|--|
| WORKING WITH THE PUBLIC | Will people be dealing with public? | NO | If 'No' move to next hazard. If 'Yes' see space below to identify and assess any risks. |
| e.g. visitors, contractors | Examples of risk: drowning, tripping, repetitive strain, musculoskeletal, risk of high pressure hot oil? | | |

CONTROL MEASURES - Indicate which procedures are in place to control the identified risk:

- All participants are given a minimum instruction
- All participants are given the relevant safety instruction
- All participants are given the relevant safety instruction
- All participants are given the relevant safety instruction
- All participants are given the relevant safety instruction
- OTHER CONTROL MEASURES: please specify any other control measures that have been implemented

