

MONITORING THE IMPACT OF PEDESTRIANISATION SCHEMES ON MOBILITY AND SUSTAINABILITY

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► State of the art paper, Literature review

FR

L'extension de la zone piétonne à Bruxelles a suscité de vives discussions quant à ses impacts sur la mobilité et l'environnement. En raison de l'absence d'un système de monitoring exhaustif, de nombreuses parties prenantes ont contesté la crédibilité et l'exactitude des quelques données publiées à ces égards. En outre, certaines incidences faisant l'objet de plaintes n'ont pas encore été objectivées. Ce papier donne un aperçu des impacts potentiels des piétons sur la mobilité et le développement durable, établi à partir d'une revue de la littérature. Sur base des données disponibles, il revient ensuite sur les effets de l'extension de la zone piétonne du centre-ville bruxellois, et étaye une série de recommandations spécifiques pour la mise en place d'un monitoring de ses impacts sur la circulation, la répartition modale, le stationnement, la pollution de l'air, la consommation d'énergie, la sécurité, le bruit, la dynamique financière et la santé.

NL

De uitbreiding van de voetgangerszone in Brussel verwekte hevige discussies over de gevolgen voor mobiliteit en leefmilieu. In afwezigheid van een integrale monitoring werd de geloofwaardigheid en juistheid van de gepubliceerde data door vele belanghebbenden in vraag gesteld. Daarenboven werden sommige geponeerde effecten niet gesteund door consistente gegevens. Deze bijdrage geeft op basis van de literatuur een overzicht van de mogelijke impact op mobiliteit en duurzaamheid. Op basis van beschikbare gegevens wordt dan de impact van de uitgebreide voetgangerszone in het Brusselse stadscentrum aangegeven. Er worden specifieke aanbevelingen gedaan om de impact inzake verkeer, modal split, parkeren, luchtpollutie, energieverbruik, veiligheid, geluid, financiën en gezondheid te monitoren.

EN

The extension of the pedestrian zone in Brussels has initiated heated discussion about its impact on mobility and the environment. Due to the lack of a comprehensive monitoring scheme, many stakeholders have questioned the credibility and accuracy of the data published regarding the impact of the scheme. In addition, there have been claims of certain effects that have not been supported by consistent data. This paper gives an overview of the potential impact of pedestrianisation schemes on mobility and sustainability based on a literature review. Then we outline the impact of the extension of the pedestrian zone in the centre of Brussels based on the available sources and give specific recommendations for monitoring the impact on traffic, modal split, parking, air pollution, energy consumption, safety, noise, financial effects and health.

Introduction

Generally, pedestrianisation schemes are devised in order to reach a number of objectives related to traffic, mobility, economic, environmental and social sustainability. In order to detect whether the objectives set out have been reached, extensive monitoring of their impact is required. Comprehensive monitoring is based on credible sources of data, designed in a way that ensures the comparability of data over time and is meaningful for the citizens and stakeholders that are affected by, or involved in, the implementation of the pedestrianisation scheme.

In line with international examples, the extension to the main boulevards of the pedestrian zone in the Brussels city centre has initiated a heated discussion about the impact on mobility and the environment [Vanhellemont, with Vermeulen, in this portfolio]. Due to the lack of a comprehensive monitoring scheme the credibility and accuracy of the data that have been published about the impact of the scheme were questioned by many stakeholders (e.g. shop owners, city centre employers). In addition, there have been claims of certain effects that have not been supported by consistent data, such as a change in road traffic levels, pedestrian flows, availability of parking etc.

‘The paper provides an overview of the potential impact of pedestrianisation schemes on mobility and sustainability based on an international literature review’

Therefore, the aim of this paper is to give an overview of the potential impact of pedestrianisation schemes on mobility and sustainability based on evidence from the international literature. We investigate what kind of effects have been monitored in various schemes across Europe and what types of data were collected to monitor them. Then we outline the impact of the extension of the pedestrian zone into the city-centre of Brussels as reported by available sources. Finally, we give recommendations on data collection for the monitoring of the impact of the Brussels scheme.

1. Potential impact of traffic calming and pedestrianisation on mobility

International literature and reports on pedestrianisation schemes [Wallström, 2004; Gehl and Gemzoe, 1996; Gehl and Gemzoe, 2001; Read,

1992; Monheim, 1994; Rossington, 2007; Cairns *et al.*, 2002] considered the following effects of pedestrianisation and traffic calming schemes.

Traffic volume and congestion

Most pedestrianisation schemes aim to decrease road traffic in the targeted areas. There is an immediate impact on traffic in the streets where traffic is restricted and a broader impact on the roads that surround the pedestrian area where displacement of traffic may occur. Changes in traffic volume are usually measured by the volume of car traffic per day. Cairns *et al.* [2002] compared the impact of roadspace reallocation schemes (bus lanes, traffic calming, pedestrianisation) by comparing the level of road traffic before and after the scheme was implemented on the altered route or area and on parallel or alternative routes (expressed in percentage). Often the traffic is measured at cordons that surround the pedestrian area or the wider city centre area [Wallström, 2004].

Number of pedestrians

Apart from road traffic, the number of pedestrians using the pedestrianised streets compared to the previous situation is also an important indicator of pedestrianisation schemes.

Parking management

Parking management largely determines the volume of road traffic towards and within a city centre. Pedestrianisation may decrease the availability of parking by removing parking places in the pedestrianised streets. Additionally, parking management strategies may be adapted by introducing or increasing parking fees and limitations on the duration of parking. Usually the number of parking places available in a specified area are monitored including on-street and off-street public parking. Park and ride facilities in the outskirts of a city or city centre in connection with frequent public transport services into the centre can also reduce demand for individual traffic into a pedestrianised centre. Such schemes are monitored through examining the modal split of trips into the city centre and the number and occupation of Park and Ride facilities (e.g. Oxford).

Modal share of trips

By reallocating road space to public transport, cyclists and pedestrians a change in modal share of trips within and to the pedestrianised area is expected. This is measured by comparing modal share (percentage of trips) to or within the city centre based on travel surveys.

Besides the direct impact on traffic and modal split, pedestrianisation schemes also aim to achieve secondary objectives that are the results of changes in traffic. These objectives are related to economic, environmental and social sustainability.

Air quality

Improved air quality is the most important environmental impact of pedestrianisation. Generally, this is measured by comparing the levels of Sulphur dioxide (SO₂), Nitrogen oxides (NO_x), Carbon monoxide (CO) Lead (Pb) and Particulate matter (PM_x) to levels before the implementation of pedestrianisation schemes [Wallström, 2004].

Social effects

Social impact includes the impact on traffic safety especially for vulnerable road users (pedestrians and cyclists) and health (through improved air quality, reduced noise pollution and increased modal share of active modes that bring more physical activity into the daily life routine).

Economic impact

Finally, there is an economic impact since changes in parking charges and the availability and cost of public transport have an impact on the affordability of reaching the city centre by influencing the total cost of mobility. This latter was however, not monitored in the literature and reports we reviewed.

It must be noted that monitoring of the direct impact of pedestrianisation schemes is difficult. Goodwin *et al.* [1998] state that monitoring is often not carried out to evaluate the scheme and therefore some data may be missing or may not be representative. Change of behaviour is difficult to assess without regular travel behaviour surveys which are usually expensive. In many cases, it is difficult to distinguish between the actual impact of the pedestrianisation scheme and other transport interventions. Potential sources of bias may result from the lack of multi-day surveys that address day-to-day variability, lack of data on the longer journey detours outside of the monitored area due to traffic restrictions, shorter detours within the study area if only cordon counts are used, traffic growth due to other factors such as growth of income and car ownership and finally, partial sampling of surveys which do not consider previous non-users of cars and thus overestimate the traffic reduction [Goodwin *et al.*, 1998; Wallström, 2004]. Improvements in air quality can also be attributed to other factors such as improved vehicle technologies, speed limits and modal shift due to other factors such as extreme events [Wallström, 2004] like the terrorist attacks in Brussels (March 2016).

2. Impact of the extension of the pedestrian area on traffic in Brussels

The impact of the extension of the pedestrian zone in Brussels was not comprehensively monitored by public nor private actors and no comprehensive evaluation report has been published to date. The

interim evaluation of traffic by the public administration Brussel Mobiliteit-Bruxelles-Mobilité is based on various data sources provided by the City of Brussels, Brussel Mobiliteit, Atrium and ProVélo, to measure traffic volumes (not modal shares) [Bruxelles Mobilité, 2016, not public]. It reflects the situation during and after the 8-month trial period of the circulation plan (between 29 June 2015 and 28 February 2016) although due to the lack of systematic data collection the data refers to varying time periods. Therefore it is very difficult right now to assess the quality of the results.

‘The impact of the extension of the pedestrian zone in Brussels was not yet comprehensively monitored’

The report of Bruxelles Mobilité indicates an increase in the number of pedestrians on the central Boulevard from 10,000-14,000 pedestrians/day in 2014 to 27,000-38,000 in August and September 2015 [Bruxelles Mobilité, 2016, not public]. These figures, alleged to Atrium, were deservedly disputed by ARAU¹ since the two sides (measured at the counting points “41” and “48”) of the boulevard were not taken into account together as basis for comparison. If we take the mean count provided by Atrium for Anspach 41-48, we observe that 2010 with 30,584 pedestrian flows was at the top², whereas the mean count between August and October 2015 was 27,482³, rather similar to the previous years (2011-2014). Therefore the mean count in 2015 is showing on the whole no major impact of the pedestrianization on the pedestrian flows, despite the fact that these flows show important variations from one month to the next, according possibly to weather conditions⁴. Note that these countings were made before the lockdown (November 2015) and the Brussels terrorist attacks (March 2016).

In the Bruxelles Mobilité report, a significant increase in the number of cyclists was detected at the Beurs van Brussels from 200 (2013) to 414 (2015) in the morning peak and from 206 to 315 in the evening

¹ ARAU. 01/03/2016. « Non, le piétonnier n’attire pas plus de piétons ». Press release.

² Atrium, 2011. *Rapport. Flux piétons 2010. Tendances d’évolution 2006-2007 > 2010*. [Online]. Consulted on 21/08/2016. Available at: http://intranet.atrimum.irisnet.be/library/2011/1/Flux_pi%C3%A9tons_2010_tendances_2006-2007_2010_c.pdf

³ Atrium. 15/10/2016. « Atrium a compté en moyenne 1.347.133 passants par jour. » Press release.

⁴ Atrium. 28/10/2015. “Le piétonnier passe dououreusement son premier grand oral.” Press release.

peak. These numbers should, however, be treated with caution since they also reflect the general increase in the popularity of cycling overall in Brussels⁵. In the immediate surroundings of the pedestrian zone, positive impact on cycling was detected where cycling conditions were improved (e.g. Dansaertstraat). At the same time, however, on routes where no efforts were made to accommodate cyclists a decrease of bicycle traffic was detected (e.g. Koloniënstraat, Keizerlaan).

The use of the stations of the Villo! bike-sharing service shows a decrease by 11% at Place De Brouckère and Place Fontainas and a slight increase by 2% at the Place de la Bourse between September 2014-2015. It is, however, not certain to what extent these changes are attributable to the pedestrian zone or to other factors such as the general popularity of Villo, a change in the number of subscribers etc.

Concerning road traffic, the report says the overall volume of motorised traffic in downtown decreased. No changes were detected in peak hours in November 2015 compared to June 2013 on Poincarélaan, Zuidlaan, Saintelettesquare and Kruidtuinlaan between Pacheco and Gineste. No significant changes in traffic on the small ring were detected, when the previously detected traffic was redistributed within the Pentagon. Overall, the increase in traffic volume in some streets (e.g. around the Central Station and Keizerlaan) (270 vehicles/hr increase) is much smaller than the decrease directly caused by the closure of the central boulevards (decrease by 1450 vehicles/hr). We could not yet access the methods used to gather these data that should be linked to change in the number of visitors (that might be affected by other causes as tunnel closures, terrorist attacks, etc.). A negative impact on taxi speeds is indicated without reference to concrete data. [Bruxelles Mobilité, 2016].

3. Impact of the pedestrian area on parking in the Brussels city centre

A pedestrian zone indicates that parking is not allowed anymore in the zone [Brandeleer *et al.*, in this Portfolio]. In the case of the Brussels pedestrian zone, it means a significant loss of parking places in the public space in the current configuration. In the first months after June 2015, the loss of parking places was even higher, due to the fact that additional streets like Zuidstraat (between Rouppeplein and Lombardstraat) were included in the zone, but removed from the zone later on.

⁵ The "Observatoire du Velo en RBC" (Pro Velo) counted the number of cyclists at 15 places in the Brussels Capital Region and they counted 220 cyclists (2013) and 275 (2015) which is a 25% increase. If this is accounted for the increase at the Beurs is 165%. [Bruxelles Mobilité, 2016, not public].

Despite road signs indicating a pedestrian zone, and therefore the prohibition of parking, parking seems to be tolerated by the police in some streets in the new pedestrian zone, e.g. the south part of Anspachlaan (between Lombardstraat and Fontainasplein). This situation is similar with the one prevailing in Nieuwstraat at night [Brandeleer *et al.*, in this Portfolio], although this possibility is not allowed by the traffic laws.

One of the characteristics of Brussels is the presence of a lot of car parks, both public and private, inside its city centre. This is the consequence of a policy followed from the 1950s. This situation creates important constraints for the pedestrian zone:

- These car-parks attract important traffic flows in the heart or in the immediate surroundings of the pedestrian zone;
- Their presence makes pedestrianisation impossible for the streets that lead to them and potentially the enlargement of the pedestrian zone beyond its current perimeter;
- Their number and their scattered localisation makes it difficult to design P-routes to access and to come out of the car-parks.

‘The many car parks in the city centre make pedestrianisation impossible for the streets that lead to them and their scattered localisation makes it difficult to design P-routes’

When the pedestrian zone was planned, the willingness of the Brussels City College was to create four additional public car-parks, namely Vossenplein, Nieuwe Graanmarkt, Ijzerplein and Rouppeplein. The aim was, on the one hand, to compensate the loss of parking spaces in the public space and, on the other hand, to supply a bigger number of parking spaces in order to attract more visitors and customers, particularly those who cannot or do not want to come by other means of transport than car. Moreover it was argued that in some peak periods (e.g. Winterpret) the availability of the existing car-parks was too low, although in some other time periods they seem under-occupied.

Opposition to the creation of a new car-park under Vossenplein was very strong and successful, as shown by the authorities their project, replacing it with another, smaller, one, near the Brigittines. On August 31, the Mayor declared that the car-parks under Nieuwe Graanmarkt and near the Brigittines would not be built but that the project for two additional car-parks remained.

Progressively reducing the number of car-parks according to the term/deadline of their environmental permit is no longer on the agenda. It seemed difficult for today's Authorities to lead an action that would suggest that cars are not welcome in the city centre knowing the difficulties faced by the pedestrian zone at the beginning, exacerbated by the Brussels "lockdown" (after the terrorist attacks of November 13 in Paris), the Brussels attacks of March 22 and the closing of some tunnels in Brussels (especially the Stefaniatunnel between February and August 2016).

4. Adaptations in public transportation after the extension of the pedestrian area in Brussels

The extension of the pedestrian zone to the Brussels "grands boulevards" at the end of June 2015 led to an important adaptation of the STIB/MIVB bus network. The metro and tram networks were not affected since they are both underground in this part of the city. Changes in the bus network were twofold. On the one hand, City Hall wanted to scatter the bus terminals that were previously concentrated at rue Henri Maus (next to Place de la Bourse) and Place De Brouckère. Their reasoning was from their point of view the two strong effects (spatial and visual) of these terminals on the pedestrian zone. On the other hand, the separate lane for buses Wolvengracht/ Stormstraat and Schildknaapsstraat/ Arenbergstraat which was in the opposite direction of the cars, has been reversed (to be in the same direction of the cars) and partly suppressed. The aim of City Hall was to reduce traffic jams in these streets, especially during periods of loading and unloading of goods. The possible impact of these changes brought about by pedestrianisation (which still need to be verified by empirical observations) are:

- Transit from one form of public transport to another (bus, tram or metro) more difficult in the city centre, reduced visibility/readability of the bus terminals/network for the users and increase of the travel duration;
- Lengthening or reduction of the "commercial speed" of the buses approaching or leaving the city centre;
- Increase or decrease of car speed.

In terms of timetables, the implementation of the pedestrian zone has not led to important changes in the frequency of the public transport supply, whether STIB/MIVB, De Lijn or SNCB.

On the whole, the public transport supply in the city centre has not been modified fundamentally with the implementation of the pedestrian zone but the dissemination of the bus terminals and the move of some of them away from the pedestrian zone may have affected the service negatively. Moreover, the

extension of the pedestrian zone was not used as an opportunity to improve the accessibility of the city centre by public transport [Lebrun, in this Portfolio]. Yet, some extensions of the tramway network exist, such as the deviation of the Koningsstraat tramline through the Central Station or the conversion of bus service 71 into a tram service that would serve the city centre either through Pachecolaan or another route, without speaking about an older East-West tramline project.

5. Health impact of a modal shift in the pedestrianisation

Today, air pollution is a major environmental and health problem (e.g. premature mortality, cognitive decline and neuropathology and preventable illness), especially in urban environments with high traffic density [Genc *et al.*, 2012]. In 2010, ambient particulate matter (PM) pollution was ranked 9th among the leading risk factors for global disease burden and accounted for 3.1 million of deaths worldwide due to respiratory, cardiovascular and cerebrovascular diseases [Lim *et al.*, 2012]. Transport is the most important source of air pollution in the European cities and as such, has a significant role in improving air quality and public health.

'We need to assess the impact of a large car-free zone on the health of the inhabitants and commuters'

In order to improve air quality in urban areas and meet European standards⁶ the number of cars must be decreased in favour of cleaner modes of transport, e.g. public transport and active transport (AT) modes such as cycling and walking. A modal shift from cars to walking and cycling has been proven to be effective in decreasing O₂ emissions, air and noise pollution, consumption of fossil fuels and congestion caused by motorized forms of transport [Int Panis *et al.*, 2010]. From the health perspective, a modal shift to AT will also help to meet the physical activity guidelines as outlined by the World Health Organisation (WHO) [WHO, 2010], which is particularly important because physical inactivity (not meeting the recommended physical activity levels), is the fourth highest risk factor for global mortality [WHO, 2009].

⁶ Directive 2008/50/EC of the European Parliament and of the council of 21 May 2008 on ambient air quality and cleaner air for Europe. [Online]. Consulted on 26/08/2016. Available at: <http://eur-lex.europa.eu/eli/dir/2008/50/oj>

Car-free zones, like the Brussels pedestrian zone, have the potential to increase quality of life of those living and working in the surrounding area and encourage citizens to shift from private motorisation to cycling and walking. In order to assess the impact of a large car-free zone on the health of the inhabitants and of the commuters, we can conduct an economic assessment of the health benefits of walking and cycling by estimating the value of reduced mortality that results from regular walking or cycling.

The tool suggested for such research is the online WHO Health Economic Assessment Tool (HEAT)⁷ [Kahlmeier *et al.*, 2014]. The HEAT addresses the question: for a given volume of cycling within a defined population, what is the economic value of the health benefits? Through the data showing the number of people walking or cycling as a result of the car-free zone, and their duration of this exercise, HEAT can calculate the economic value of the health benefits that occur as a result of the reduction in mortality due to their increased physical activity.

The health impact of environmental noise is a growing concern among both the general public and policy-makers in Europe. Road traffic noise has been shown to increase the risk of ischaemic heart disease, including myocardial infarction, increase the risk of high blood pressure, decrease the cognitive ability in children, disturb sleep, increase the risk of tinnitus and annoyance [WHO, 2011]. The results indicate that at least one million healthy life years are lost every year from traffic-related noise in the western part of Europe. The WHO have set limits in order to protect the citizens: during the day the maximal noise level should not exceed 55 dB(A) L_{den} ⁸ and during the night the maximal noise level should not exceed 40 dB(A) L_{den} . People living in the pedestrian zone are directly influenced by a decrease in the number of cars as the major source of noise pollution in urban zones comes from motorised traffic.

6. Data needs for the evaluation of the impact of the pedestrianisation scheme in Brussels

Based on our review of schemes we have identified a set of data that should be analysed in order to monitor the impact of the extension of the pedestrianised area in Brussels. Table 1 outlines the

⁷ WHO. 2016. *Health Economic Assessment Tool*. Available at: <http://www.heatwalkingcycling.org/index.php>

⁸ Contrary to decibels (dB) that express absolute noise levels, dB(A) or 'A-weighting' expresses relative loudness perceived by the human ear. L_{den} (level day-evening-night) is a common EU indicator that corresponds to the average noise level throughout the day, evening and night, to which a citizen is exposed over the period of a year. [Online]. [European Commission, 2016]. Available at: http://ec.europa.eu/environment/noise/europe_en.htm

types of data that should be collected or obtained, the recommended method of data collection and analysis and the timescale of monitoring (Table 1). The table does not only contain data that is needed to monitor the impact of the mobility of persons. It also takes into account the data needs for monitoring the impact of logistics activities since most of the effects are similar (e.g. due to vehicle traffic). Therefore we provide a table here that comprehensively outlines the data needs for both mobility and logistics. For specific details on data collection for logistics see Verlinde *et al.* [in this Portfolio].

We have grouped data under two main themes: 'transport' and 'sustainability'. Transport refers to the direct impact on traffic and travel patterns while sustainability effects are the secondary impact through changes in traffic, travel and transport demand. The table includes the recommended method of data collection and the potential data provider. For the period of monitoring we defined a longer period between 2014 June until 12 months after the construction works are finished in order to detect more long term behavioural changes. The spatial extent of the monitoring is normally the area within the Pentagon but impact on travel behaviour and traffic should be measured in an extended area. Due to the lack of comprehensive monitoring in Brussel, our recommendation is to set up a monitoring plan based on the data suggested in Table 1 and carry out regular monitoring of data related to mobility, economic, environmental and social impact.

Conclusion

Without a proper monitoring system it is difficult to give conclusive results on the impact of the pedestrian zone on the mobility system. In this paper we gave an overview of which effects were reported on similar pedestrian zones abroad.

'A comprehensive monitoring framework is proposed to assess the impact of the pedestrian zone on mobility of persons and goods and on health'

Next we overviewed the results from the first preliminary study made by Brussels Mobility. We then set up a monitoring system so that the pedestrian zone can be monitored in a more objective and solid way. We propose to the authorities and the transport operators to collaborate with us so that we can collect the necessary data and start the analysis.

Theme	Data type	Data unit	Method of collection	Period of monitoring	Data source/provider	Spatial unit	Passenger/freight	
TRANSPORT	TRAFFIC	Traffic volume	Vehicles/hour; Vehicles/day	Vehicle counts (periodic manual, loop or camera-based counts)	From 2014 June until 12 months after the construction works are finished	Bruxelles Mobilité/City of Brussels [reports of subcontractors on traffic countings] ProVelo's Fietsobservatorium	Roads within Pentagon, Small Ring (R20)	both passenger
		Pedestrian flows	Number of pedestrians/hour	Counts (manual, with cameras) Mobile phone locational data	From 2014 June until 12 months after the construction works are finished	City of Brussels, Atrium countings, mobile phone operators	Anspachlaan Brouckereplein Adolphe Maxlaan	passenger passenger
		Reliability of public transport (buses)	Excess waiting time* (minutes)	GPS on buses	From 2014 June until 12 months after the construction works are finished	STIB/MIVB statistics	Bus services within the Pentagon	passenger
		Traffic congestion	Average speed/link/hour	Floating car data from SatNav operators	From 2014 June until 12 months after the construction works are finished	BeMobile, TomTom, ...	Small Ring, streets within Pentagon, major roads leading to the Small ring	both
	MOBILITY	Modal split for trips within and into the city centre (Pentagon) (public transport, cycling, walking, cars)	Percentage (of number of trips or length of trips)	Calculations based on travel behaviour surveys	Yearly	Travel behaviour surveys with residents, visitors and employees	Brussels Metropolitan Area	both
		Passenger volume on public transport	Passengers/hour (alighting/boarding)	MOBIB smartcard data analysis	Every 6 months from 2014 June until 12 months after the construction works are finished	MOBIB smart card data (bus/metro boarding only, premetro boarding and alighting)	Services/stops within the Pentagon	passenger
				Traditional passenger counts		passenger counts (STIB/MIVB)		passenger
		Utilisation of bike sharing stations	Number of rentals and returns/hour	VILLO big data analytics	From 2014 June until 12 months after the construction works are finished	VILLO use data		passenger
		Utilisation of car-sharing stations	Number of rentals and returns/hour	Analysis of provider's data	From 2014 June until 12 months after the construction works are finished	CAMBIO/ZENCAR statistics		passenger
	PARKING	Parking occupancy (cars) of off-street and on-street parking	Percentage	Analysis of provider's data	Yearly	Statistics from parking garage operators, on-street counts	Pentagon	passenger
								both
		Parking capacity	Number of on-street and off-street parking spaces	Official statistics	Yearly	City of Brussels, Bruxelles Mobilité		both
		Level of parking charges	Level of on-street and off-street parking charges by time and day	Official publications of the City of Brussels Price list of private parking operators	Yearly	City of Brussels	Pedestrianised zone and area in 10 minutes walking distance from the pedestrianised zone	passenger
								passenger
		Parking restrictions	Maximum parking duration per time and day	Official publications of the City of Brussels	Yearly	City of Brussels		both
		Capacity of Park and Ride facilities	Number of parking places of Park and Ride facilities that provide access to the city centre	Official statistics	Yearly	Bruxelles Mobilité	Brussels Region	passenger
Average utilisation of Park and Ride facilities to access the city centre	Percent/day (during the day)	Official counts	Yearly	Bruxelles Mobilité	Brussels Region	passenger		

Theme	Data type	Data unit	Method of collection	Period of monitoring	Data source/provider	Spatial unit	Passenger/ freight
SUSTAINABILITY SOCIETY	Number of accidents	Number of road accidents per month by severity and by vehicle type (fatal, severe, light)	Official police statistics	2014 June – 12 months after the construction works are finished	Police records	Within Pentagon	both
	HEAT index	Traffic counts (see above)					both
		Modal shift (see above)					
	Noise level	dB(A)	Official measurements	Yearly	City of Brussels	Within Pentagon	both
ENVIRONMENT	Sulphur dioxide (SO ₂) concentration/emissions	µg/m ³ (or ppmv, parts per million by volume) or gram	Concentration based on official measurements; emissions can be calculated based on travel behaviour surveys among drivers (passenger and freight transport)	Yearly	Bruxelles Environnement or City of Brussels	Within Pentagon	both
	Nitrogen dioxide (NO ₂) concentration/emissions	µg/m ³ (or ppmv, parts per million by volume) or gram	Concentration based on official measurements; emissions can be calculated based on travel behaviour surveys among drivers (passenger and freight transport)	Yearly	Bruxelles Environnement or City of Brussels	Within Pentagon	both
	Particulate matter (PM2.5 and PM10) concentration/emissions	µg/m ³ (or ppmv, parts per million by volume) or gram	Concentration based on official measurements; emissions can be calculated based on travel behaviour surveys among drivers (passenger and freight transport)	Yearly	Bruxelles Environnement or City of Brussels	Within Pentagon	both
	Carbon dioxide (CO ₂) emissions	gram	Calculations based on travel behaviour surveys among drivers (passenger and freight transport)	Yearly	City of Brussels	Within Pentagon	both
	Energy consumption	litres or kWh (depending on fuel type)	Calculations based on travel behaviour surveys among drivers (passenger and freight transport)	Yearly	City of Brussels	Within Pentagon	both
ECONOMY	Cost per delivered item	Euro	Surveys among 'receivers'	Yearly	City of Brussels	Within Pentagon	freight
	Cost per received item	Euro	Surveys among transport operators	Yearly	City of Brussels	Within Pentagon	freight
	Cost for passengers	Euro	Survey of travellers	Yearly	City of Brussels, Brussels Mobility	Brussels Metropolitan Area	passenger

Table 1. Data needs for a comprehensive evaluation of the impact of the pedestrianisation scheme in Brussels

*Excess waiting time experienced by passengers over and above what might be expected of a service that is always on time [Local Government Association, 2016].

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