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MEASURING THE IMPACT OF MOBILITY MEASURES IN THE HAGUE: TRAFFIC, LIVEABILITY AND ECONOMY

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1. INTRODUCTION

The municipality of The Hague (The Netherlands) is currently implementing a package of measures that are aimed to increase the accessibility and the quality of life in the northern part of the city centre. This is an area with many (local) shops, restaurants, cafes and cultural facilities. The area also hosts numerous (inter)national institutions and embassies. Due to the structure of the city, the area has to deal with a lot of through traffic, while the area is not equipped for this. This leads to traffic congestion, poor road safety, noise nuisance and harmful emissions. It is preferred that this traffic uses alternative routes around the area (Figures 1.1 and 1.2).

The measures should not only prevent through traffic, but are also explicitly intended to increase the quality of the public space and thereby contribute to the quality of life of the residents. The measures should contribute to the ambitions that The Hague has in view of its mobility transition. Examples of measures in the package are the adjustment of traffic lights, the closing of roads, the introduction of one-way traffic on roads and the redesign of roads and adding more space for pedestrians, cyclists, trees and greenery. The package of measures has been drawn up as a co-production of 24 interest groups and semi-governments, in which they together developed the plan. The implementation of the measures began in 2022 and will continue through 2026.

Monitoring and evaluation of the effectiveness of the measures is of great importance, because of three reasons:

1. *Accountability* – The implementation of the measures demands the investment of large amounts of public resources. The public has the right to know the impact of the measures. Also, when the impact is known, the municipality will be able to learn for future projects.
2. *Facilitating interim adjustments* – The implementation of the measures takes place in several rounds. Each year, a new round of measures will be put into practice, based on the current status of the traffic and the effects of measures that have already been implemented.

Figure 1.1: Study area, with the three main thoroughfares, that experience much through traffic.

3. *Involvement of stakeholders* – Many stakeholders are involved in the package of measures, each with their own interests. Because the measures are implemented in rounds and the measures of each round are determined in consultation with the stakeholders, it is essential that a monitoring and evaluation process takes place that facilitates the discussion and brings facts into it. The monitoring and evaluation process should give confidence and bring stakeholders together.

For these reasons, the municipality, together with Goudappel, has developed an extensive framework for monitoring and evaluation. Several principles guided the development of the framework:

- *An integral framework* – We not only measure indicators related to traffic, but also give substantial attention to the perspectives of liveability and economy.
- *Objective and subjective data* – We not only measure hard indicators, such as traffic intensities and number of companies, but also measure the perceptions and opinions of residents, visitors and entrepreneurs, as important target groups. It is their area after all.
- *Open and innovative data* – We make as much use as possible of data that is already available and/or that comes from innovative data sources that have distinct advantages over more traditional data sources, such as Floating Car Data.

This paper presents the framework for monitoring and evaluation. It discusses the context, the selected indicators, the data sources and the way of determining impacts. First, this paper seeks to inspire other cities that see themselves confronted with the same problems and ambitions and that also want to develop and implement data-driven policies, in close cooperation with residents and other stakeholders. Second, this paper aims to add knowledge in the field of monitoring and evaluation. It is not a very exciting subject among policy makers, however, in order to develop successful policies aimed at making our cities more liveable and attractive, it is important to report on effects and to learn from cases. This is all the more important as, unfortunately, evaluation of transport policies is still not common practice (Van Wee et al. 2023; Nijland et al., 2010).

Figure 1.2: Streets in study area that experience frequent congestion.

2. PARTICIPATORY PROCESS

2.1 Package of measures as a result of a co-production process

24 stakeholders have drafted the package of measures in a co-production process, in which they worked together on defining the problem, setting the aims, finding strategies for solutions and defining concrete measures with regard to the transport situation in the area. This group of stakeholders consisted of, among others, several residents' organisations, several business associations, representatives of the public transport company, the police and interest groups for cyclists and public transport users. The resulting plan, including 35 measures for improving the area, is in fact 'owned' by the group of stakeholders. The process, which was facilitated and guided by the municipality, was complex and challenging due to the many stakeholders

involved and the wide variety of interests. However, the process resulted in a plan that is widely supported.

The city council adopted the plan almost in its entirety. After that, the timeline of the measures was determined. The measures have been assigned to a specific year. The measures of the first year have been given the official green light for implementation. Implementation of successive years' measures will be approved after a review procedure, in which the results of interim monitoring play a major role.

2.2 Participatory monitoring and evaluation

The monitoring and evaluation project is designed as a participatory monitoring and evaluation project. That means that stakeholders are closely involved in the process. Unlike in the process of preparing the package of measures, where stakeholders jointly formulated the measures in a co-production, the stakeholders have only a consulting and advising role in the monitoring and evaluation project. The stakeholders have a role in:

- The design of the measurement plan;
- The interpretation of the results;
- The selection of next rounds' measures based on the results.

We mutually support each other in this process. We provide data to facilitate a fact-based discussion about the measures of the next round. On the other hand, stakeholders provide us with local knowledge and help interpret observed changes and identify effects in the area. They also signal what is going on in the area in terms of developments and sentiments.

We report about the collected data not only in official documents, but also publish the collected data in a dashboard that is publicly available. In addition to presenting results, the dashboard also allows the stakeholders to play with the data themselves. The dashboard makes it possible to view indicators side by side and to select time periods by yourself (in the case of continuous data).

This participatory process strengthens stakeholder engagement, enables evidence-based discussion and contributes to the legitimacy of the outcomes (see also Ellen & Breman, 2019).

3. SELECTION OF INDICATORS

In the plan with the package of measures, the stakeholders formulated a set of goals that the measures aim to achieve:

- 15% reduction of through traffic per day and 25% reduction of through traffic in the morning peak;
- Less stationary traffic in the streets;
- Improvement of air quality;
- More space for pedestrians and cyclists;

- Increasing numbers of pedestrians and cyclists;
- No deterioration of driving times of public transport;
- Better connection between important shopping streets / hotspots;
- Improvement of the quality of public space (by redesigning streets and adding more greenery);
- Maintenance of car accessibility;
- Minimising side effects, such as detour traffic.

Based on these goals and the first ideas about potential indicators of the stakeholders, we came up with 21 indicators to measure the progress on the goals. These are centred around 13 subjects, that together represent the perspectives of mobility, liveability and economy (see Figure 3.1). The indictors related to mobility and liveability follow directly from the goals of the package. The indictors related to economy were selected in order to address the concerns of business owners in the area. A share of the business owners was afraid that the measures would negatively impact their business, as they thought the car accessibility of the area would decrease.

We pay great attention to surveying the opinions of residents, visitors and business owners. This is for three reasons. First, the measures are essentially designed to improve the quality of the environment for their benefit, so it is key to survey them accordingly. Second, involving the public in the monitoring and evaluation benefits the target groups' involvement in the measures and might increase support among them.

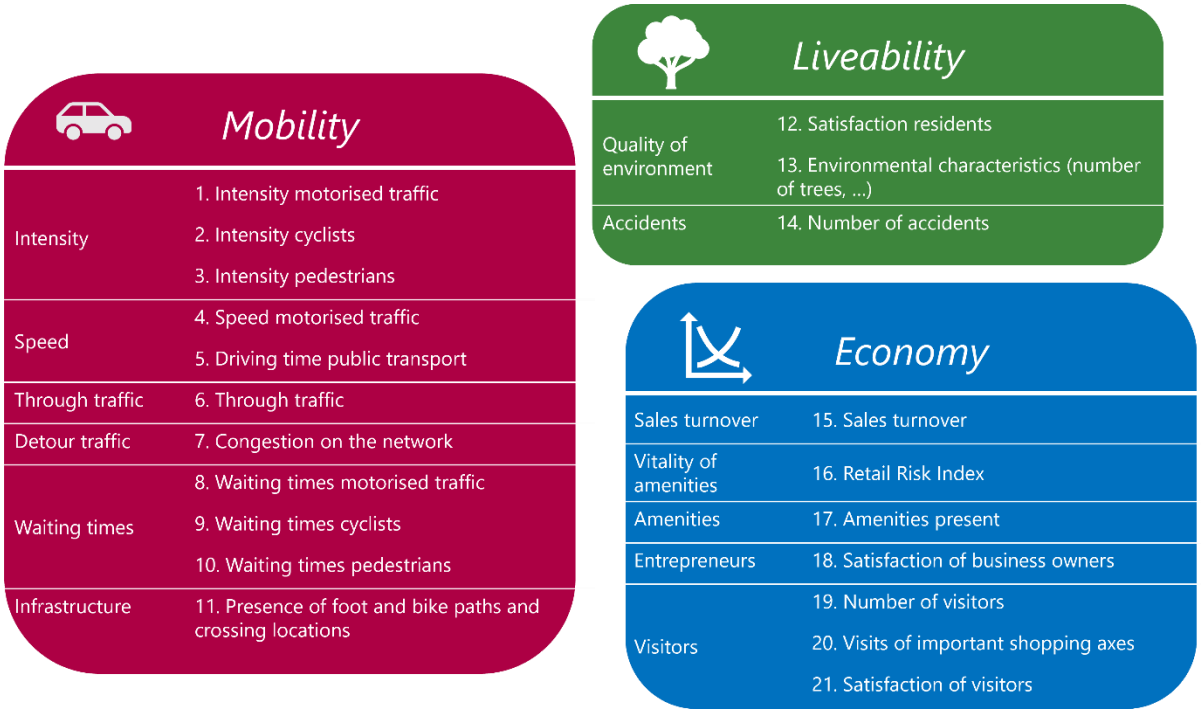

Figure 3.1: Indicators

Third, surveying the target groups allows us to make a stronger connection between opinions / behaviour and the measures, by questioning them to review how changes in opinions and behaviour relate to the measures that have been implemented.

4. DATA COLLECTION IN PRACTICE

In this part, we describe the monitoring and evaluation framework in more detail. We describe the operationalisation of indicators and pay special attention to the use of some innovative measurement methods.

In the process of operationalising the indicators and selecting the data sources, we followed the following principles:

- Preference for data that the municipality of The Hague itself is already collecting or that is available as open data;
- Preference for new and innovative measurement methods. The availability of Floating Car Data (FCD), for example, offers many possibilities. The use of this data can provide more valuable insights at lower costs compared to more traditional measurement methods;
- Preference for data sources that provide data for longer periods of time. This avoids relying too much on data collected for only one or a few days, which can be affected much by specific circumstances (e.g. weather conditions). The longer the period for which data is available, the more accurately trends can be determined and corrections for external circumstances and autonomous trends can be applied.

Table 4.1 provides an overview of the indictors, with the data source and a small description.

With regard to the indicators, it is relevant to note that air quality is not selected as an indicator. We choose to first look into the development of traffic intensities (as a proxy for air quality) and to model changes air quality based on traffic data and characteristics of the environment when traffic intensities will change substantially.

Also, important context indicators are taken into account, such as the number of inhabitants, number of jobs and car ownership.

The first round of data collection has been carried out in September 2022, in order to set the baseline. At this moment (September 2023), the second round of data collection takes place.

Here, we want to highlight three data sources and discuss them in detail, from the perspective of the principles given above.

4.1 Data from traffic light installations

As is the case in many cities in the Netherlands, in The Hague many traffic light installations have inductive loop detectors that count the number of cars passing. The Hague is the first city in the Netherlands that made these data available via the portal of NDW (Nationaal Dataportaal Wegverkeer / National Portal Road Traffic Data). This facilitates an efficient data collection and analysis process.

Many traffic installations have also loop detectors on cycling paths, which provide counts of cyclists. These are not as accurate as desired – they sometimes have problems with groups of cyclists standing still at the detector – however, as these data are continuous data, are freely available and are collected for multiple locations in the area, we preferred this data instead of organising a separate count of cyclists.

4.2 Floating Car Data (TomTom)

In our approach, we make use of Floating Car Data (FCD) from TomTom. In 2022, we bought the data for our study area, however from early 2023 this data has become freely available for Dutch road authorities, as part of a deal with NDW. We use the FCD to measure through traffic, traffic speeds and flows at intersections. The data is highly flexible as it can be used for any desired time period and for time periods in the past. Therefore, we can easily carry out additional analyses if desired.

When using FCD, one needs to carefully think about how to use the data; after all, the data is not suitable for all analyses. Making statements about absolute numbers of traffic is tricky, because FCD covers only a proportion of the vehicles and the degree

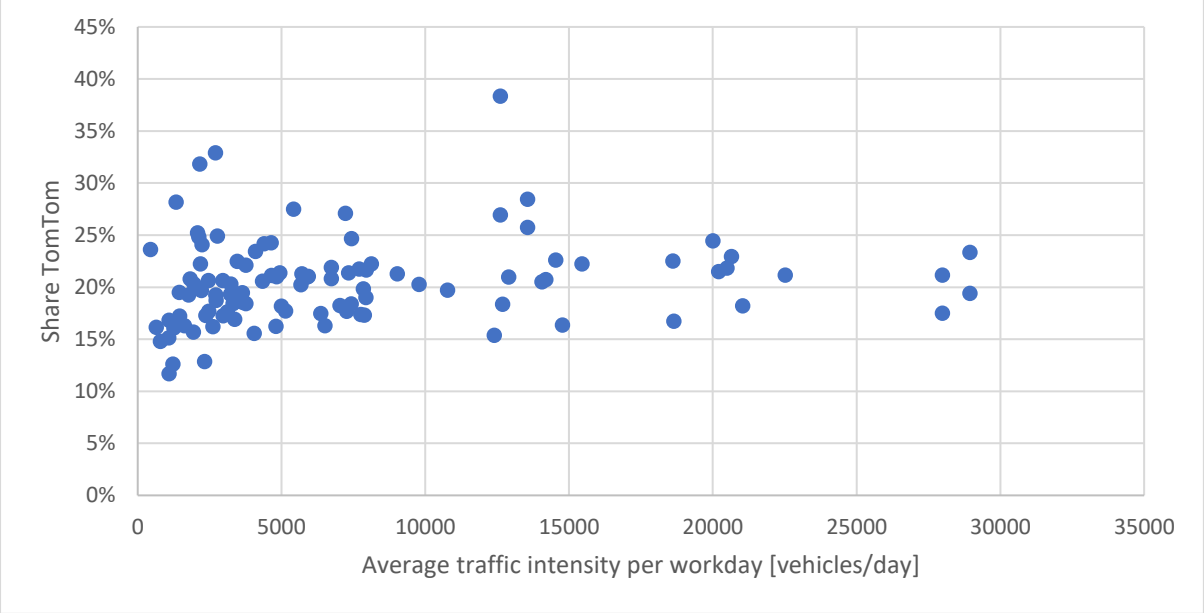

Figure 4.1: Ratio of number of vehicles measured by traffic counts at streets to number of observations TomTom FCD.

of coverage can differ per street, especially in an urban context. In our study area, the degree of coverage is around 20%. We compared the traffic counts on streets with the coverage of TomTom FCD, based on the data collected in the baseline measurement of September 2022, and found that the average coverage seems to be the same for streets with higher and with lower traffic intensities, but that there is a greater variance among streets having lower traffic intensities (Figure 4.1).

The proportion of cars driving with TomTom systems has increased in recent years and is projected to further increase in the coming years, so absolute observations from TomTom FCD over the years cannot simply be compared to make statements about developments in the total vehicle use.

Nevertheless, FCD can be used well for analysing units that are less dependent on the degree of coverage, such as speed. In addition, the problem of varying coverage can be reduced by making statements about larger areas rather than individual streets and by using the data for the determination of relative rather than absolute results.

In our study, we use FCD to analyse speeds on road sections, the proportion of through traffic in the entire study area and waiting times at intersections for motorised traffic. As for through traffic, in 2019 a license plate study was carried out to determine through traffic and to determine the reduction target. At the end of the programme, in 2026, another license plate study will be conducted to determine whether the reduction goal has been reached. We deploy FDC to monitor the trend in the intervening years, as carrying out a license plate study is very expensive. We have replicated the license plate study from 2019 with FCD and the results correspond well. This way, we make an optimal combination of an accurate study on the streets and cheaper deployment of FCD.

4.3 GPS registrations mobile phones (Resono)

We use GPS registrations of mobile phones to provide insights into the number of visitors at specific locations. This data comes from the firm Resono, which estimates the frequency by which any chosen location is visited, based on GPS registrations of mobile phones of a sample of about 2 million persons in the Netherlands. Although we assessed this data as not suitable for determining the absolute numbers of visitors, in our view it is suitable for providing insights into trends in visitor numbers. A benefit is that the data is continuous data and that we can select each time period and hour of the day for our analyses, also in the past. Techniques such as cameras might be more accurate to determine the number of persons in a shopping street, however, these techniques are often much more expensive.

Another reason for using this data is that it can be easily determined whether a phone that has been identified in one area has also been present in another area within a certain time period. That makes it easy to say something about how well certain streets are connected to each other in terms of combined visits.

Indicator	Goal	Data source / methods	Description
Mobility			
1. Intensity motorised traffic	• 7% decrease per day • 13% decrease per morning peak hour	Inductive loops at traffic light installations, pneumatic tubes, cameras (where tubes are not possible)	Traffic intensities are measured at 65 locations (see Figure 4.2).
2. Intensity cyclists	Increase	Inductive loops at traffic light installations	Cyclist intensities are measured at 30 locations.
3. Intensity pedestrians	Increase	Registrations GPS locations, modal split module	Resono offers a tool to predict mode of transport in selected areas based on average speed (car, bike, walk). We acknowledge that this method may not be very accurate, however we use this method as we are more interested in trends than in actual numbers of pedestrians. We measure pedestrian intensities at 8 selected streets / hotspots.
4. Speed motorised traffic		FCD	The speed on the roads is a proxy for traffic flow. The speed of motorised traffic is measured at 15 selected trajectories.
5. Driving time public transport	No deterioration of driving times	Registration of driving times in busses and trams	The implementation of the measures should not lead to a worsening of the performance of public transport. Therefore, driving times of buses and trams traversing the area are monitored.
6. Through traffic	• 15% decrease per day • 25% decrease per morning peak hour	FCD / licence plate study	Decreasing through traffic in the area is key to the programme. The reduction aims have been determined based on a license plate study in 2019, which serve as the baseline for this indicator. After the programme, the licence plate study will be replicated, to find out whether the aims have been reached. Meanwhile, through traffic will be

			monitored using a FCD framework that uses the same measuring points (see Figure 4.2).
7. Congestion on the network	Maximum of 15% increase of traffic around study area	FCD	FCD observations are used to detect if locations outside of the study area experience higher or lower traffic intensities. In this analysis, the autonomous trend in number of FCD observations is controlled for, based on the actual measured traffic intensities at several 'anchor' locations.
8. Waiting times motorised traffic	Decrease	FCD	High waiting times at intersections indicate high levels of stationary traffic. With the Intersection Replay tool, that makes use of FDC of TomTom, we measure the presence of queues at 10 intersections.
9. Waiting times cyclists	Decrease	Registrations at traffic light installations	In stimulating the use of bikes, it is important to guarantee a good flow for cyclists. In the NDW portal, data about average waiting time per cyclist is available, based on algorithms that use inductive loop detectors and information about green / red light periods.
10. Waiting times pedestrians	Decrease	Registrations at traffic light installations	In stimulating walking, it is important to guarantee a good flow for pedestrians at intersections. The NDW portal has data available about time periods between asking for green and getting green light for pedestrians.
11. Presence of foot and bike paths and crossing locations		Registration data of municipality	As part of this indicator, we monitor the m^2 of footpath and bike path and the number of (improved) crossing facilities for cyclists and pedestrians.

Liveability			
12. Satisfaction residents		Survey	In a survey, a random sample of inhabitants is asked about their opinions regarding aspects related to traffic and the environment and about their travel behaviour.
13. Environmental characteristics		Registration data of municipality	As part of this indicator, we monitor the m^2 of greenery, number of trees and the length of different types of pavement, as a lower proportion of roads should consist of asphalt.
14. Number of accidents		Registrations of the police	Accident by outcome: only material damage, injury or fatalities.
Economy			
15. Sales turnover	No decrease	Statistics Netherlands	We use data about sales turnover of small and medium sized enterprises (SME), that Statistics Netherlands has available based on VAT records. Sales turnover are monitored in 8 shopping streets, distinguishing between the industries 1) retail and hospitality, and 2) services (see Figure 4.2 for these streets).
16. Retail Risk Index	No decrease	Locatus	Locatus is a firm in the Netherlands that provides all different types of retail related data. For different industries, Locatus provides performance indicators for shopping streets.
17. Amenities present	• No decrease of number of amenities • No increase of vacancies	Locatus	We monitor the presence of amenities in the shopping streets, distinguishing between different industries.

18. Satisfaction of business owners		Survey	A survey measures, among others, business owners' satisfaction with their shopping street, the perceived customer flow and the extent to which they feel customers can easily reach their shops.
19. Number of visitors	Increase	Registrations GPS locations	Based on data of Resono, we monitor the number of visitors per day in the 8 shopping streets.
20. Visits of important shopping axes	Increase	Registrations GPS locations	One of the aims of the programme is to better connect important streets / hotspots in the study area. A proxy for this is the share of visitors that do not only visit area A but also area B. With data of Resono we can monitor this percentage.
21. Satisfaction of visitors		Survey	At five locations, visitors in shopping streets are asked to give their opinion about different aspects of the shopping streets. They are also asked for their mode of transport, their satisfaction with the accessibility and the money they spent and/or expect to spend in the street at the day.

Table 4.1: Description of the indicators.

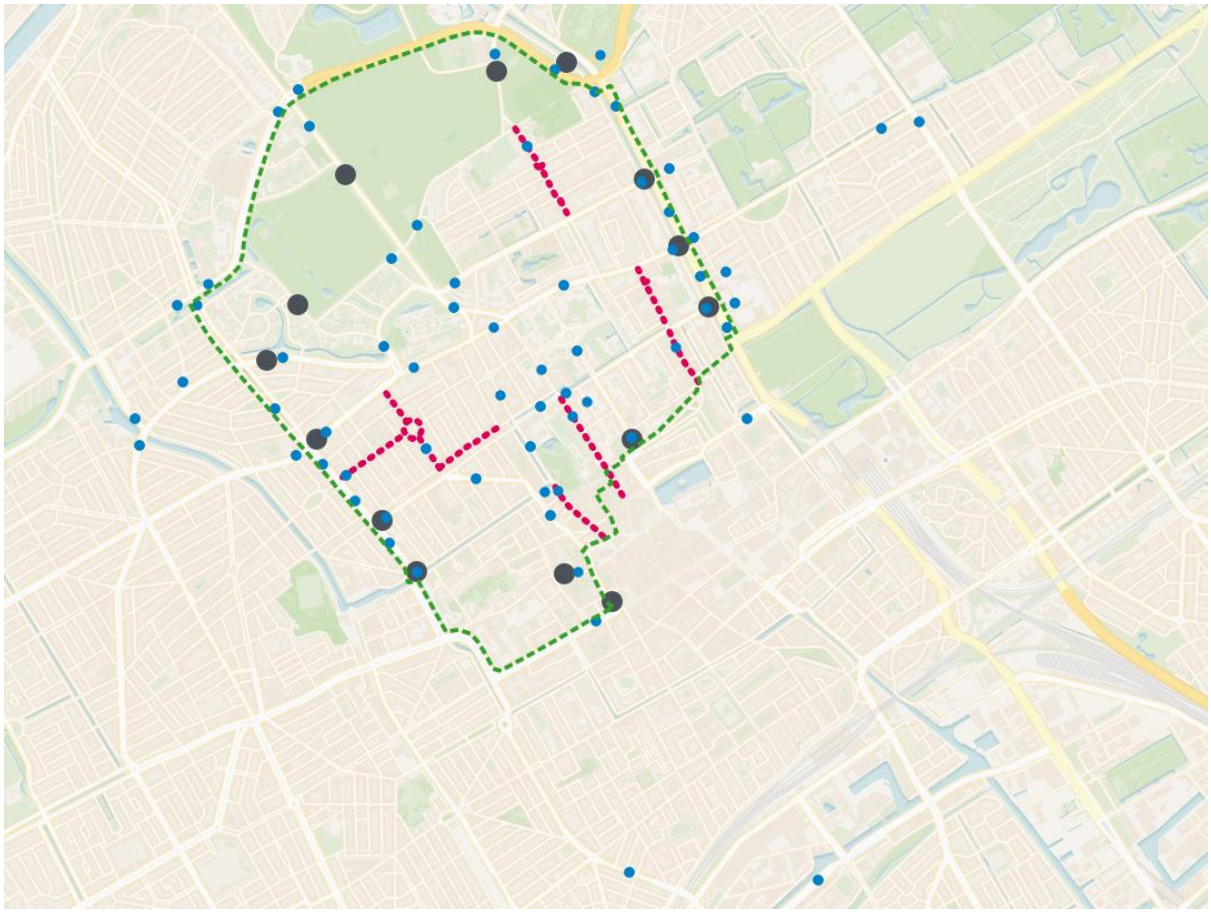

Figure 4.2: Locations where motorised traffic is counted (blue), locations used to determine share of through traffic (grey) and the 8 shopping streets, for which economic indicators are measured (red).

5. DETERMINING EFFECTS

In the monitoring and evaluation process, we want to know to what extent changes in mobility, liveability and economy in the study area are related to the measures taken and to autonomous and external factors. We use a combination of three techniques to determine the effects of the measures:

- *Benchmarking* – We examine how the development of indicators in the study area compares to the development elsewhere in The Hague and – when relevant – comparable areas in the Netherlands.
- *Statistical testing* – We use regression modelling to determine whether two measurements statistically differ from each other, while correcting for autonomous and external factors. Therefore, we apply continuous data as much as possible, as with this type of data it is easier to detect when changes occur and to distinguish between possible causes in the modelling process.

- *Expert judgement* – In the complex context of big cities, with roadworks, incidents and events seemingly present anywhere and anytime, it is not possible to create a laboratory environment to perfectly test the impact of individual measures. With quantitative analysis, we can get to a certain point, however, expert judgement will be always needed to evaluate the effectiveness of measures where figures are not available or the above techniques are inadequate.

6. CONCLUSIONS AND DISCUSSION

In this paper, we presented the framework for monitoring and evaluating a large-scale package of mobility measures in The Hague. We observe that monitoring and evaluation is an increasingly critical requirement when implementing integrated mobility programmes. For example, monitoring and evaluation is a required part of the Sustainable Urban Mobility Plans (SUMP), which cities in the EU with more than 100,000 inhabitants are obliged to have from 2026 onwards due to European regulations. At the same time, monitoring and evaluation has not always been a popular topic. Policymakers often pay substantially more attention to the process of developing policies than to the period afterwards. There is often a lack of capacity to organise monitoring and evaluation properly and on time. Determination of effects requires thoroughly thinking about goals, indicators and data sources prior to implementation; it is not simply a matter of reflecting for a few hours after project implementation. Third, conducting and evaluation is often perceived as difficult for methodological reasons. Isolating effects and establishing causality is not easy in a context where many other factors can also contribute to observed changes (Beverling et al., 2009; Shadish et al., 2002).

The difficulty to draw firm conclusions should not be a reason not to measure anything at all. Estimating effects starts with a good grasp of relevant autonomous trends and developments. With the application of benchmarking and statistical models, together with a choice of the right data, effects can be estimated to a certain extent. In addition, it is also relevant to question the target groups themselves. They can provide information on how the measures impact their opinions and behaviour, which is valuable information for interpreting effects. At the same time, the use of expert judgement will always remain necessary to draw conclusions based on data.

Monitoring and evaluation processes can greatly benefit from many new and innovative data sources that have seen un upsurge in recent years, such as the expanding availability of FCD and the rapidly increasing number of cameras and sensors in public spaces. The availability of these data sources makes good thinking about M&E framework all the more critical. Measuring does not always mean knowing; in fact, it can sometimes contributes to the feeling of *not knowing* because one doesn't know where to look for determining effects. This emphasises the need to think carefully about how to set goals, select indicators, choose data sources and test effects.

In our study, we do not focus solely on indicators in the field of mobility. Also the perceptions of inhabitants about the liveability of the study area have an important role in our framework. Therefore, we focus on several economic indicators and the perceptions of business owners and visitors about the (economic) attractiveness of the area. We observe that little is known about the precise relationship between mobility measures implemented by city councils and economic performance, as only a limited number of cases pay attention to this relationship in an empirical way and analyses on this domain do not always have much depth. Therefore, there is a need for knowledge development in this area.

We organised this monitoring and evaluation project as a participatory monitoring and evaluation project. The package of measures that was drafted is a co-production of a large group of stakeholders and a great number of the same stakeholders are also closely involved in the M&E process. The participatory nature of the evaluation lies in the fact that stakeholders contributed in drafting the measurement plan and that they contribute in interpreting the data and advising about the measures of next rounds, based on the results of interim monitoring rounds. We mutually support each other in this process. We feed the discussion with data, so that the discussion can be take place based on facts and evidence. Additionally, stakeholders provide us with local knowledge and help to interpret observed changes and to identify effects in the area. This process gives legitimacy to the results and facilitates learning together (see also Ellen & Breman, 2019). From the municipality's side, setting up such a process requires considerable investment in time and energy to make it work. Also, it requires good agreement on the precise roles and mandates of the stakeholders involved. Nevertheless, in our opinion, it is very valuable to engage in such a process together.

BIBLIOGRAPHY

Beverling J., Groot, W., Lijesen, M, Savelberg, F. & van der Werff, E., Na het knippen van het lint. Het ex post evalueren van infrastructuur [After cutting the ribbon. Ex post evaluation of infrastructure], Kennisinstituut voor Mobiliteitsbeleid, 2009

Ellen G.J & Breman, B., Samen meten is samen weten – Participatieve monitoring voor case Leegveld [Measuring together is knowing together – Participatory monitoring for the Leegveld case.] WUR/Deltares, 2018.

Nijland, H., Wortelboer-van Donselaar, P.M., Korteweg, J.A.C. & Snellen, D., 'Met de kennis van nu': leren van evalueren ['With today's knowledge': learning from evaluation], Planbureau voor de Leefomgeving (PBL) & Kennisinstituut voor Mobiliteitsbeleid (KiM), 2010.

Shadish, W.R, Cook, T.D. & Campbell, D.T., Experimental and Quasi-Experimental Designs for Generealized Causal Inference, Belmont, U.S.A, Wadsworth Cengage Learning, 2002.

Wee, B. van, Annema J. A. & Barneveld, S. van, Controversial policies: growing support after implementation. A discussion paper, Transport Policies, 2023, 139, 79-86.