IMPACTS OF URBAN ROAD LAYOUT ON ROAD SAFETY: HOW TO EVALUATE?

M. MILLOT
CETE Méditerranée, France
Marine.Millot@developpement-durable.gouv.fr

ABSTRACT

Road layout improvements aim to reduce the use of car and to develop alternative means of transport, but what about their impacts on road safety? Nowadays, road managers could rightfully ask this question. One solution is to realise an evaluation of road safety in road layout improvements. Then, how to evaluate? As there is little literature on this subject, this article presents a method built within PREDIT research program framework. This method is based on several existing approaches which are used rarely together: quantitative approach of road safety and qualitative approach of road safety with help of accident scenarios, a detailed analysis of the road layout and analysis of uses and practices on fitted out site. A cross-analysis enables to identify points of convergence and divergence in all approaches; it enables also to connect road safety problems with the way of using public space. For instance, the method was tested on seven road layout improvements. The results point out such problems as lack of consideration for pedestrians, difficulty for two-wheelers to integrate traffic when public transport lane involves road width reduction, wrong use of cycle lanes (for delivery, parking…)

1. WHY EVALUATE?

French urban transport policies aim to reduce the use of car in town, in favour of public transport, cycling and walking. In order to promote such means of transport, new road layouts are often set up: public transport lane, cycle lane on arterial roads, traffic calming zone on local streets... Road safety is rarely a priority regarding road layouts. Nevertheless, road layouts may influence road safety as they involve new practices, new kind of mobility and new uses of public space. For example, cycle lanes may improve two-wheelers mobility. Then, if cycle-lanes improve bicycles safety, what are the effects on motorised two-wheelers? And globally, what kind of effects does road layout product on all kind of users?
As these tools are being more and more developed, it becomes then necessary that urban planners and road managers learn to identify their effects on road safety.

An evaluation of road safety in road layout improvements may be an answer. Indeed, the evaluation enables at first to measure the efficiency of an improvement, that is to say to check its impact on road safety, considering all means of transport: are they all taken into account? Who gains or loses thanks to an improvement?
The check of efficiency may be enlarged from the improved site to a widened area, as adjacent roads. For instance, important improvements - as tramway lanes - create mobility constraints for motorised vehicles by reducing the number of ways. Meanwhile, if parallel roads are not improved and alternative means still not developed, traffic transfer may occur, which would contribute to an increase of road accidents.
This efficiency may be evaluated in terms of duration, notably regarding the evolution of uses and the development of new transport means. For instance, some previous evaluations had shown a good cohabitation between bus and cycles in bus lanes. But are these results still valid with the emergence of a cycle policy that raises cycle frequency from a few users to a hundred ones at peak hours?

Furthermore, evaluation may enhance our knowledge of uses related to improvement. For instance, cycle lanes aim at developing cycling but they may enhance other uses in case public space is limited: car stopping near commercial areas, or circulation of motorised two-wheelers trying to get out of traffic jams. Consequently, cohabitation problems with cycles may occur.

Finally, the evaluation may be a support for local information and control policies, for example when a road layout is not understood or respected by users. It helps also to answer questions from users representative, administrative authorities, politics groups or else.

Nevertheless, a straight and easy method is necessary to make a good evaluation of a road layout improvement respecting road safety requirements. But there are few methods for road safety level evaluation. They are often built on quantitative approach, while this kind of evaluation requires the integration of other approaches: potential migration of traffic and accidents, evolution of type of accidents, effects of related urban projects… Therefore, it is important to determinate an appropriate methodology for evaluation.

2. THE DEVELOPED METHODOLOGY OF EVALUATION

This study was managed by the Centre of Urban Planning, Transport and Public Facilities (CERTU) and realised by seven Technical Study and Engineering Centres (CETE Lyon, Méditerranée, Nord-Picardie, Normandie-Centre, de l'Ouest, du Sud-Ouest, de Toulouse). The built methodology is based on several existing approaches that are seldom used together: a quantitative assessment [1] and a qualitative approach [2] of road safety based on accident scenarios, a detailed analysis of the road layout [3] and an analysis of the uses and practices on the site [4]. Six stages are defined with the data required. Then a cross-analysis helps identifying points of convergence and divergence found in every approach and then enables to connect road safety problems with the way public space is used.

2.1 1st Stage: Researching the goals of the improvement

There is often no place for road safety in major goals of road layout improvement. It is taken implicitly into account in some aspects like traffic calming, speed reduction, development of no-polluting means of transport, etc.

That is why it is important for the evaluator to know the improvement initial goals, to be able to identify their link with road safety. It facilitates the evaluation of the efficiency of the improvement.

2.2 2nd Stage: Defining the study area

Road safety evaluations are often limited to the improved area. Nevertheless, some studies [5] have shown that traffic may be transferred to neighbouring roads, where accidents may then occur. Indeed, impacts of an improvement are not limited to a selected street or area but may concern a wider area, depending on scale and nature of the action.

Therefore, the evaluation must integrate the improvement's whole area of influence. This area may be defined thanks to: natural or artificial cuts (i.e. rivers or railroads), organisation of urban mobility network and its alternative itineraries, major lines of mobility demand.

Figure 1 – Defining an area of influence (orange) around an improved street (green)

2.3 3d Stage: quantitative assessment of road safety

Improvement evaluation requires checking the efficiency level regarding evolution of accidents number and nature. The quantitative assessment analyses evolutions of accidents numbers before and after improvement. The qualitative approach deals with the type of accidents and their progress.

The number of accidents with casualties are analysed at least on a 3 years period before the road layout installation, and on a 3 years period after the road layout set up. Works period is almost never taken into account, sometimes even the entire year that includes works period is neutralised, in order to eliminate users adaptation period.

The quantitative assessment may point out evolutions of types of users, it may also highlight temporally or spatial phenomenon as transfer of road accidents on neighbouring roads.

A third stage will allow us to learn about evolution of road safety. Nevertheless, a qualitative approach is necessary for a really good comprehension.

2.4 4th Stage: Qualitative assessment of road safety

The qualitative approach is based on a sequential analysis of police reports [6] that decomposes the accident story in several phases, from the first movement of the users to the final crash. It also points up links between accident, public space management, network structure and uses.

In case accidents number is high, it is interesting to refer to accident scenario [7]. Accident scenario can be defined as a prototype based on a series of accidents with global similarities, regarding chain of facts and causal relationships. The use of the INRETS accident scenario references [8,9] enables to easily compare evolution of road accident types by identifying scenarios that may appear or disappear after the improvement.

2.5 5th Stage: defining the uses of the site and their evolution

Road safety may help to reveal dysfunctions between public space management, road network organisation and uses. Therefore, the evaluation cannot only be limited to an

accidents analysis. It requires the analysis of the site functioning, comparing it before and after improvement, in order to understand the evolution of uses and practices.

It requires observing:

- nature and importance of users' movements for all means of transport,
- their behaviour during the movements (for instance: speed, drawn trajectories, use of non authorised ways…),
- other uses of public space, as local life (for instance: children games, market,...), livery, car parking, etc.

Furthermore, interviews with various actors - such as road designers, users of the road improvement, municipal technical services or shopkeepers - help compensate for lack of data and give new point of view on the analysis.

2.6 6th Stage: analysing road layout

Road layout is considered as directly concerned in 30 to 40% of the accidents. Even if drivers respect circulation rules, they will never be able to avoid making mistakes. Therefore, road network manager has to create conditions for these mistakes to be less numerous and to be as little prejudicial as possible. It is particularly important in the case of new road layouts.

One of the recommended methods is road layout analysis, with the support of a grid referring to every theme of road safety. This grid is used on national French road network in the "CSPR" framework. It aims at assuring that every road safety constraint is taken into account [3]. Local communities may adapt the method to better include specific characteristics issued from their own layout.

The grid refers to various road layout components to be observed and compared with existing technical recommendations: general conception, geometry, junction, pedestrians, cycles, public transport, traffic calming, 70km/h area, 30km/h area, signs, equipments, landscape, urban furniture, material and particular situations.

2.7 Synthesis: a cross-analysis

Knowledge drawn from previous approaches refers to two aspects:

- quantitative: road accident evolution, major aims of the site or of a part of the site, speed measures, traffic transfer, etc.
- qualitative: behaviour data, safety feelings, appropriation of space improved with several means of transport, differences between initial goals and road layout improvement actual impacts.

It is then necessary to synthesise the various elements collected during the study. The crossed table enables to make this synthesis by identifying points of convergence and divergence in every approach. Columns represent themes of the six previous stages (road safety, road layout, environment, etc.), while lines show every type of involvers, goals of the improvement, etc. This table allows confronting users feelings with the objective analysis of the improvement.

Finally the presented method must enable to identify positive and negative impacts that a road improvement may produce on road safety. These impacts may affect spatial or temporally aspects, means of transport, users feelings, goals, etc.

3 USE THE METHODOLOGY ON 7 ROAD LAYOUT IMPROVEMENTS

3.1 The seven road layout improvements studied

The method was tested through the studies of seven French types of improvements: a tramway lane, a bus lane, a bus lane shared with cycle, three cases of cycle lane with reduction of the arterial road width and a case of pavement shared between pedestrians and bicycles.

3.1.1 A tramway lane in Nantes

This new means of transport was planned in the Urban Transport Policy. The studied site featured an arterial road connected to city centre. Its improvement consisted in (i) reducing the number of road lanes from two to one lane per way, (ii) integrating tramway in a separated lane in the middle of the street or in a mixed-lane with cars when the street is too narrow, (iii) taking bicycles into account by means of cycle lanes or mixed areas.

3.1.2 A one-way bus lane in Rouen

The road layout studied was located on an arterial road that links suburbs to Rouen. The improvement consisted in narrowing the arterial road to integrate a bus lane in the middle of the street.

3.1.3 A bus lane shared with bicycles, in Lyon

This improvement was carried out on an one-way arterial road in the centre of Lyon. It consisted in (i) sharing the bus lane with bicycles by widening the bus lane, (ii) creating a cycle lane on the other side of the street, (iii) thus reducing the number of road lanes (3 before improvement, 2 after).

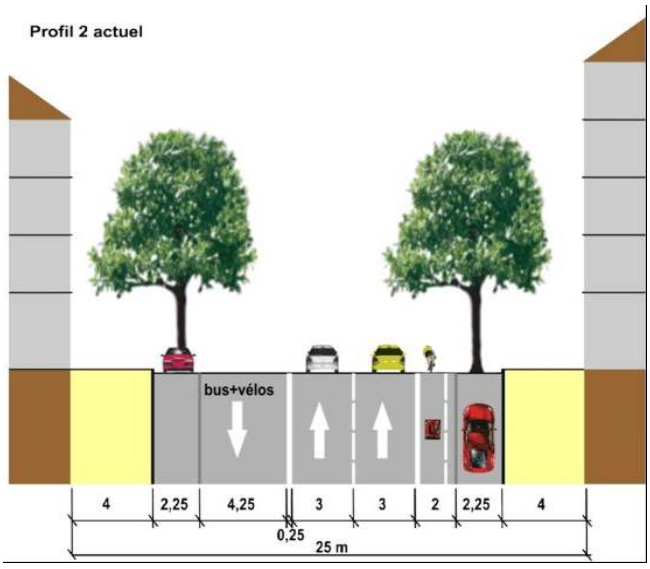

Figure 2 –Bus lane shared with cycles in Lyon

3.1.4 A narrower arterial road with the creation of a cycle lane in Lille

The improvement was carried out on a peripheral arterial road in Lille. This road was composed of two lanes per way, separated by a central reservation. The road layout

consisted in reducing the number of lanes (one per way) and creating a cycle lane on each side.

3.1.5 A narrower arterial road with the creation of a cycle lane in Bordeaux

The studied area is located in the suburbs of Bordeaux, near the university. It originally comprised two lanes per way separated by central reservation. Its improvement consisted in reducing its width by eliminating a lane per way, widening the central reservation and creating a cycle path on each side (or a cycle lane, depending on the sector).

3.1.6 A narrower distributor road with the creation of a cycle lane in Martigues

The studied road is a main road towards city centre. It is was a one-way road, made up of two lanes. The improvement consisted in eliminating a lane for the creation of a cycle lane on the right, widening the pavement on the left.

3.1.7 Sharing of a pavement by pedestrians and bicycles and implementation of a separated road lane in Toulouse

The site is located in the centre of Toulouse. The improvement consisted in narrowing the road by creating a central reservation. The goal was to avoid turning movement. Car parking is authorized on the central reservation. The pavement has been separated for pedestrians and two-wheelers, but not widened.

Goals stated for these road layouts were:

- public transport development,
- better sharing of public space, specially for two-wheelers and pedestrians,
- reduced speed,
- traffic calming.

Road safety is rarely mentioned as such. It was taken into account only in Toulouse case, due to numerous road accidents involving turning movements.

3.2 Evaluation's results

In a first stage, the evaluation of the seven road layout improvements presents results that are shared by all sites. It shows that a majority of road layouts enhance privileged means of transport but may be unfavourable to the others. Pedestrians' aspect is generally forgotten. And even if pedestrians are implicitly taken into account, it is not sufficient to guarantee their safety.

It is the same for motorised two-wheelers: either they are directly penalised by the improvement, or they use improvement in a diverted way. In a first case, high width reduction of 50 km/h' streets may involve effect of plucking: two-wheelers are trapped against the edge when cars try to overtake them. In a second case, they may be tempted to use cycle lanes and then may surprise motorised vehicles drivers, unable to anticipate their speed as they are crossing the road layouts.

Figure 3 – On the left: narrow way along a bus lane – On the right: moped on a cycle lane

Then, this crossed evaluation enables to reveal road safety problems on similar road layouts.

Concerning cycle lanes, the evaluation points out the importance of maintaining a neutral space - of 0.5m minimums - between cycle lane and car parking area, in order to avoid accidents involving cycles when drivers open the door. Furthermore, diverted uses of cycle lanes are largely pointed out: car parking in commercial areas or in much frequented areas, stopping of delivery trucks when there is no other space available. These elements force cycles to join vehicles traffic, despite their important difference of speed and the risk associated. Another relevant problematic concerns management of bus stop along cycle lanes: should we interrupt cycle lanes just before bus stop -in order to facilitate cycles integration to traffic- or should we allow buses to stop on cycle lanes?

Figure 4 – Cycle lane invaded by car parking on the left – by a bus on the right

Concerning public transport improvements, the evaluation shows their place in the development of this mean of transport. They often give the opportunity to reorganise the entire public space. As they involve reduction of space dedicated to cars, public transport improvements may influence drivers' speed reduction. Nevertheless, if road width becomes too small, motorised two-wheelers may feel safer on a public transport lane, which involves risk of accidents at crossroads. Moreover, axial public transport lanes may involve effect of cut when crossroads do not allow half-turn and resident access: these kinds of manoeuvres may then be made on public transport lane.

CONCLUSION

The method presented in this article was tested on seven French urban road layout improvements. Results reveal all the interest of an evaluation of road safety, in particular when road safety was not the improvement first goal. Indeed, the proposed method presents a global view on an improvement, regarding spatial or temporally aspects, as well as regarding the integration of all means of transport. It also highlights unwanted effects of separated transport policies that may enhance a given means of transport to the detriment of the others. The effects on road safety may then be immediate. The method insists although on the importance that all urban road layout have to integrates all aspects of public space uses, that is to say not only movements but also car parking, delivery and in a general way, local life. Indeed, these aspects may be in conflict with movements and create road safety problems. Finally, the proposed method allows us to identify derivations linked to the improvement such as users adapting themselves to imposed constraints.

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