CONNECTIVITY & TRANSPORT

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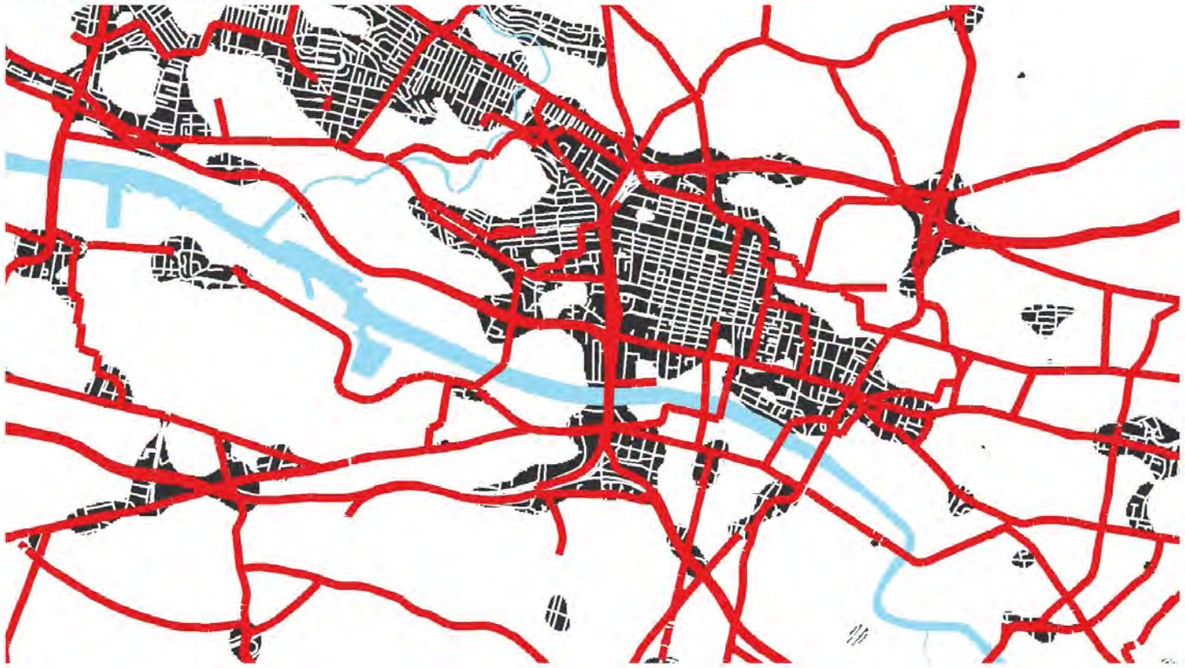
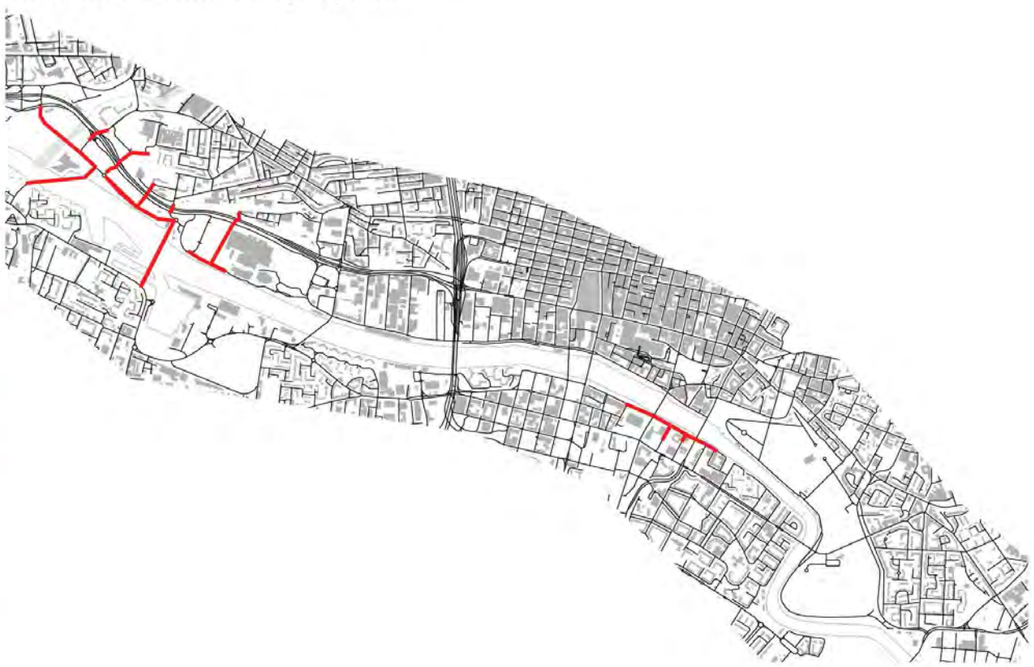
Summary of MCA analysis

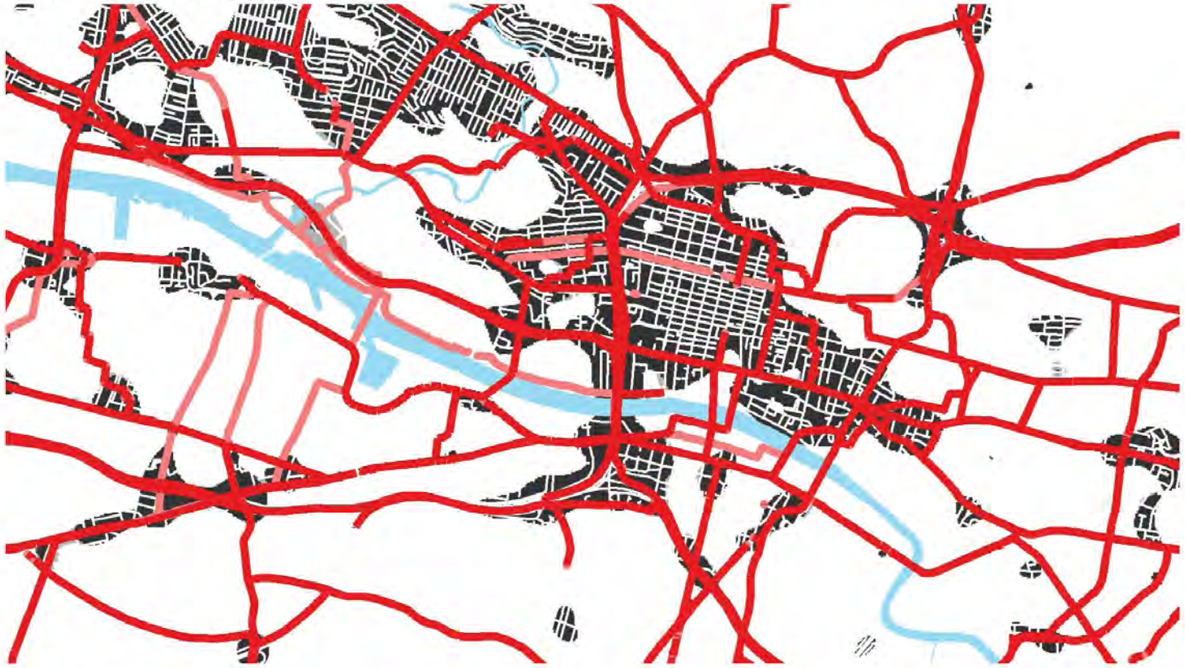
Centrality today



New connections in proposal



Centrality in proposal



Legend

Local closeness centrality:
- High
- Low

Betweenness centrality:
- High
- Low
- Increased closeness centrality
- Increased betweenness centrality

High centrality implies:

- the area is easily accessible
- the rest of the city will benefit from the area's activities
- a higher potential for commercial services

For more information about...

...why and how to measure centrality, see page 3.
...centrality today, see page 3-4.
...proposal to increase centrality, see page 5.
...centrality of the proposal, see page 5-6.

About the MCA analysis

Why measure centrality?

The centrality of a place can tell us something about its potential. It is more likely that we will find a store or a restaurant near a large road in a city centre than at a cul-de-sac in the outskirts of town. Knowledge about the centrality of a place is therefore essential to determine what land use is appropriate.

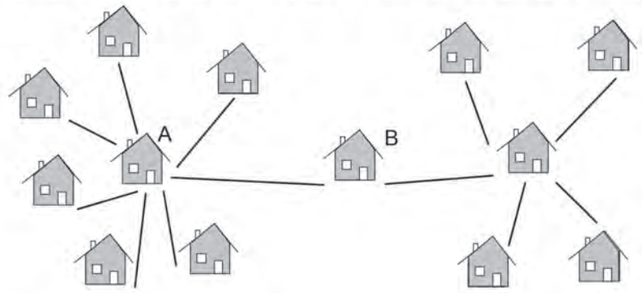


Fig. 1: 13 houses and the roads between them. Together they form a network.

Centrality can be measured in many ways. Figure 1 shows a village with 13 houses and the roads between them.

In the figure, both house A and house B are centrally located but in different ways:
- A is central in that it is *close* to many other houses.
- B is central in that it is on the road *between* a lot of the houses. If someone want to go and visit someone else in the village it is likely that they will pass by house B.

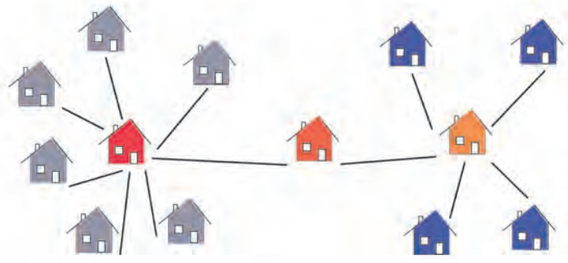


Fig. 2: Closeness centrality.

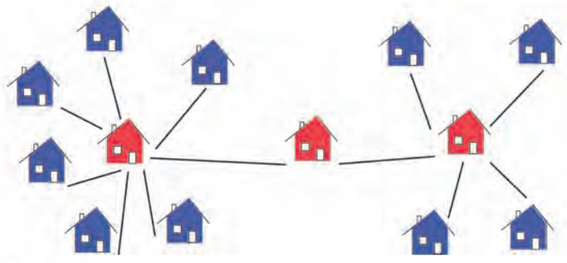


Fig. 3: Betweenness centrality.

LOW HIGH

How do you measure centrality?

Multiple Centrality Assessment (MCA) is a spatial analysis that maps the distribution of centrality in a network. The data is represented with colours where the most central is red and the least central is blue. If we take a look at a whole city we can map the streets as edges and street intersections as nodes. The whole system is called a network.

Closeness centrality measures how near a node is to all the other nodes in the system along the shortest paths. An example is shown in figure 2.

Betweenness centrality measures how often a node is located on the way between any other couple of nodes. An example is shown in figure 3.

Centrality can be calculated globally or locally. Global centrality measures a node's relation to all other nodes in the network. Local centrality measures a node's relation to other nodes within a specified distance. Thus, we can distinguish between areas that are central from a local perspective and areas that are central from the entire city perspective (Porta & Latora 2007; Porta, Crucitti & Latora 2006).

What we are investigating through the MCA analysis

The question we are investigating is how the River Clyde is connected to the city. Figures 4-7 show global betweenness, global closeness and local closeness. The local closeness is 400 and 1200 metres to capture the areas that have high centrality in a local perspective.

Centrality today:

Fig. 4: Global betweenness centrality.

Fig. 5: Global closeness centrality.

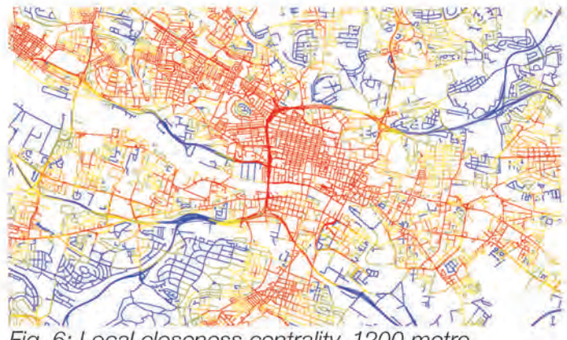


Fig. 6: Local closeness centrality, 1200 metre.

Fig. 7: Local closeness centrality, 400 metre.

References:
Porta, S. & Latora, V. (2007). Multiple centrality assessment: mapping centrality in networks of urban spaces. *Urban sustainability through enviromental design,* ss. 101-105.
Porta, S., Crucitti, P. & Latora, V. (2006). The network analysis of urban streets: a primal approach, *Environment and Planning B: Planning and Design,* 33, ss. 705-725.

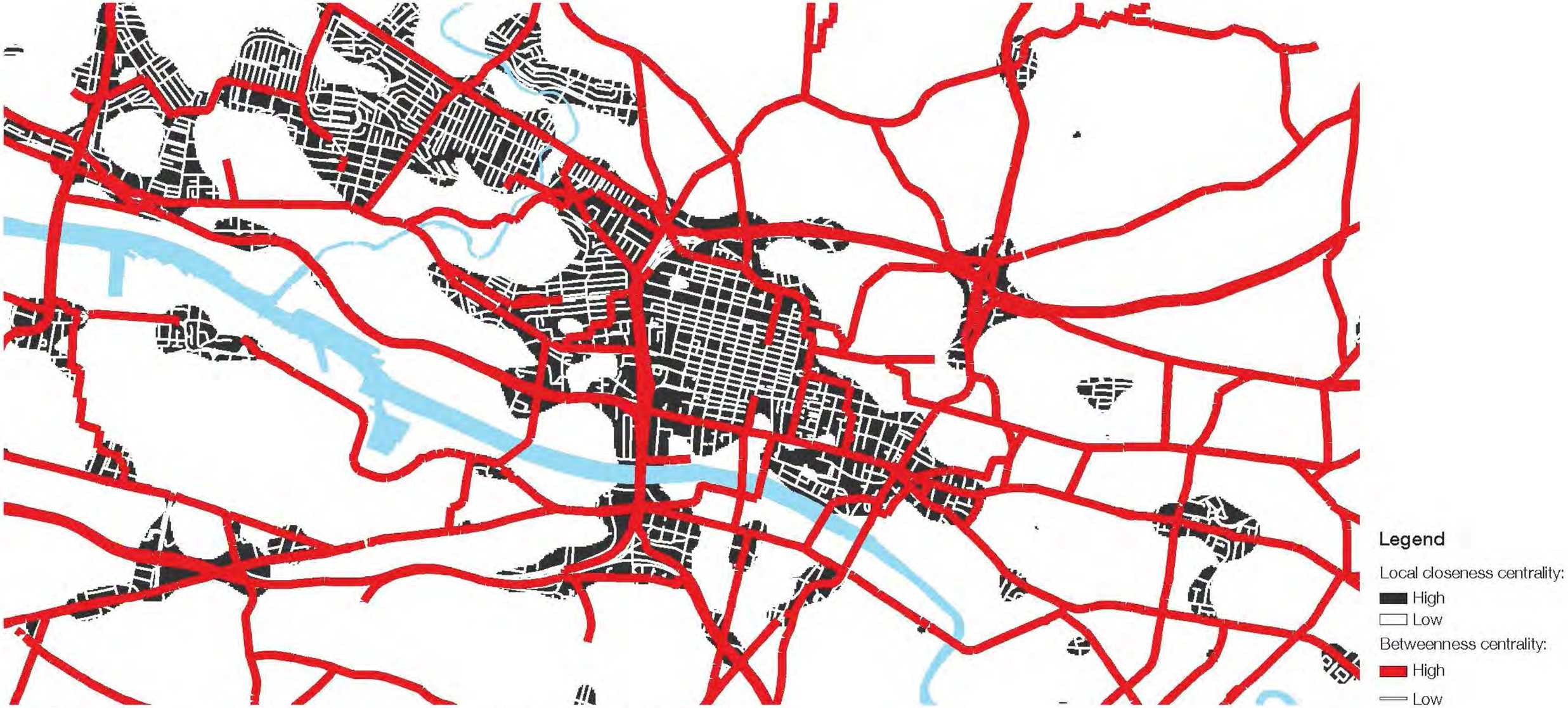


Fig. 8: Summary of centrality today. 20% highest closeness centrality (kernel 200 m) + 10% highest betweenness centrality.

Analysing what the MCA maps show

It is interesting to study the overlap between the closeness centrality and global betweenness. It can tell us which areas that have potential to be central because of its strong local location and the main routes that pass through the city. As we can see in figure 5, the whole area around the River Clyde and the city centre have a high global closeness centrality. The local closeness centralities and the global betweenness centrality have more variation around the River Clyde and the city centre.

Figure 8 show the overlap of local closeness centrality (400 m) and global betweenness. Here the local closeness centrality has been converted to kernel density maps (radius 200 m) to show the density of local closeness centrality. With this it is possible to compare it with the global betweenness. Figure 8 shows the areas with the 10% highest centrality closeness. The betweenness centrality shown is the 10% highest values.

Conclusion

Figure 8 shows that the areas around Partick, Riverside Museum, SECC and Govan is poorly connected. This is a problem because then the rest of the city will not benefit from the resources in these areas. It also means that it will be difficult to commercial entities. The road network reinforces the weakness these areas already suffer from. Almost no areas on the south side of the river are in the 10% highest closeness centrality range while the City Centre and West End have a greater degree of closeness centrality.

Proposal

Proposal to increase centrality

To increase the centrality along the River Clyde we propose a change that is based on three pillars (figure 9-11), which are the following:

1. New connections along river Clyde.
2. New connections across the Clyde, resulting in that there is 800 metres between each bridge.
3. New connections across Clydeside Expressway/Pointhouse Road.

Figure 12 shows all the new connections that has been made combining the three pillars. It is our proposal to increase centrality.

Fig. 9: Pillar 1.

Fig. 10: Pillar 2.

Fig. 11: Pillar 3.

Fig. 12: Connections to increase centrality.

Centrality of proposal

Fig. 13: Global betweenness centrality scenario.

Fig. 14: Global closeness centrality scenario.

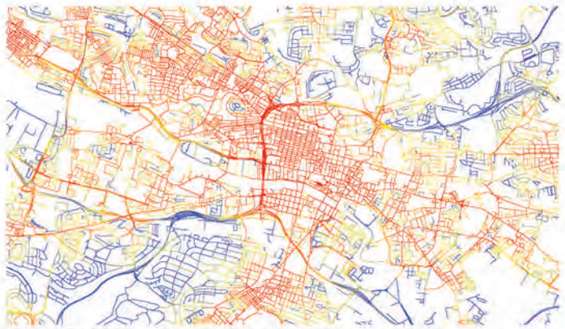


Fig. 15: Local closeness centrality scenario, 1200 metre.

Fig. 16: Local closeness centrality scenario, 400 metre.

The proposal of new connections in the network. Figures 13-16 show the global betweenness, global closeness and local closeness. The local closeness is 400 and 1200 metres to capture the areas that has high centrality in a local perspective.

To compare how the local closeness and the global betweenness has changed, a kernel density map are made in the same way as the existing network. This makes it possible to identify the differences between the existing network and scenario 1, and also what the results means.

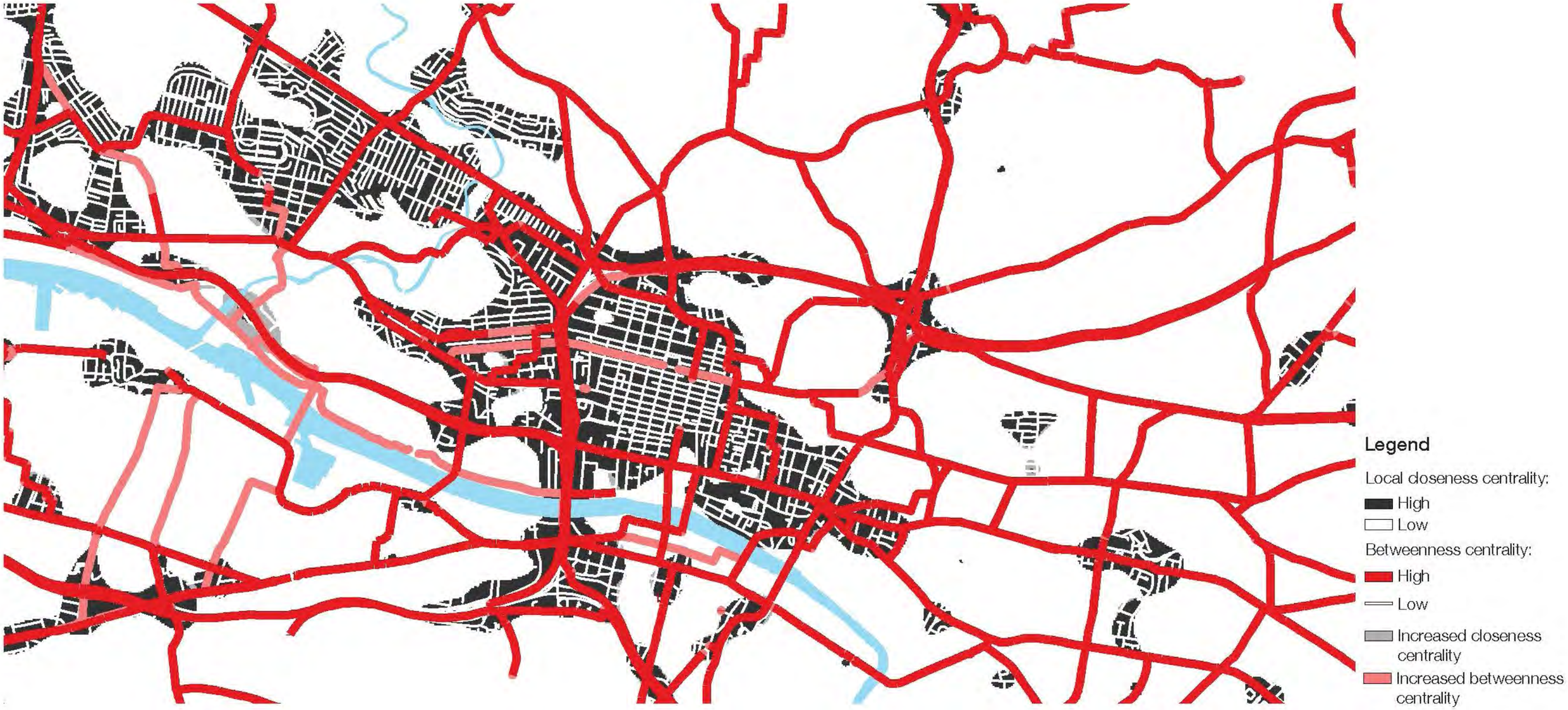


Fig. 17: Summary of centrality in proposal. 10% highest closeness centrality (kernel 200 m) + 10% highest betweenness centrality.

Centrality of proposal

The overlap of closeness centrality and bewteenness centrality of the proposal was calculated in the same manner as of figure 8. The newly created centralities are shown in light red and light grey.

Conclusion

The areas around Partick, Riverside Museum, SECC and Govan gets higher closeness and betweenness centrality. The betweenness centrality also increases in the city center, and on the south side of river Clyde. This implies that the proposal contributes to making Partick, Riverside Museum, SECC and Govan a more connected part of the city, which is crucial for the areas possibilies.

Public transportation

Fig. 18: Map of public transport service with bus, subway and train stops.

Process of making the map

Through using maps we have created for bus, subway and train routes and stops, we have come to a conclusion that show the level of public transport service along the River Clyde. A perimeter from each and every bus, subway and train stop has been made and the barriers taken into account to make the map. The radius of the stops are different:

- Bus stops are 200 metres.
- Subway stops are 400 metres.
- Train stops are 800 metres.

Conclusion

When putting together all these transparent layers, you can see where the public transport service is sufficient or not by the brightness of the colour. The area around Central Station is well provided with transport services while the area around West Street is less provided. Along the River Clyde there are many areas that is not well connected with public transport. In some areas there is almost nothing at all, e.g. the area around the Exhibition Centre and Glasgow Green. There are some, but it is not sufficient to create a move lively environment along the river. Along the river there is mostly bus stops and to get to the area from subway and railway stops one has to cross barriers.

Perceived Quality

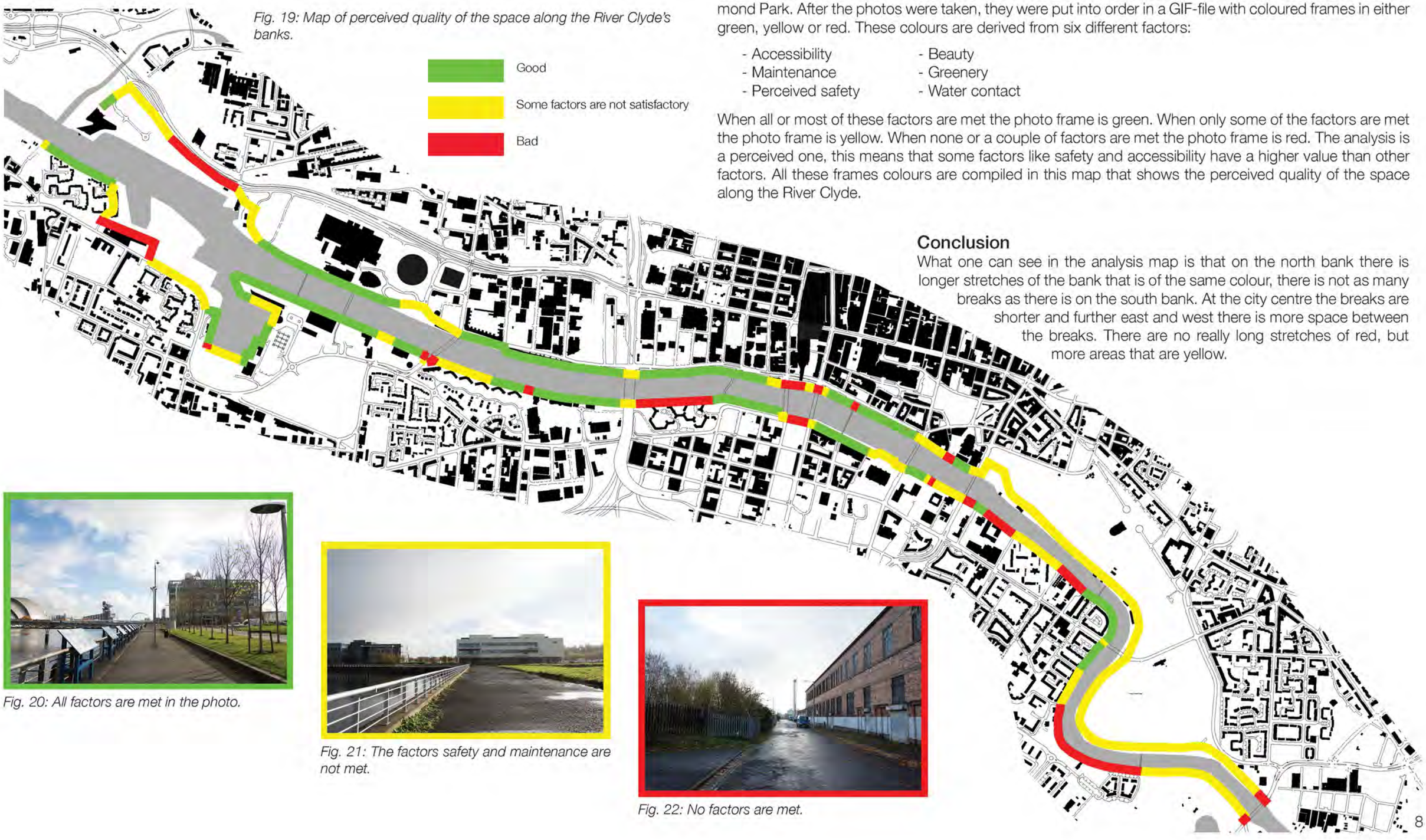


Fig. 19: Map of perceived quality of the space along the River Clyde's banks.

Analysis of perceived quality of the space along the bank of the River Clyde

To make this analysis around one thousand photos was taken while walking along the north and south bank of the River Clyde. Every twentieth step one photo was taken straight forward. The north walk was from the Transport Museum to the end of Glasgow Green, and the south walk was from Govan to Richmond Park. After the photos were taken, they were put into order in a GIF-file with coloured frames in either green, yellow or red. These colours are derived from six different factors:

- Accessibility
- Maintenance
- Perceived safety
- Beauty
- Greenery
- Water contact

When all or most of these factors are met the photo frame is green. When only some of the factors are met the photo frame is yellow. When none or a couple of factors are met the photo frame is red. The analysis is a perceived one, this means that some factors like safety and accessibility have a higher value than other factors. All these frames colours are compiled in this map that shows the perceived quality of the space along the River Clyde.

Conclusion

What one can see in the analysis map is that on the north bank there is longer stretches of the bank that is of the same colour, there is not as many breaks as there is on the south bank. At the city centre the breaks are shorter and further east and west there is more space between the breaks. There are no really long stretches of red, but more areas that are yellow.

Fig. 20: All factors are met in the photo.

Fig. 21: The factors safety and maintenance are not met.

Fig. 22: No factors are met.

Rubrix of how the photos along the River Clyde has been classified (fig. 23)

	GREEN	YELLOW	RED
ACCESSIBILITY	The route is accessible for bicyclists, pedestrians and people with disabilities. The route has no barriers over a long stretch.	The route is accessible for bicyclists and pedestrians. The route has some minor barriers, like traffic roads crossings or change in ground cover.	The route is only accessible for pedestrians. The route has barriers like fences.
MAINTENANCE	The maintenance of ground cover, surrounding walls and greenery are all good.	The maintenance is lacking in some areas, like surrounding walls or ground cover.	There has been no maintenance done in a long time.
PERCEIVED SAFETY	The place feels safe. With good lighting, people moving about, with no places where someone can hide.	The safety of the place is lacking, either there is no people moving about or narrow places.	The place is unsafe, no lighting, no people and narrow spaces.
BEAUTY	The place has well thought-out details, variation and possesses a human scale. There is new and old landmarks, greenery and a possibility of get an overview of a large space.	There is beauty but it is lacking in details, variation and human scale.	The place has no beauty. It is monotonous, there is barriers that obscure the view or long stretches of hard surfaces and traffic.
GREENERY	The place has a lot of greenery that are well kept or occur in neutral shape as in parks.	The place has little greenery that is not well kept.	The place has no greenery.
WATER CONTACT	The place has a visually close contact with the water.	The water is visually seen but is further away.	The water is not seen at all.

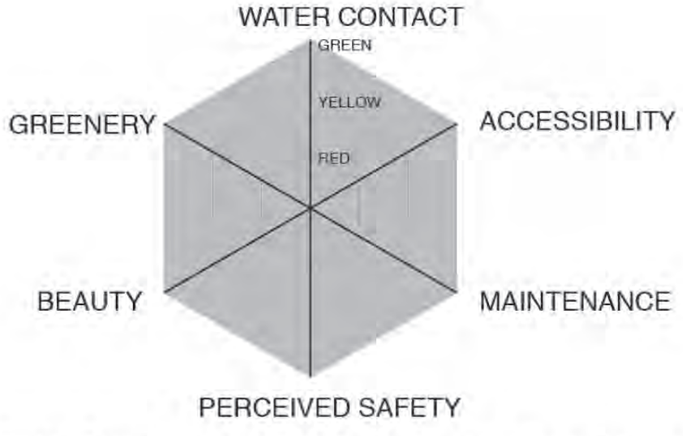


Fig. 24: Radar chart of the factors from figure 21. All factors are on the green level.

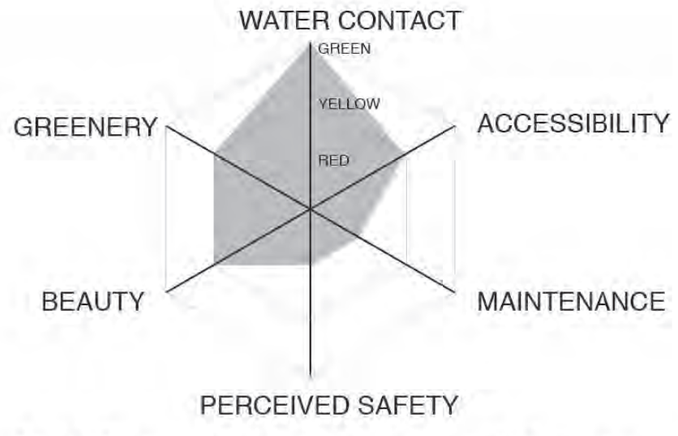


Fig. 25: Radar chart of the factors from figure 22. Some factors are met but most are on the yellow level.

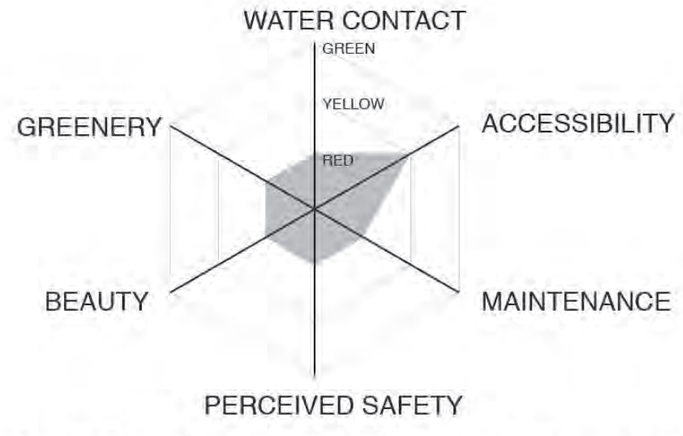


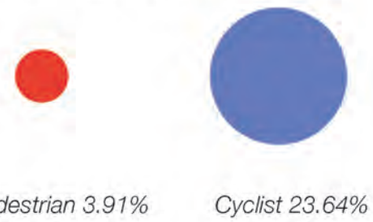
Fig. 26: Radar chart of the factors from figure 23. Most factors are on the red level.

Pedestrian & cyclist

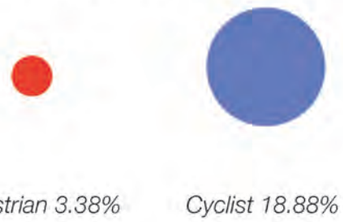
Pedestrian in comparison to cyclist at different sites

Fig. 27: Site 1. Broomielaw intersect Washington Street with pedstrian and cyclist count.

Fig. 28: Site 5. Saltmarket intersect Clyde Street with pedstrian and cyclist count.



Pedestrian 3.91% *Cyclist 23.64%*



Pedestrian 3.38% *Cyclist 18.88%*

Pedestrian Count

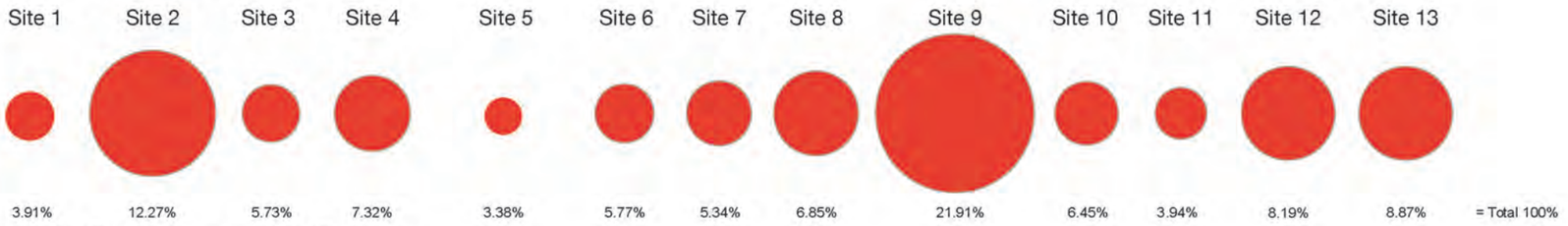


Fig. 29: Pedestrian count on different sites.

Cyclist Count

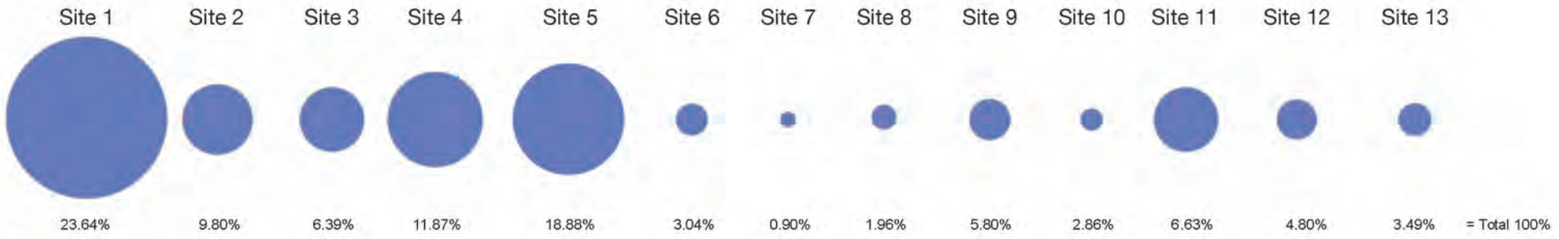


Fig. 30: Pedestrian count on different sites.

Movement of pedestrian and cyclist along and across the River Clyde

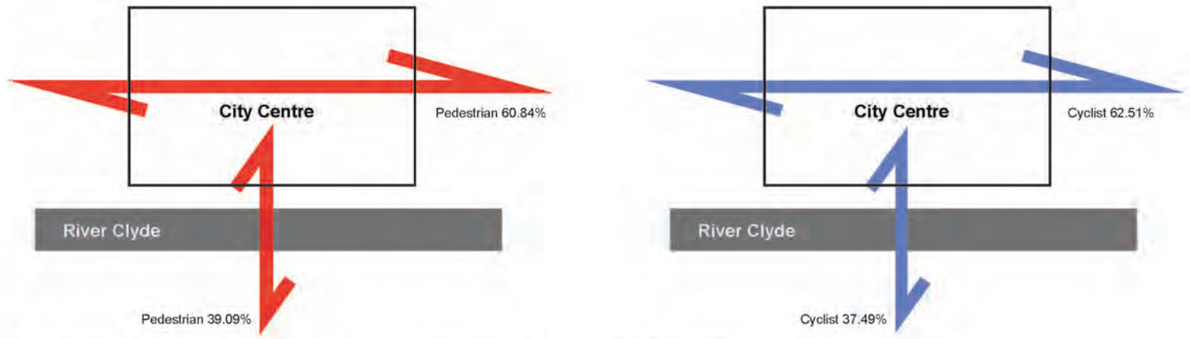


Fig. 31-32: Relation between movement along and across the River Clyde.

Conclusion

In Glasgow City the majority of cyclists are sharing the same path or road with pedestrian and cars. From 2007 to 2013, the total number of cyclist in the city increased by 127.4% and the casualties of cyclist increased by 50%. The number of cyclist are in contrast to the number of pedestrians, this at the same place where they were counted. This result shows that the pedestrian and cyclists likely avoid each other on the shared path. An assumption has been made that a shared path might not be efficient enough as the number of cyclist increases. Therefore a proper biking lane is required to control the circulation for a large number of cyclists on the road and paths to reduce the casualty rate.

Based on the cyclist data provided by the City Council of Glasgow, it shows that there is 23.64% cyclists at site 1 and 18.88% cyclists at site 5, which shows a significant larger number of cyclists taking the bike lane along the River Clyde and a lesser number of cyclists moving across the river. The reason is that the provided bike lane along the river is almost traffic free compared with the other sites.

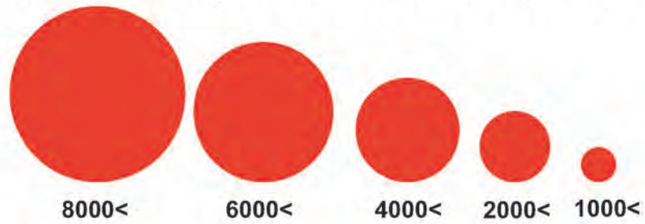
Overall, there is a larger movement along the River Clyde and through the City Centre than across the river for both pedestrian and cyclists. This shows that the road structure is poorly connected from the south side to the City Centre. Therefore more connections are needed for users to move from the south side to City Centre.

Pedestrian Mapping

Pedestrian Mapping Information

The diagram show the number of pedestrian count of 13 pinned sites around the city centre provided by the City Council Glasgow. The grey arrow show the direction of pedestrian moving in and out of the city centre 14 hours in a day. This data show larger number of pedestrians moving through the City Centre and lesser number of pedestrians moving across the River Clyde.

The number of pedestrian count at site 1 to site 13



13 Pinned site of pedestrian count

SITE 1 Broomielaw - Washington Street
SITE 2 Tradeston Bridge - Broomielaw
SITE 3 Glasgow Bridge - Clyde Street
SITE 4 Victoria Bridge - Clyde Street
SITE 5 Crown Street - Clyde Street
SITE 6 Bridgegate - King Street
SITE 7 Saltmarket - St. Andrew Street
SITE 8 High Street - Bell Street
SITE 9 Trongate - Albion Street
SITE 10 Portland Suspension Bridge - Clyde Street
SITE 11 King George Bridge - Clyde Street
SITE 12 Argyle Street - Oak Street
SITE 13 St. Vincent Street - India Street

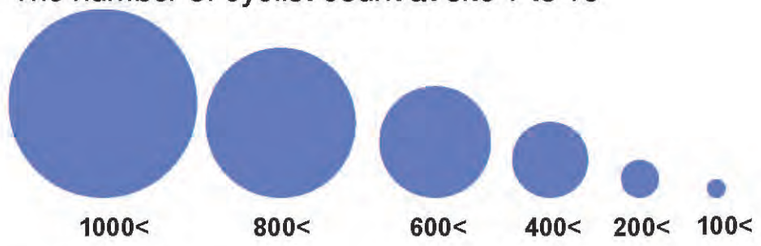
Fig. 33: Pedestrian map with pedestrin count in different points in the city.

Cyclist Mapping

Cyclist Mapping Information

Diagram show the number of cyclist count with 13 pinned sites around the city centre provided by the City Council Glasgow. The grey arrow showing the direction of cyclist moving in and out of the city centre 14 hours in a day. This data show larger number of cyclist moving along River Clyde and lesser cyclist moving across the River Clyde.

The number of cyclist count at site 1 to 13



13 Pinned site of cyclist count

SITE 1 Broomielaw - Washington Street
SITE 2 Tradeston Bridge - Broomielaw
SITE 3 Glasgow Bridge - Clyde Street
SITE 4 Victoria Bridge - Clyde Street
SITE 5 Crown Street - Clyde Street
SITE 6 Bridgegate - King Street
SITE 7 Saltmarket - St. Andrew Street
SITE 8 High Street - Bell Street
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SITE 10 Portland Suspension Bridge - Clyde Street
SITE 11 King George Bridge - Clyde Street
SITE 12 Argyle Street - Oak Street
SITE 13 St. Vincent Street - India Street

Fig. 34: Cyclist map with cyclist count in different points in the city.

Bike lane & Bike Racks

Mapping Information

Diagram show the location of bike racks provided in Glasgow City and the green path shows the existing bike lane. This show that the bike lanes are not well connected. However it does not mean the biking network is poorly connected. Because majority of cyclists in glasgow city are allowed to have share path or road with pedestrian and vehicles.

Legend of bike lane and bike racks

- Bike rack
- Bike lane

Fig. 35: Map of cycle routes and bike racks.

Bus Mapping

Mapping Information

The map show the location of bus stops and where the bus routes are situated.

Bus Mapping Legend

- Bus stop
- Bus routes

Fig. 36: Map of bus routes and stops.

Railway & Subway Mapping

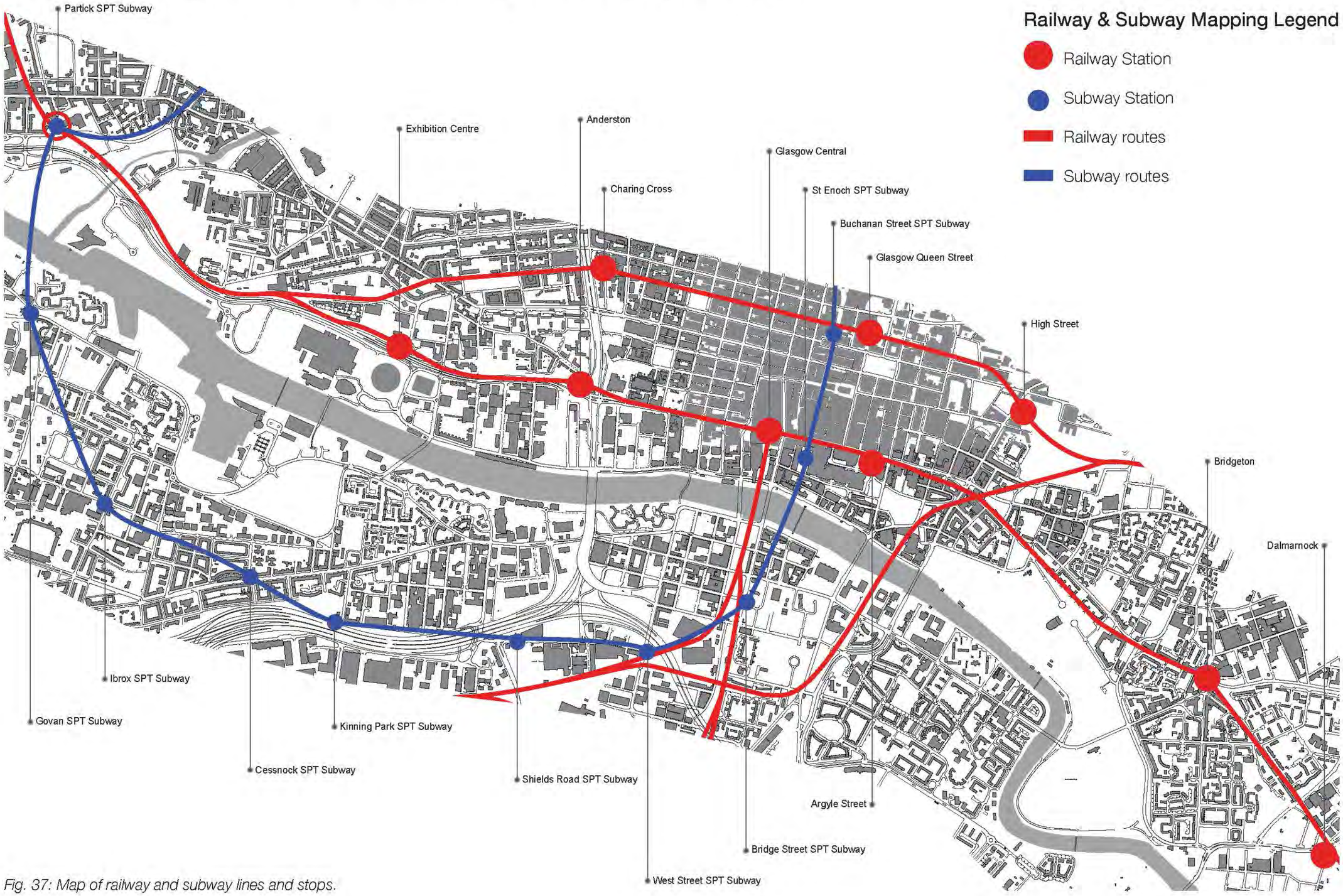


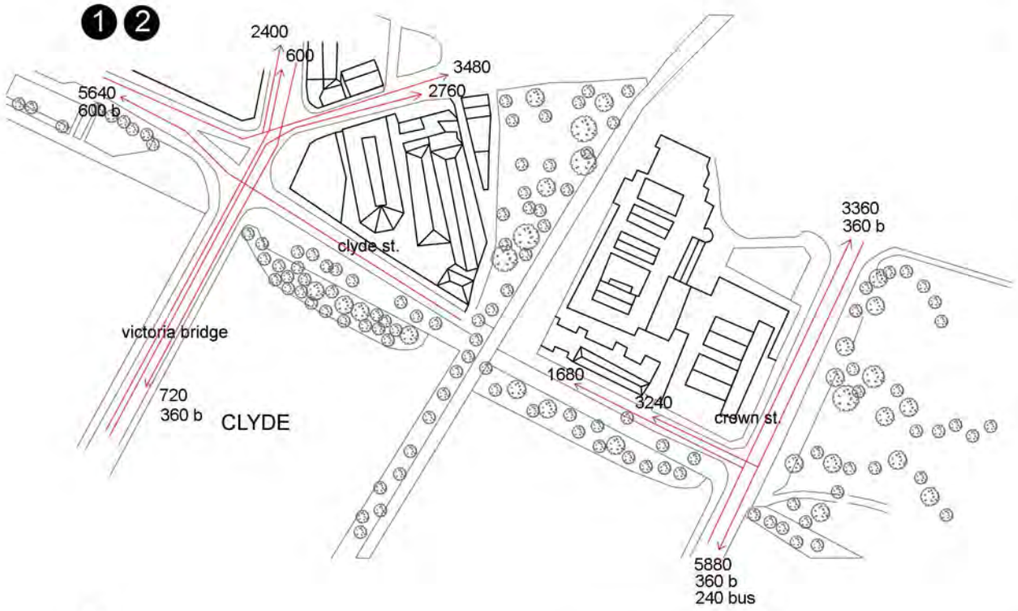
Fig. 37: Map of railway and subway lines and stops.

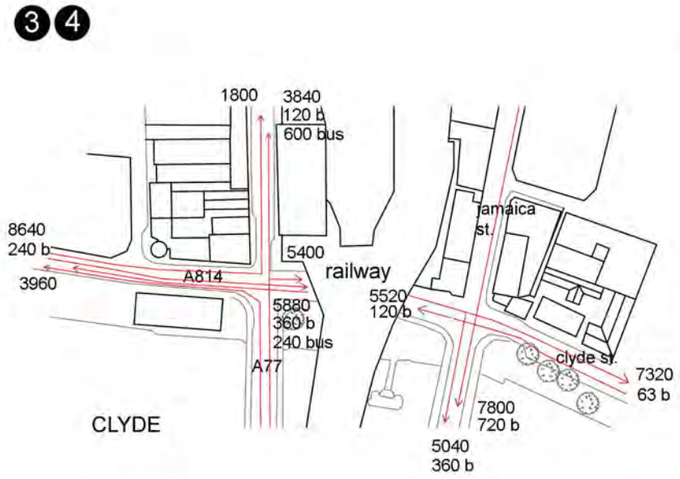
Future Glasgow: Re-Clyde

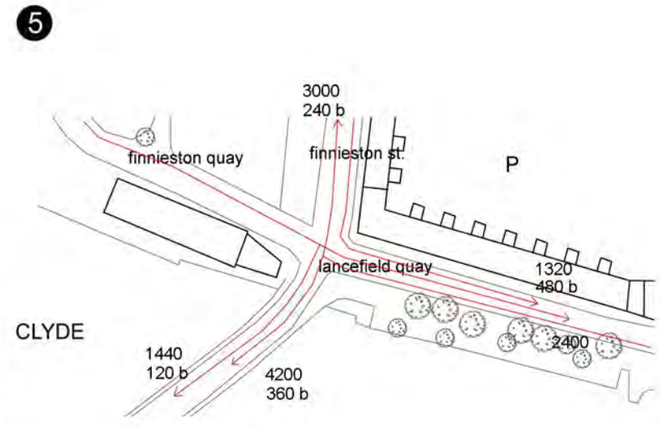
Motorway-Express way
Main street
Secondary road
Pedestrian street
Exchange points

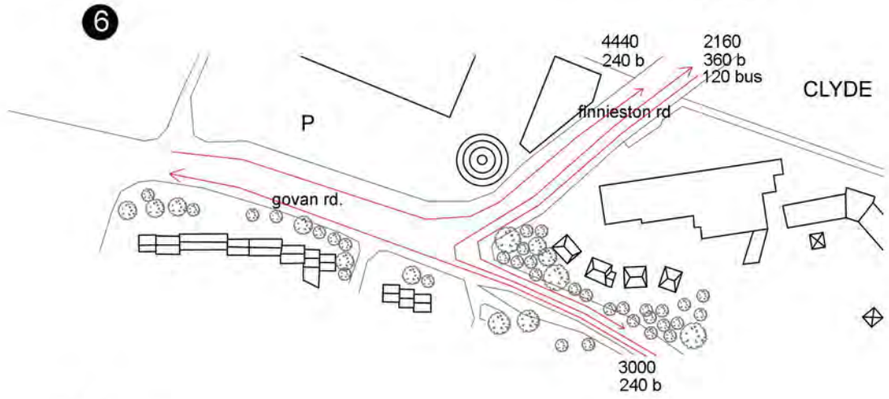
Hierarchy roads map

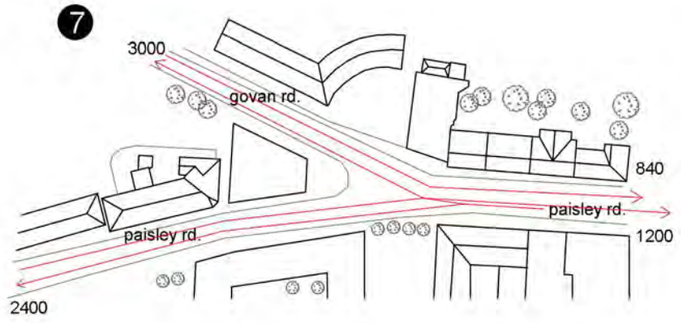
Traffic flows

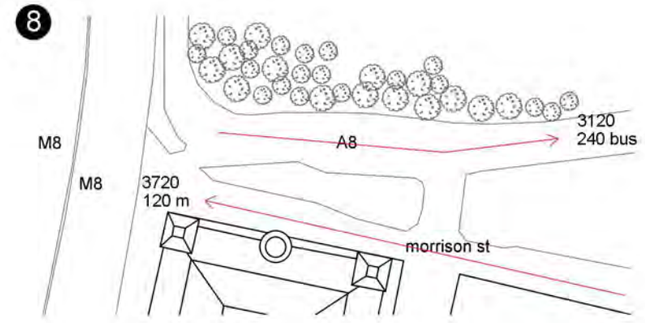


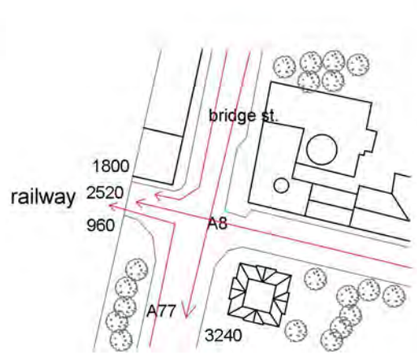


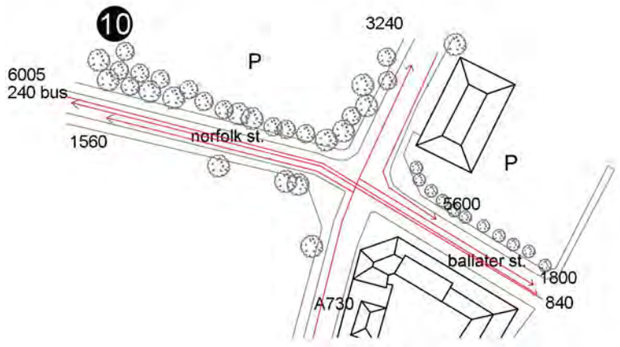


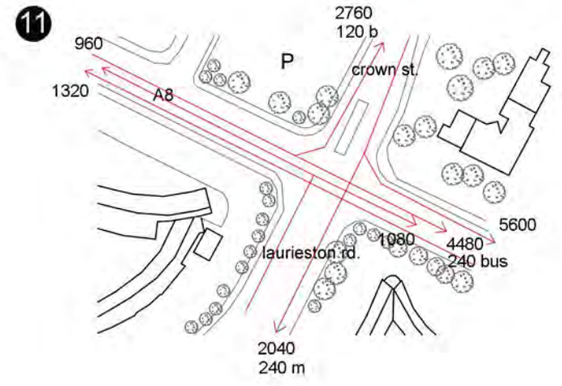




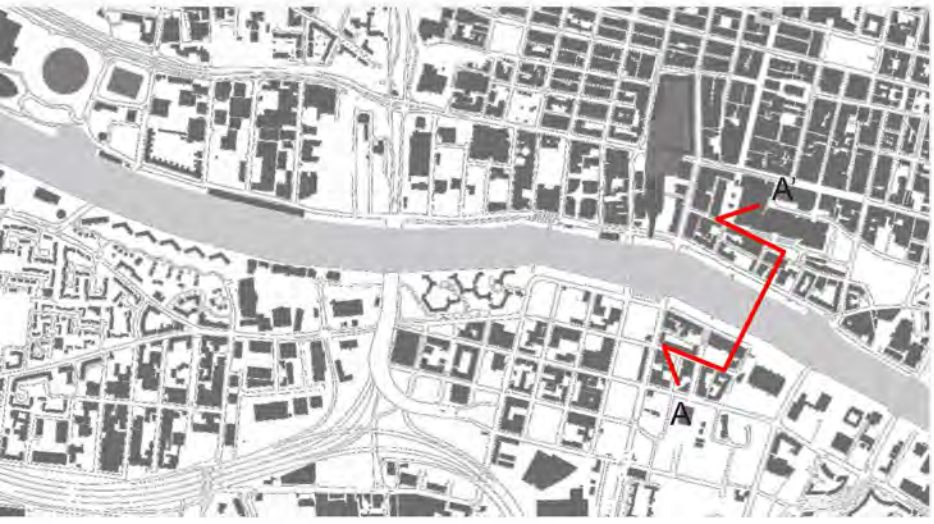


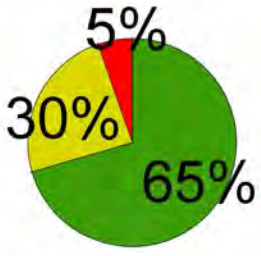


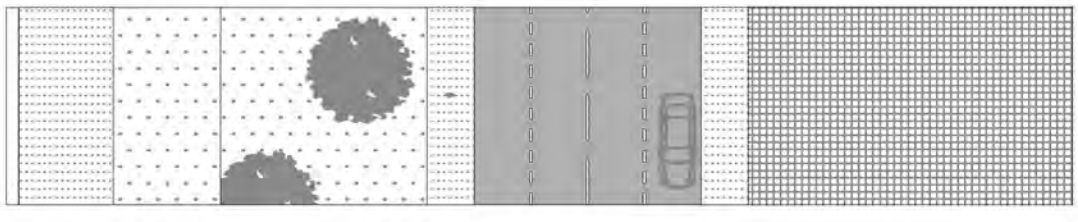


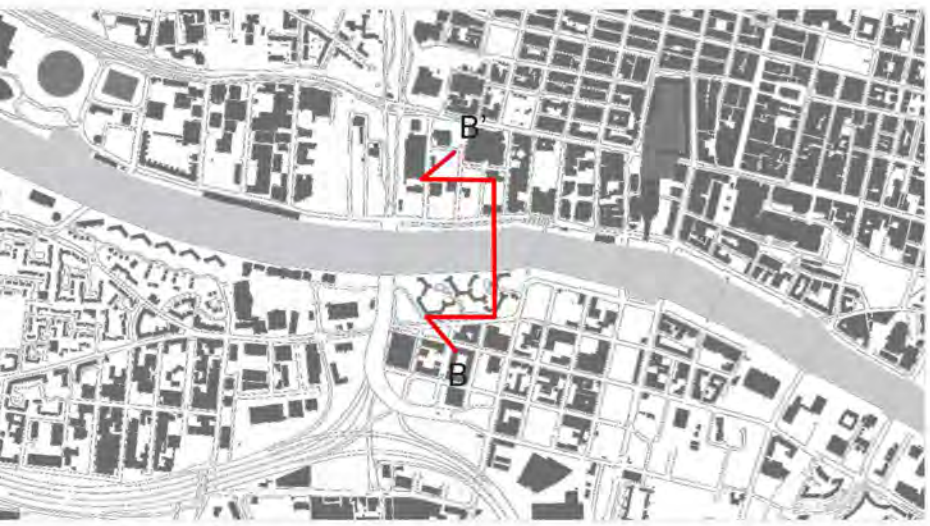


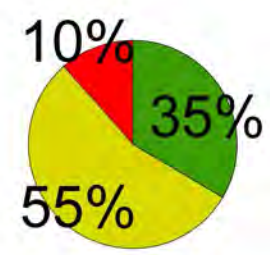
Intersections

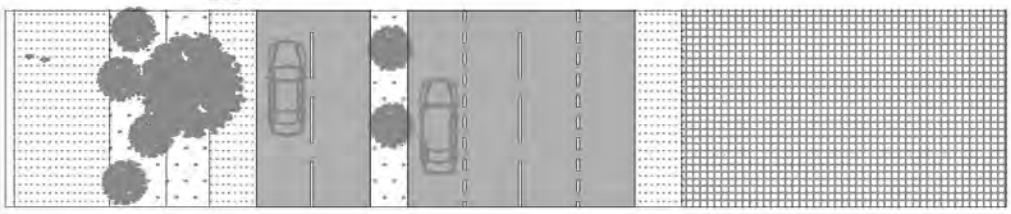


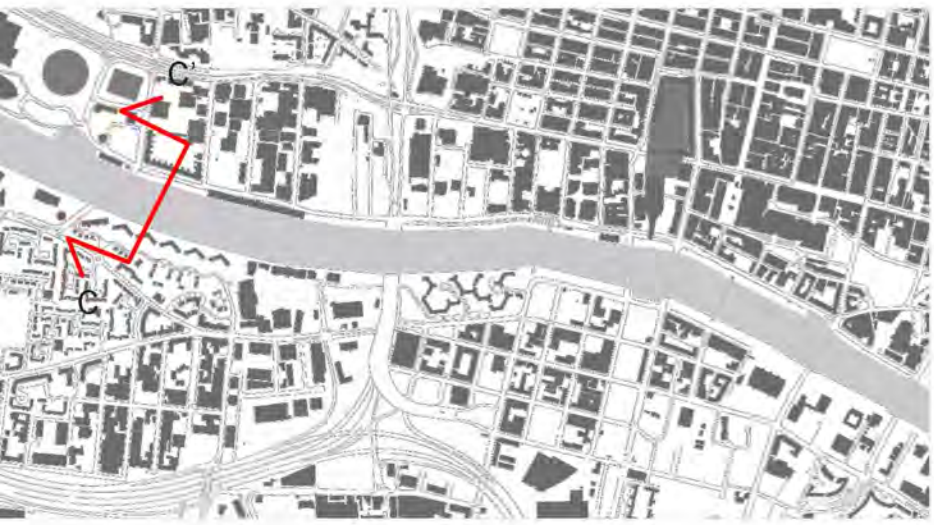


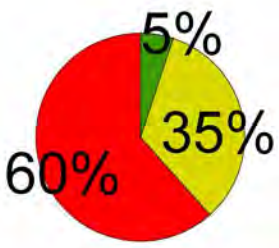


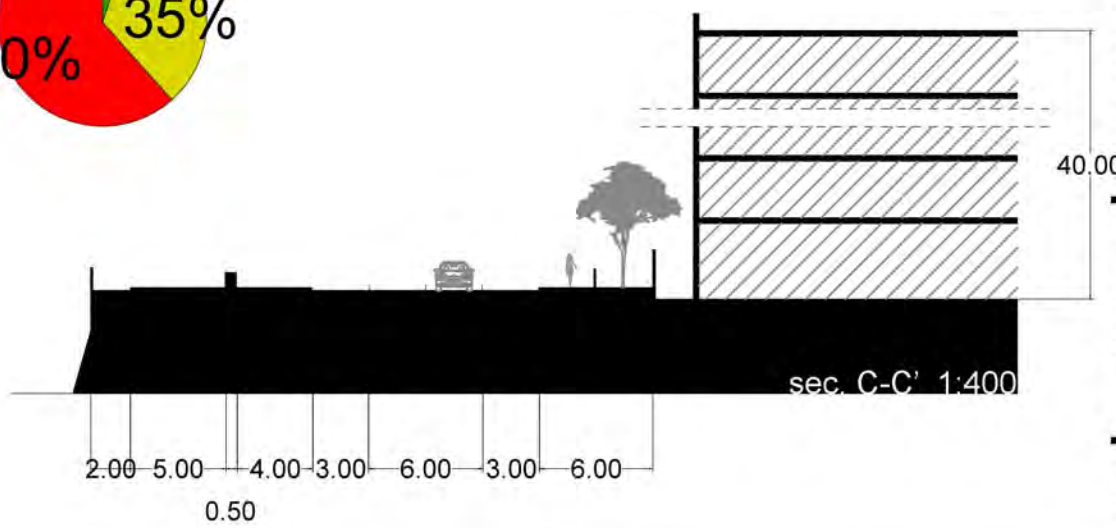


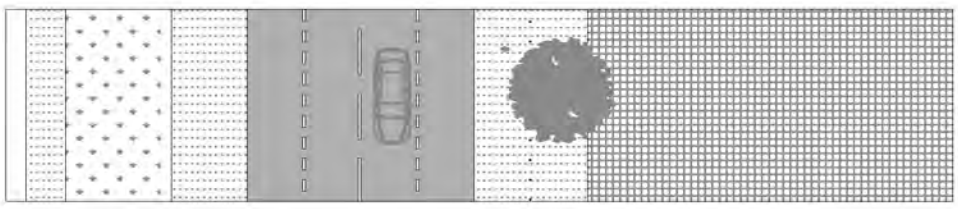












office
residential
commercial

speed < 30 km/h
speed 30-50 km/h
speed > 50 km/h

Sections and speed percentua