MULTIMODAL SUSTAINABLE TRAFFIC MANAGEMENT IN THE NETHERLANDS

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1. INTRODUCTION

Some 20 years ago a handbook was published which described an approach in nine steps to develop and implement a consistent and accepted (in terms of political objectives) set of traffic management measures and the necessary technical and information infrastructure. It was called the *Handbook Sustainable Traffic Management* (Rijkswaterstaat, 2003, figure 1), 'sustainable' because it was aiming at lasting traffic management solutions for bottlenecks in the road network.

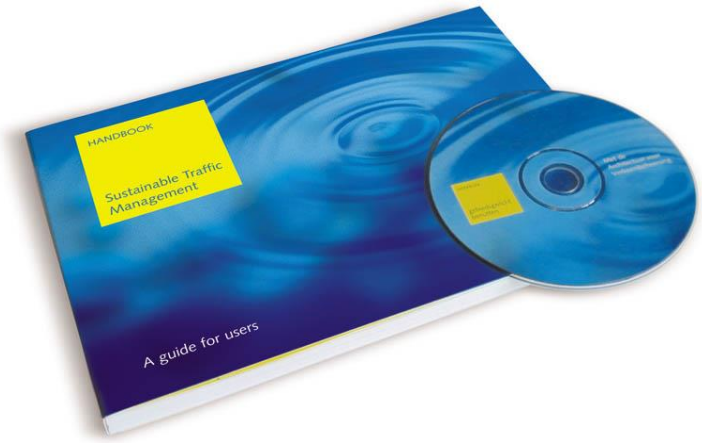

Figure 1: Handbook Sustainable Traffic Management

The first step in the approach is to initiate the project and involve all stakeholders, establish the project organisation, and to make sure that the various parties involved agree on the goals. The next step is to translate these goals into a number of policy objectives that describe the desired situation. These objectives are translated into prioritised routes and crucial network parts in the so-called control strategy and numbers are added to these priorities in the fourth step, the frame of reference, in which threshold values for key performance indicators are defined. The comparison of the current situation with the frame of reference leads to a list of bottlenecks, locations where the current situation do not meet the threshold values from the frame of reference. For these bottlenecks, services are developed (e.g. increase speed, or decrease flow) and traffic management measures are chosen. After implementation, these measures will accomplish the services. All steps are discussed and taken in agreement with all stakeholders. In the end, the approach leads to a final set of measures, supported by all stakeholders. And once the scheme has been ratified at

the political level, the implementation of the measures, the design of control scenarios and, finally, operational traffic management can be started (Taale, *et al.*, 2004).

After the publication of the handbook, the method was applied in numerous regions and cities in the Netherlands, leading to new implementations of traffic management measures. Based on practical experiences, the method was extended with the focus on safety (Rijkswaterstaat, 2007) and was adjusted to be in line with practical applications and to align with new approaches and requirements (Van Kooten, *et al.*, 2011). Not only the priority, but also the function of a road is considered. The function is important to develop and take measures in line with how the road is used. Also, a control philosophy was added, in such a way that measures could be deployed efficiently and in line with priority and function.

Also, to facilitate the approach a tool was developed. This sketch and calculation tool supported the steps and made it possible to determine the impact of the proposed traffic management services and measures. The effects could then be compared to the formulated policy objectives or other sets of measures (Taale and Westerman, 2005).

However, the approach described in the handbook is unimodal and focusses on car traffic. In the complex urban environment of a modern city, this approach and favouring car traffic does not suffice anymore. Considering liveability and sustainability, cycling, walking and public transport have become equally important modes, or even more important modes. Also, mobility is growing and the available space is becoming scarce. Choices on how to operate traffic in such complex and intertwined networks (involving multiple modes) have to be made and there was a need for a policy framework to support these choices. Therefore, using the old handbook as a basis, a new multimodal network management framework has been developed (Adams, *et al.*, 2023). In this paper this new framework and the steps involved are discussed and some applications are given.

Figure 2: Guidelines for a Multimodal Network Management Framework

2. THE MULTIMODAL NETWORK MANAGEMENT FRAMEWORK

Nowadays traffic management is a complex task. Policy choices have to be made and operational decisions have to be taken on how to deal with car, trucks, busses, bicycles and pedestrians in the network and how to keep them safe and flowing, especially where they interact. Without a clear and transparent framework to base these decisions upon, problems and arbitrariness could occur. Sustainable regional and urban mobility requires a widely supported vision on the desired use of the different networks.

A multimodal network management framework offers such a vision. It is a translation from mobility policy into and clear and unambiguous description of the desired situation for the different networks. Which mode has priority on route X? What is the average travel time mode Y has to meet? Which operational speed is the target for the bus on relation A-B? To compare this ideal situation with the actual one, it becomes clear where challenges are and bottlenecks between modes become visible. For the bottlenecks, policy makers and traffic managers can formulate solution directions in line with the desired situation for the networks. The translation from a mobility policy into the desired situation is done in six steps (see figure 3).

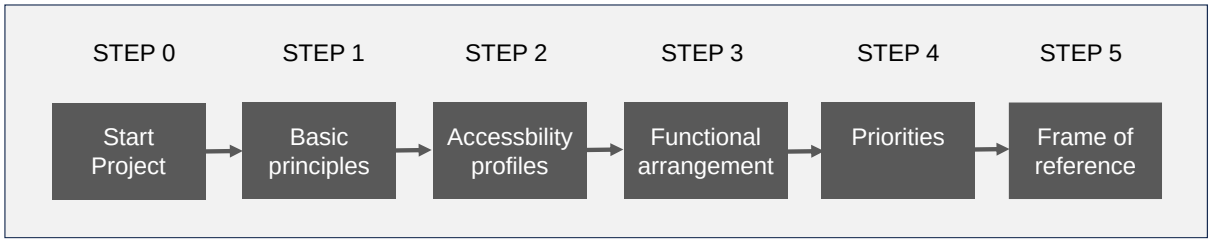

Figure 3: Steps to come to a Multimodal Network Management Framework

2.1 Step 0: Start the project

In this step the goals of the project should be clearly defined. What is the project hoping to achieve and what policy goals are tackled? What are the current ambitions? Normally those ambitions can be found in policy documents, such as a mobility plan, a public transport vision or a bicycle strategy. Possibly there are conflicting goals which can be identified. It is also important to think about how the framework will be used in practise. Is it only to determine the bottlenecks, for policy monitoring and evaluation, or also for the design of the traffic management measures? The application intended is important for the organisation of the process. The modular structure of the method makes it possible to skip steps which are not necessary for the intended application of the results.

Another aspect in this step is the scope of the project. It should be fixed in terms of geographical area, time horizon (current or future situation), modes to consider, etc. Finally, the process should be organised and stakeholders invited. Stakeholders can be all kinds of organisations: road authorities, public transport companies, service providers, interest groups, etc. It is important that stakeholders from all modes of transport are represented in the project; this is the only way to ensure that the project will be a collective effort with sufficient (political) support.

2.2 Step 1: Determine the basic principles

In this step the policy objectives are listed. What are the current agreements and ambitions for traffic and transport in the city or region? These should be checked on consistency and possible conflicts of interest can be discussed with all parties involved. Also, the most important areas that attract and/or produce traffic can be specified in this step. Not every area is important for the accessibility of the region or city and therefore a limited set of areas can be defined. Figure 4 gives an example for a fictitious city.

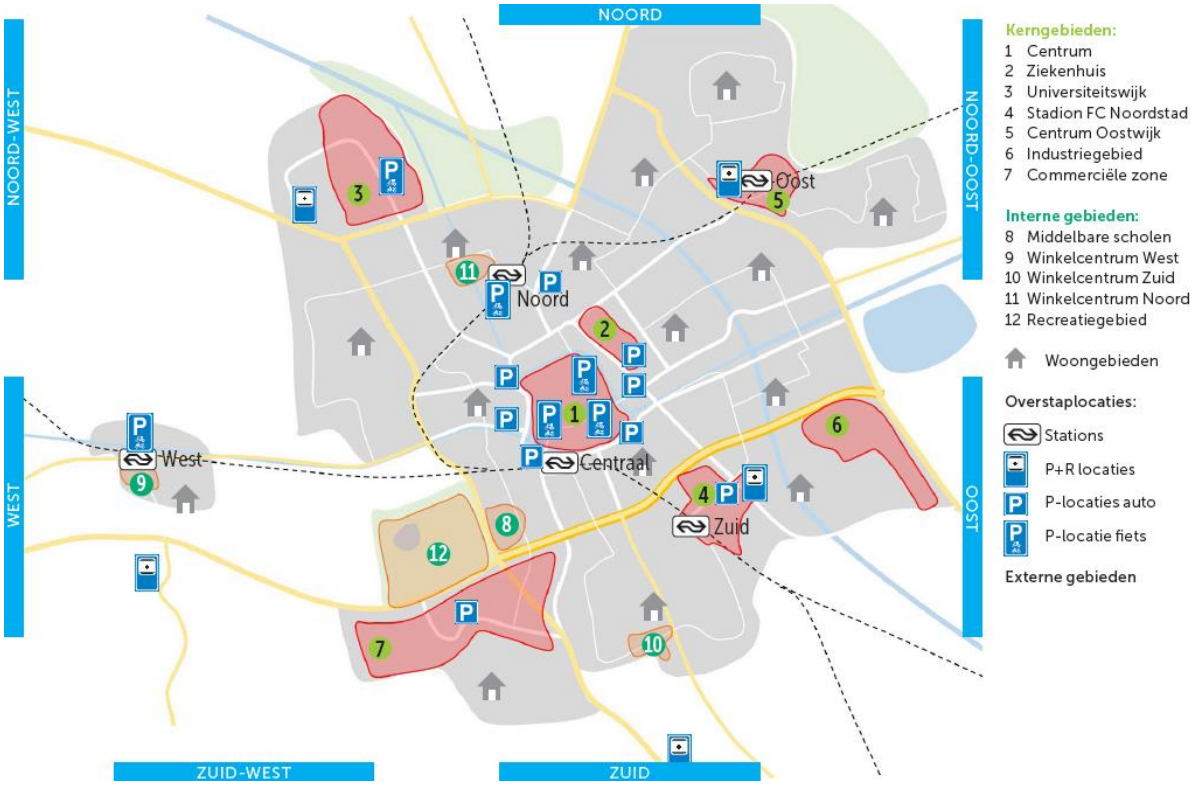

Figure 4: Areas and locations that are included in the multimodal framework

Next the available networks per mode are identified. These are the networks that can be used for travelling between the areas and where the traffic management efforts are focussed on. Areas are connected with relations and it is necessary to describe which relations are there and how they should be facilitated with different modes. Doing this, and with determining which roads are used by these relations, a network of preferred routes will emerge in step 2. Sometimes, certain traffic is not allowed on specific roads, for example trucks in school zones. These roads should be identified and documented.

2.3 Step 2: Determine accessibility profiles

Accessibility profiles are the basic principles, but more specific and further detailed per area. Profiles are used to answer questions, such as: How important are car, public transport and bicycle for the accessibility of the city centre? Which specific relations exist between the different areas? Which routes are preferred to be used by these relations and what is the importance of those routes?

In the previous step the basic principles were formulated. Mostly they are stated in general terms. To detail them, it is best to start with the ‘top locations’ in the area and describe for these locations the motives to stay there (living, shopping, working, etc.) and by which modes the area should be reached. After that, the relevant traffic relations between areas are mapped and the importance of the different modes on these relations, depending on the importance of the areas, are determined. It also useful to determine which variables (accessibility, reliability, safety) and related indicators (speed, travel time, variance in travel time, number of accidents) are needed to describe the quality of the relations between the areas.

Mapped on the different networks (car, public transport, bicycle) these relations lead to preferred routes and possibly alternative routes. Based on the importance of the relations, the routes can be prioritised. To facilitate a multimodal trip, it can be useful to develop the preferred routes in a multimodal way. So, for example, if a relation is connecting an external area to the city centre, then the unimodal preferred route would be car with parking in or around the city centre. However, a good alternative would be to lead the preferred route by car to a multimodal connection or hub outside the city. There, a transfer can be made to public transport or shared bike and the trip is continued on the preferred route for public transport or bicycle.

2.4 Step 3: Determine the functional arrangement

At the end of step 2 it is clear how the networks should function on the level of relations and which routes are preferred. However, in practice the network links should be used in accordance with the policy goals on accessibility, safety and sustainability. For this a multimodal function map is developed, which describes the intended use of the networks. It is important to determine what the desired function of the network links is and what conditions hold for safety and sustainability.

First, it is important to determine which functions can be distinguished. For example, for bicycles there could bike highways, main bike routes or recreational routes and for cars there could be motorways, regional roads, but also roads to open up an city area and side streets. For every function that is used a description is needed, containing the characteristics, the types of users and traffic related aspects (flow level, maximum speed, etc.). This description is called the function profile. Next to plotting the functions on the networks, the function profile is also the basis for determining bottlenecks later on and identifying the best suitable (traffic management) measures.

Then the functions can be projected onto the networks, with the goal to assign a function to every network link, based on the policy objectives from step 1 and the preferred routes of step 2. It is best to work with the separate modes on different maps. Also, locations where road users can choose between different routes or different modes can be marked. After that, the maps for different modes can merged into one multimodal map (see figure 5).

Figure 5: Multimodal function map with the PT networks in front

Finally, a check is done on the consistency between the functions of a road and the design of that road. Are links designed in such a way that they can fulfil their function? In other words: is the function map feasible? This check can lead to adjustments for the function of certain network links or even preferred routes (determined in step 2). The function profiles and the function map together form the functional arrangement of the city or region.

2.5 Step 4: Decide on priorities

In step 3 functions are assigned to links. To facilitate and manage traffic on those links, choices have to be made: between traffic of different modes and functions, but also between the same modes and functions. How can that be done? Which road user gets priority if space and time is scarce, for example on an intersection?

Designing and implementing traffic management measures is constantly making choices. To make these choices in a coherent and transparent manner, principles have to be defined. First, policy documents should be checked on statements on priorities. For example “in our city public transport has absolute priority”. Then determine if these priorities hold in the whole area, or that a distinction can be made between zones with different priorities. In this way, a priority list of the functions from step 3 can be made. For example, high frequency public transport has priority over a local bus. Priorities can differ in different time periods, e.g. during the morning peak, weekend, holidays or an event. This list of priorities is the basis for decision making on distributing the available capacity among different modes or on conflicts between modes.

The list of priorities can help in redesigning roads, but it also gives a solid foundation to detail traffic management measures. However, sometimes exceptions have to be

made. For instance during timeslots when schools start or end, the priority of bike traffic might be redefined. The guidelines for possible exceptions should be determined, with a description on how they influence the list of priorities.

2.6 Formulate the frame of reference

In this final step the multimodal frame of reference is formulated, combining all results from the previous steps. Also, the practical consequences of policy choices are covered. If on a route the bicycle has a high priority, what does that mean for the travel time on that route. Which reliability is needed on the roads leading to the city? And how to monitor sustainability? This step is meant to specify and quantify all those things, so policy goals become measurable.

To determine if goals are met, it is necessary to specify what should be measured and which indicators should be monitored. In steps 2 and 3, a start with this has been made and in this step the indicators are established. To monitor the indicators data sources are needed and therefore, an inventory of available data sources should be made. Confronting the need for data with the available data sources and their quality, leads to a definite list of indicators.

For this final list of indicators specific thresholds can be defined per mode. With these thresholds, the desired level of performance is given. For example: the speed on the traffic volume on this road should not exceed 500 vehicles/hour or the travel time per bike on this route should not be higher than 14 minutes. If an indicator does not meet the threshold, there is a bottleneck. The thresholds can differ in time, but should not be unfeasible in reality and correctly reflect the ambitions and policy objectives of the road authority.

3. APPLYING THE MULTIMODAL NETWORK MANAGEMENT FRAMEWORK

In this chapter, some applications of the multimodal network management framework are given. It gives further details on how the framework can be used in practise.

3.1 Current situation and bottlenecks

A first application of the multimodal framework is an assessment of the current situation. Do the networks functions as planned? Or better formulated: Do the networks function as described in the framework? If the framework is ambitious than this check will result in a number of bottlenecks.

First, as part of the frame of reference from step 5 a list of indicators is available. Using historical data for these indicators, information comes available on the current use of the networks, such as the traffic flows, speeds and travel times, but also information on safety and emissions can be assessed using data. Comparing data on the current situation with the threshold values from the frame of reference, bottleneck locations emerge, but also locations or routes where spare capacity is available.

From the analysis of the data it becomes clear where the problems are and how big they are. To prepare for the development of solutions, a qualitative description of the

bottlenecks is useful. It could contain the connection with the functional arrangement from step 3, the severity of the bottleneck, the priority and the relationship between bottlenecks. If necessary, the multimodal priorities in the framework can be used to prioritise the bottlenecks.

3.2 Solution directions

When it becomes clear where traffic is obstructed in the networks and bottlenecks form on a structural basis (not only car, but also public transport and bicycles!), solutions can be developed. For that it is necessary that basic infrastructure is settled. Road side equipment is necessary to implement traffic management and should fit the functionality of the network parts. To check if this is the case, the function profiles from step 3 can be used. If necessary, adjustments to the infrastructure or road design can be made to improve the situation.

If the basic infrastructure is ready, the bottlenecks found can be handled. For this in principle three solution directions are available: demand management, traffic management or infrastructural adjustments. If these solution directions are not possible or the results are unsatisfactory, it could be necessary to adjust the preferred situation or lower the ambitions.

For every bottleneck, the solution directions can be prioritised. They should fit the function of the road from the function map and the impact should be in proportion to the severity of the bottleneck. Also, the solution direction should be realistic and feasible and negative side effects, such as rat running or traffic increase on other important roads, are negligible.

With this information the list solution directions can be connected to the list of bottlenecks and the description can be extended with the desired impact, the feasibility of the solution, the time horizon (e.g. morning peak, year of implementation) and possible interaction with other bottlenecks.

3.3 Sub-networks

The five-step process of chapter 2 can also be applied to sub-networks, by zooming in on a part of the network. For all steps some aspects need attention. For example, for the description of the goals in step 1 more details could be necessary, e.g. extra attention to safety around school zones or focus on liveability if an important road in a residential area is redesigned. Also, the scoping could be different with respect to time horizon and modes.

For the sub-network the basic principles should be detailed and specified. Every aspect could be different from the larger network. So, areas and locations, traffic relations, networks and specific roads should be considered again. The same holds for the accessibility profiles from step 2. For the function map from step 3 new functions can be added, which are more in line with the local area. If there are new functions, then the priority determined in step 4 could be different. This has to be checked, just the like aspects and indicators in the frame of reference.

The multimodal network management framework for sub-networks can be used for different purposes: the deployment of demand and traffic management measures to deal with bottlenecks, the redevelopment of an old industrial area into commercial use, the construction of new infrastructure or the development of traffic management scenarios for operational situations.

3.4 Non-regular situations

Most regions and cities will start with a multimodal network management framework for regular situations, such as the morning peak or weekend shopping traffic. But what if a frameworks is needed for a non-regular situation, such as large scale road works or frequently recurring events? The best thing to do is to adjust the existing material to that situation.

Concerning the goals: Which non-regular situation is at hand? And how will the framework be used? Also, the study area, time horizon and the modes involved could be different from the normal situation. Basic principles are available, but it could be necessary to adjust or extend them. For example: during the road works logistic centre X should be reachable at the normal level. The problems during the non-regular situation are different from the normal one. Traffic flows will divert and problems can arise at different locations. Also, transfer locations could be unavailable or inaccessible for certain road users. Possibly, infrastructure needs extension, such as an extra bus lane or a temporary bike lane.

Traffic relations can change for the non-regular situation. So, accessibility profiles could also change. If necessary, shift multimodal preferred routes or add new routes or alternative routes. Also, functions of roads can change and the function profiles need adjustment to the new situation. This means that priorities can also change. For example, during an event, the access roads for cars to the event location can be given a higher priority. Or a lower one, if public transport and bicycle are the preferred modes to the event location.

The frame of reference can be extended with extra indicators, for example modal split on certain relations or the occupation rate of temporary P+R facilities. During the non-regular situation, it is possible that worse traffic conditions are accepted. That means that thresholds for indicators should be adjusted. Dependent on the situation, the application of the framework to determine solution directions and measures could helpful. During events or road works especially communication to the road user is very important.

4. CONCLUSIONS

The multimodal network management framework is a very useful tool to translate the general traffic and transport policy of a region or city into a very specific tactical framework. That makes it very useful for reference and assistance when tackling problems in the field of multimodal demand and traffic management, but also for spatial planning and urban design projects.

Acknowledgement

The authors would like to thank Gerard van Dijck for his useful comments on a draft version of this paper and the translation of figure 5.

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