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SAFETY PROBLEMS AND DIFFICULTIES IN USING PUBLIC SPACES WITH MODERN TRAMWAYS: THE EXAMPLE OF MARSEILLES



INTRODUCTION

The redeployment of tram networks in French cities has considerably modified public spaces and the way citizens use them.

Modern tram layouts in France are usually based on dedicated lanes and contribute to the redistribution of the whole public space. These tram lanes take on various forms (tram lanes in a lateral, bilateral, axial or elevated position, with or without borders, with or without different surfacing). For example, the tram systems in Montpellier, Nice or Marseille, are inserted in exclusive lanes for the major part of their networks.

Fig. 1 Examples of modern tram layouts with dedicated tram lanes in three French cities



Avenue de la Justice de Castelnau,
Montpellier (photograph: Elisa Maître)

Boulevard de Dunkerque, Marseilles
(photograph: Elisa Maître)

Boulevard Gorbella, Nice (photograph: Elisa
Maître)

In addition to technical reasons (e.g. installing a public transport system with a certain capacity and cost) there are also in general political reasons for the decision of implementing a tram line or network. In fact, the decision to implement a modern tram system partly results from a desire to change the image of the city. Indeed, the tramway gives the image of a city that has a project for its territory, an efficient city, dynamic, sustainable, and denotes the ambitious character of its urban policy. Thus, the modern tram in France plays an important role in urban policies [1, 2]. Along with being a transport policy tool, trams in France are especially part of a desire for urban requalification that is clearly stated and planned [3]. These aims in terms of image and requalification lead to carry out substantial changes in the layout of streets equipped with tram systems, involving an architectural treatment of infrastructure and public space.

In this paper, we focus on the effects that these new forms of public spaces containing trams have on user practices. The objective of this work is to contribute to better design practices of

public spaces, for improving the safety of users, with a special attention to the readability of these spaces. We particularly wonder what influence these public spaces redesigned for trams have in terms of safety and conditions of use for all the users of these spaces. According to international scientific literature trams appear to pose special safety problems, particularly direct collisions between tram vehicles and other users, including the most vulnerable users such as pedestrians [4, 5, 6]. Indirect involvement of trams in accidents has been also demonstrated, for example by masking visibility or by generating sudden pedestrian crossings [7, 8, 9, 10].

The configuration of public spaces laid out for trams can also have an effect on safety even when the tram vehicle is not present. Very few studies deal with this subject. Nevertheless, the different configurations of tramway installations seem to create new difficulties in terms of the conditions of use of these spaces [11, 12, 13]. Previous research shows that urban environment and street design play an important role in shaping the behaviour of road users, and may create conditions contributing to (or preventing from) some forms of driving errors and accidents [14, 15, 16, 17].

Previous work we have carried out deal particularly with the role that these public spaces redesigned for trams play in the processes leading to traffic injury accidents, involving or not involving tram vehicles [18]. Based on the analysis of sample of 51 accident cases (random sample representing approximately 1/50th of all the police reports concerning traffic injury accidents occurred in France with tram systems in operation during the years 2009-2010 period) the main types of influences (on traffic accident) of public spaces laid out for trams were identified.

Overall, this work showed that public spaces laid out for modern trams in French city may contribute to some forms of traffic injury accident mainly due to the relative complexity of these public spaces and to severance effects on sections with lanes strictly dedicated to trams.

The present paper reports a complementary study regarding the case of Marseilles, where two tram lines (1 and 2) are in operation since 2007 (a third line, not taken into account in our study, opened in 2015). This study is based on two investigations:

- (i) a quantitative analysis attempting to estimate the overall effect that the implementation of tram has had on the numbers of accidents on the corresponding streets in the city of Marseilles;
- (ii) a more detailed and mainly qualitative investigation dealing with the tram line 2 in Marseilles; this investigation aims to improve the knowledge on the specific difficulties of use and safety problems encountered in public spaces with modern tramways, in order to contribute to better design practices.

1. METHOD

- ESTIMATION OF THE OVERALL EFFECT OF TRAM

As regards the first investigation, which aims at estimating the overall effect attributable to the implementation of a modern tram network in Marseilles, we analysed the numbers of traffic injury accidents occurred in the streets affected by the tram project, before and after the tram implementation, in comparison with the traffic injury accidents occurred in streets non-equipped with tram in Marseilles during the same periods. The “before period” corresponds to the years 2001 to 2003. The period of works (2004-2007) was not taken into consideration. The “after period” corresponds to the years 2008 to 2011.

Within this framework, we calculated an index of the specific evolution of the accident number in the streets equipped with tram between the “before period” and the “after period”. We have chosen this method in order to account for the effects of the introduction of the tramway and of the associated facilities.

Let x_1 and x_2 be the numbers of accidents occurred in the streets affected by the tram implementation, during the before period and after period, respectively, and N_1 and N_2 the numbers of accidents occurred in all the other streets (non-equipped with tram) in the city of Marseilles, during the same periods. An ‘index of effectiveness’ [19], which accounts for the effect of tram after controlling for the general trend in accident numbers over these periods, can be estimated as follows:

$$I = (x_2 / x_1) / (N_2 / N_1)$$

For example, a value 0.9 for this index would mean that the effect attributable to the implementation of the tram system, in the streets covered by these tram lines, would be a 10% reduction in the accident numbers.

- ANALYSIS OF SAFETY PROBLEMS AND DIFFICULTIES OF USE OF PUBLIC SPACES OF THE TRAM LINE 2

The second investigation dealt with the safety problems and difficulties of use of public spaces in the streets covered by the tram line 2 in Marseilles. In a first step, we proceeded to an overall description of the tram line 2 and its urban environment. Our field observations were based on an analysis grid where we considered three main criteria: the characteristics of

urban fabrics, the comprehension of the general organization of the public space and the practices of this space. We carried out observations at different times of the day, so as to have a good representation of the users' practices. We documented our field observations with notes and photographs. Various documents such as plans and aerial photographs were also collected.

We also produced a map showing the spatial distribution of accidents.

Then, in a second step, in order to deepen our approach by combining the in-situ analysis of public spaces, users' practices and perceptions, and the analysis of accidents, we focused the investigation on three sections of the tram line 2 (the sections of La Canebière , Cours Belsunce, and Place Sadi Carnot). These sections were selected according to two criteria: they should correspond to different urban contexts and each of them should present an important urban intensity mixing a diversity of users.

As regards the analysis of accidents, we collected and studied in detail the police reports on traffic injury accidents on these sections for the years 2008 to 2011.

We opened each accident report and made a careful reading of the summary of the facts and the various testimonies. Then we paid a particular attention to the influence of the tram system on the accident process. For this we used a method of detailed sequential analysis of the accident [20]. In our analysis, we particularly took into account the accident location, trajectories involved, as well as testimonies. We then linked our detailed accidents analysis with our field observations. These accidents analysis were supplemented by consultation of expert opinions on road safety.

As regards the analysis of practices and perceptions, our approach was based on a dual perspective of urban planner and user. Vaclav Stransky particularly describes this perspective of professional and user in his spatial analysis of pedestrian spaces [21]. We thus carried out, on the one hand, *in situ* observations of practices from a point of view of urban planner putting himself in position of user. On the other hand, we took into account the vision of the user himself/herself by conducting short interviews with different users in public space. For practical reasons, we preferred to make contact with pedestrian users of public spaces studied. However, we questioned each user about his/her practice both as a pedestrian and as a motorist, cyclist or cyclomotorist. Moreover, questions asked to users were voluntarily open so as not to influence the answers of the interviewee and to allow him to further develop her/his remarks on her/his practice of space and the difficulties she/he encounters during his shifting. These interviews were recorded with permission and then transcribed in their entirety.

2. RESULTS

- OVERALL EFFECT ON ROAD SAFETY OF THE IMPLEMENTATION OF TRAM LINES 1 AND 2

The numbers of traffic injury accidents occurred in the streets covered by the tram lines 1 and 2 in Marseilles during the before period (2001-2003) and after period (2008-2011), as well as the traffic injury occurred during the same periods in the other streets of Marseilles, are presented in table 1. The value obtained for the index I and its 95% confidence interval are also provided in this table. More detailed results can be found in a previous paper (in French) that we have published on this subject [22].

Tab. 1 Accident numbers in the streets covered by the tram lines 1 and 2, before and after the implementation of tram, and in comparison with the other streets in Marseilles

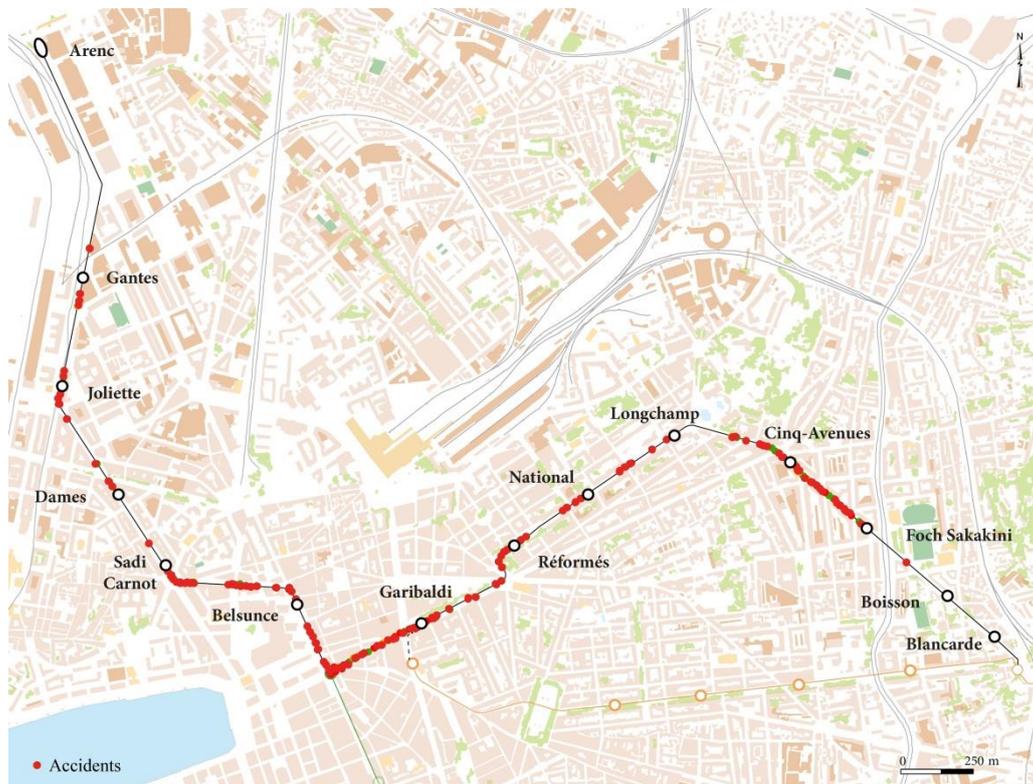
	Accident number during the before period (2001-2003)	Accident number during the after period (2008-2011)
Streets covered by trams line 1 and 2	537	175
Other streets (non-equipped with tram)	11319	10189
p -value of the chi-square test		$< 10^{-6}$
Index I (and 95% confidence interval)		0.362 (0.305 to 0.430)

The value obtained for I (0.362) suggests that, in the streets affected by the tram, the effect attributable to the implementation of the tramway system is an accident reduction of approximately 64%. This effect may partly result from the layout of the re-designed public space in these streets, but this could also result from the decrease of traffic volume, since modern tramways in French cities tend to strongly reduce the space allocated to cars in the streets where they are implemented. Overall, the beneficial effect of tram (in terms of safety) suggested by these results remains questionable, however, since the possibility that car traffic and accidents may partly migrate towards other parts of the road network cannot be excluded.

- SAFETY PROBLEMS AND DIFFICULTIES OF USE OF PUBLIC SPACES OF THE TRAM LINE 2

The geolocation of accidents occurring in the streets covered by the tram line 2 appears on the map presented in fig.2. This map showing the distribution of accidents highlights the relative abundance of accidents on the whole line, although a more marked concentration can be observed within the more central areas.

Fig. 2: Distribution of accidents occurred in the streets located along the tram line 2 of the city of Marseilles

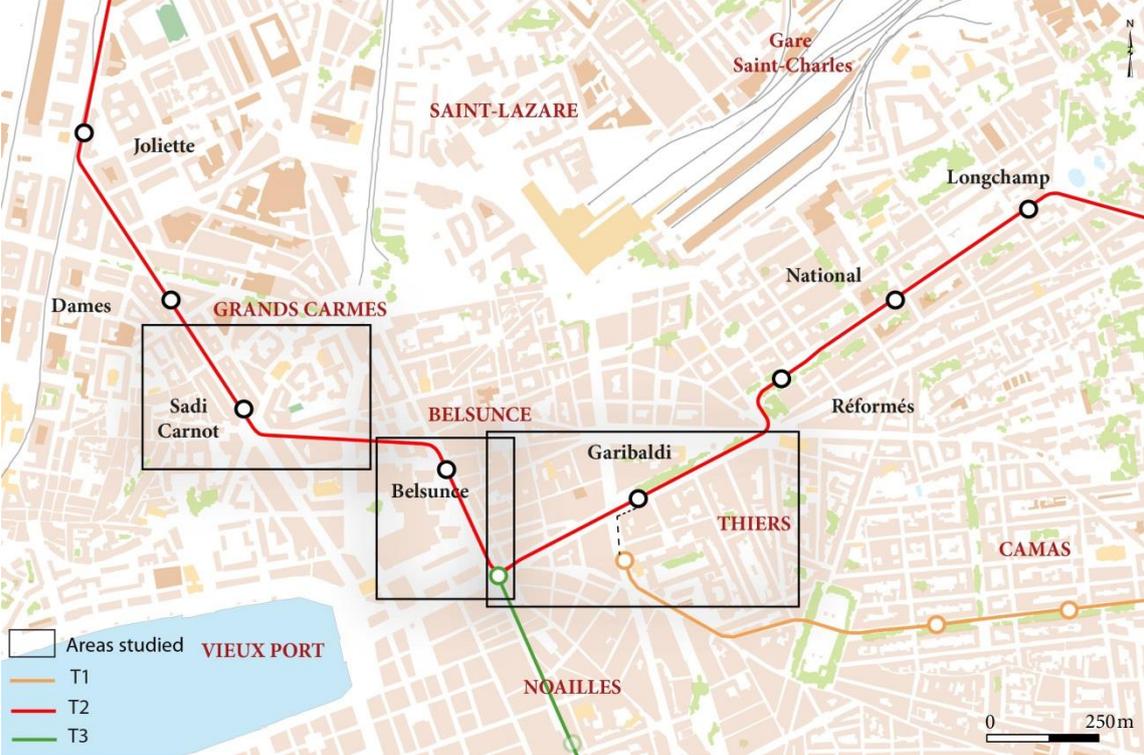


(Source : Elisa Maître)

Based on our *in situ* observation and description of the different public spaces re-designed for tram, we distinguished three main sections on which our analyses of the safety problems and difficulties of use can be deepened: at first the section of *La Canebière*, historical street, symbolic of the city; secondly, the vast pedestrian area of *Cours Belsunce* perpendicular to *La Canebière*; thirdly, the *Place Sadi Carnot*. These three sections are located in the dense urban area of Marseilles as well as the whole of line 2 (Fig. 3). Nevertheless they correspond to different urban contexts, since *La Canebière* constitutes the symbolic main street of the city, *Cours Belsunce* is characterized by its pedestrian area, and *Place Sadi Carnot* constitutes the intersection between the Haussmannian breakthroughs of *Rue de la République* and *Rue*

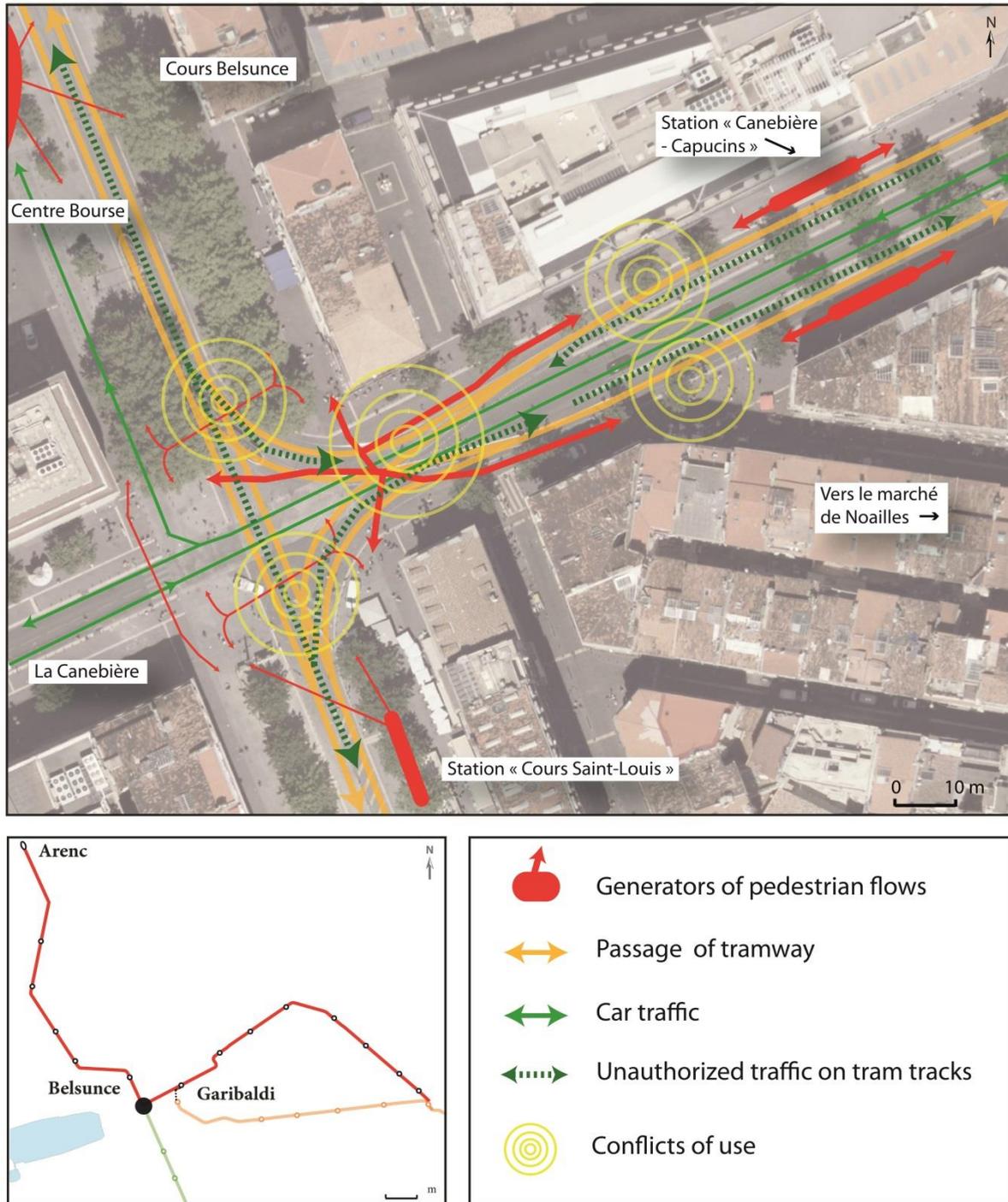
Colbert. These sections are also characterized by an important urban intensity mixing a diversity of users.

Fig. 3: Areas studied for the detailed analysis of safety problems and difficulties of use of public space



(Source : Elisa Maître)

Fig. 4: Users' practices in the sections of *La Canebière* and *Cours Belsunce*



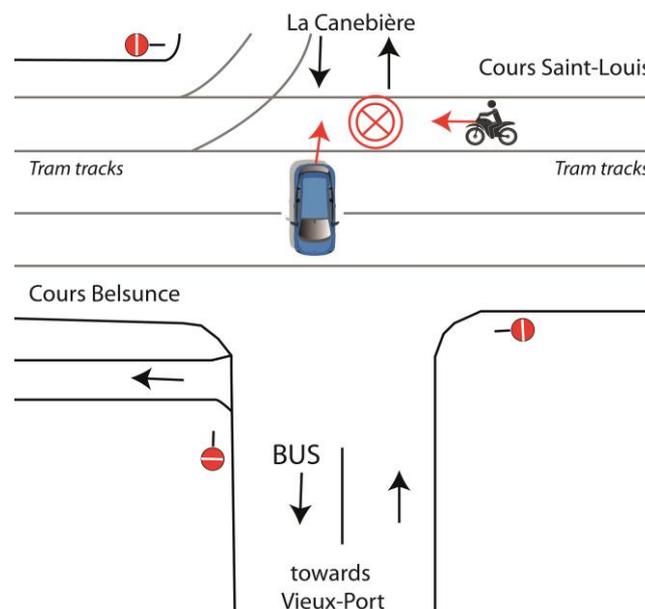
(Source : Elisa Maître)

The sections of *La Canebière* and *Cours Belsunce* include many pedestrian flow generators and are located in an area of important shopping streets of the city (La Canebière, Cours Belsunce, Rue de Rome, Cours Saint-Louis) (Fig.4). The station "Canebière-Capucins" is very busy. The access to the Noailles market also generates a flow of pedestrians. Numerous pedestrians also walk towards Cours Belsunce. Its pedestrian shopping area and the shopping center "Center Bourse" constitute the main places generating travel. These sections are also

characterized by high motorized traffic. Based on our field observations and interviews conducted with the users, different points of conflict can be identified within these sections (Fig.4).

A first in La Canebière, our accidents analyses reveal various influences of the re-design public space for tram on the occurrence of accidents. Our in situ observations also highlight conflicting points causing difficulties of use. The first type of influence corresponds to complicated space layouts leading to a poor understanding of the site or complicating users' search for information. This first type of influence affects six accident cases. Two other cases of accident are related to the incomprehension of the organization of traffic directions by motorized users. These difficulties of use particularly affect the intersection between La Canebière and Cours Belsunce.

Fig. 5: Example of an accident (*La Canebière / Cours Belsunce*)



(Source: Elisa Maître, according to the analysis of the police report)

In the accident taken as an exemple in Fig.5, a motorist arriving at intersection from *La Canebière* in the direction of *Vieux-Port*, only belatedly understands that he cannot continue straight and makes a reversing maneuver. He then hit a motorized two-wheeler (coming from *Rue de Rome* in direction of *Cours Belsunce* (in prohibited direction).

Fig. 6 : La Canebière / Cours Belsunce



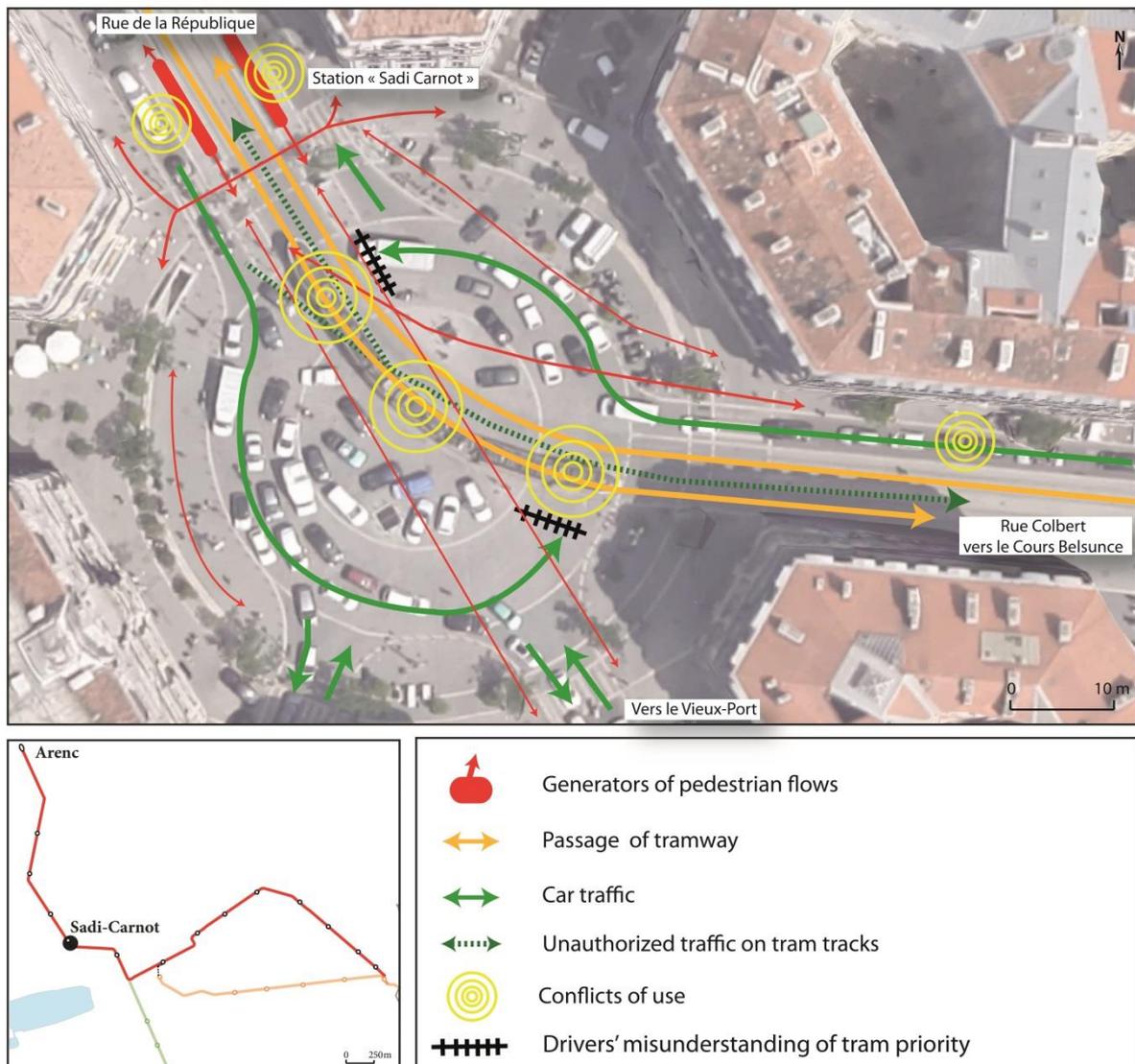
(photograph: Elisa Maître)

Furthermore, unauthorized driving or riding on lanes dedicated to trams can be frequently observed (once every 15 mn, on average) and poses safety problems; five cases of accident. Delivery men, cyclists and cyclomotorists sharp reduction in space devoted to the general traffic, and its effects in terms of congestion. Another safety problem is related to pedestrians who hurriedly cross the street to catch their tram and are hit by other vehicles (two accidents). This problem is exacerbated by the obstruction of the sidewalks by unauthorized parking which reduces the visibility, and the multiple lanes to be crossed, which can exceed the pedestrian's capacities (in terms of information processing). These safety problems are particularly salient in the link section of *La Canebière*. Other cases of accidents highlight safety problems due to the poor perception of the arrival of trams in lanes dedicated to them. According to the safety expert (who was in charge to evaluate the safety of this tram line): *"we were obliged to ask for a supplementary measure of reduced speed for the tram drivers, at 15km/h, whereas before that the speed limit was 30 km/h. In places like this, the stress is transferred to the tram driver to reduce the risks. [...] There has been a lot of emergency braking, even collisions"*.

Secondly, in *Cours Belsunce* problems of inappropriate incursion of traffic into the tram lanes also play a role in the occurrence of accidents. Furthermore, the weak salience of the tram

tracks leads to difficulties for users who cross these lanes, especially to distinguish the limits of the different spaces (Fig.6). According to users: "There is nothing that indicates that the tram arrives"; "From what I see it is pretty dangerous. There is no signposting, there is nothing at all "; It's a bit ... badly marked. The arrival of the tram is not necessarily ... well, very visible, it lacks visual warnings a little more marked ". According to the safety expert "we have problems with the colour of the tram lanes, which are similar to the rest, the border is also not very distinguishable, we have problems of visual contrasts".

Fig. 7: Users' practices in the section *Place Sadi Carnot*



(Source : Elisa Maître)

After *Cours Belsunce*, the tram is located on *Rue Colbert* and then on *Place Sadi Carnot* located at the intersection of the Haussmaniann breakthroughs of *Rue Colbert* and *Rue de la République*. The *in situ* analysis of users' practices highlights difficulties of use within this

sector, linked in particular to problems of readability of tram tracks. Pedestrians cross this area without clearly distinguishing traffic lanes from the rest of the space. Moreover, illegal parking of vehicles, which is very present in this area, constitutes obstructions to visibility for crossing pedestrians (Fig.7). In addition motorists do not always detect the oncoming trams and the corresponding signposting.

The interviews of the users provide elements on problems of weak salience of the limits between the different spaces and on the difficulties of use encountered: *"I was wondering whether I was on the road, it's a question ... but they would have to mark better"* ; *"This one [the roundabout of the square Sadi Carnot] it is not very clear for pedestrians, it lacks signposting and marking"* ; *"The first time, I suddenly found myself in front of a car, I thought it was reserved for the pedestrians"*. Moreover, according to the road safety expert: *"There were a lot of collisions in this square, people did not see the traffic light and hit the tram, and others were parked all over the place and when they left they, were no longer appropriately managed by the traffic lights and collided with the tram. There is no change in level or colour, so there are problems related to the weak salience of the tram layouts in public spaces. There are problems of readability of tramway tracks and particularly of the surface swept by the tram. This could be improved with a shift in colour or materials to see these limits more clearly. It is mainly for car drivers, but it is also used by the tram driver to determine whether the car is in his path or not to know whether he can continue »*.

On this section, three accidents occurred in relation with this problem of poor differentiation between spaces, leading to the inappropriate presence of traffic or parked cars on tram tracks.

Moreover the special status given to the tram on this type of intersection (trams always have right of way) leads to the introduction of specific signs (traffic lights on the roundabouts, for example) which contradict the general principles of operation of roundabouts (priority to the road users already on the roundabout) and may be misperceived or misunderstood by other road users.

3. DISCUSSION, CONCLUSION

The results presented in the previous section suggest, on the one hand, that the implementation of a modern tramway system tends to significantly reduce the number of accidents on the streets along the tram routes. This could be due in great part to the reduction of the space allocated to the cars in such projects (reduction of the number of traffic lanes, pedestrianisation of some sections, etc.), which probably involve a decrease in car traffic. However, as regards the overall effect of tram systems on road safety, further analyses using more global approaches would be needed, since one cannot exclude the possibility that car traffic and accidents may partly migrate towards other parts of the urban road network.

On the other hand, the results presented suggest that the new forms of public spaces induced by the implementation of modern tram systems in French cities create specific safety problems and difficulties for the various categories of road users. Although the analyses presented here were limited to a few number of sections – and therefore remain to be extended and consolidated – some main problems have been identified.

A significant part of the safety problems we have found can be related to relatively complicated layouts engendered by the addition of trams in the public space (such as the junction of several tram lines in the same restricted space) which may lead to a poor detection of the arrival of the tram or other users.

Other safety problems are related to the continuity of lanes dedicated to trams (uninterrupted at minor intersections) on some sections. Such configurations lead to severance effects in the urban fabric, which encourages unauthorized or inappropriate crossing manoeuvres by drivers. These layouts also create an effect of perceptive continuity attenuating the perception of minor intersections.

Overall, the safety problems and difficulties of use identified can often be interpreted in terms of insufficient “readability” [23, 24] of certain public spaces re-designed for tram: poor differentiation between treatments of spaces; junction of multiple tram tracks in a pedestrian area; atypical and unclear configurations.

Although they should be confirmed and completed by more systematic investigations, these findings could be taken into consideration in futures reflections on the design of public spaces in urban projects of modern tramway.

It would then be appropriate to develop competences on the readability and safety of public space, from the point of view of users' perception. Ensuring an easy "reading" of public spaces, especially for pedestrians, remains one of the difficulties encountered by planners.

Measures should be envisaged, in particular with regard to the perception of the tram crossing and the delimitation of tram lanes. In addition, the continuity of lanes dedicated to trams (uninterrupted at minor intersections) could be called into question. More generally, lessons can be learned from the practices of the various European cities concerning public spaces re-designed for trams.

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