ROAD SAFETY MANAGEMENT IN LISBON: DEVELOPMENT OF EFFICIENT CORRECTIVE SAFETY MEASURES.

Carmen Carvalheira
(corresponding author)
Department of Civil Engineering, University of Coimbra
Coimbra, Portugal
carmen@dec.uc.pt

Luís Picado Santos
Department of Civil Engineering, University of Coimbra
Coimbra, Portugal
picsan@dec.uc.pt

Sandra Gomes
LNEC - Laboratório Nacional de Engenharia Civil
Lisbon, Portugal
sandravieira@lnec.pt

João Lourenço Cardoso
LNEC - Laboratório Nacional de Engenharia Civil
Lisbon, Portugal
joao.cardoso@lnec.pt

Abstract

A research project, "*IRUMS – Safer urban roads*", aims to develop a procedure for the explicit consideration of safety issues in the decision making process of urban transportation networks and in the allocation of resources for street renewal. More specifically, criteria for selecting dangerous urban sites (areas or sections) are being defined and a procedure for selecting efficient infrastructure corrective safety measures is being developed. Co-financed by the Foundation for Science and Technology, this project is carried out by the National Laboratory of Civil Engineering and the Department of Civil Engineering of the University of *Coimbra*, with the cooperation of the Lisbon Municipality and the Portuguese Police.

Five years road accident records, data on road infrastructure characteristics and traffic and land use information were collected and integrated in a Geographic Information System, where all information may be graphically visualized and analysed. The database and the process of feeding it are broadly described in this paper.

This paper also presents a State of the Art for Urban Road Safety Measures that will be associated to evaluate different possibilities of implementation in the Lisbon Network.

INTRODUCTION

"IRUMS – Safer urban roads" comprises a five year accidents database for Lisbon (2003-2007). All accidents were collected directly from official participations of accidents done in Portugal by PSP (Portuguese Public Police). For each accident, this database can answer these fundamental questions: where (location), when (year, month, day, weekday and hour), injuries (deaths, serious and light wounded), weather conditions (to detect if a wet pavement could have been one of the cause) and how the accident occurred (thru the accident scheme that is associated in the database as it is possible to see in Figure 1). All this information is being associated to the Geographic Information System *ArcGis*, and analysis will be done starting from the cartography evaluating the information in database.

A GIS database enables to evaluate at the same time the alphanumeric information and also the information about the road characteristics not only about the accidents locations but also the macro cartographic information, as is possible to see in Figures 1 and 2. This is obviously important when the main objective is to define road safety measures.

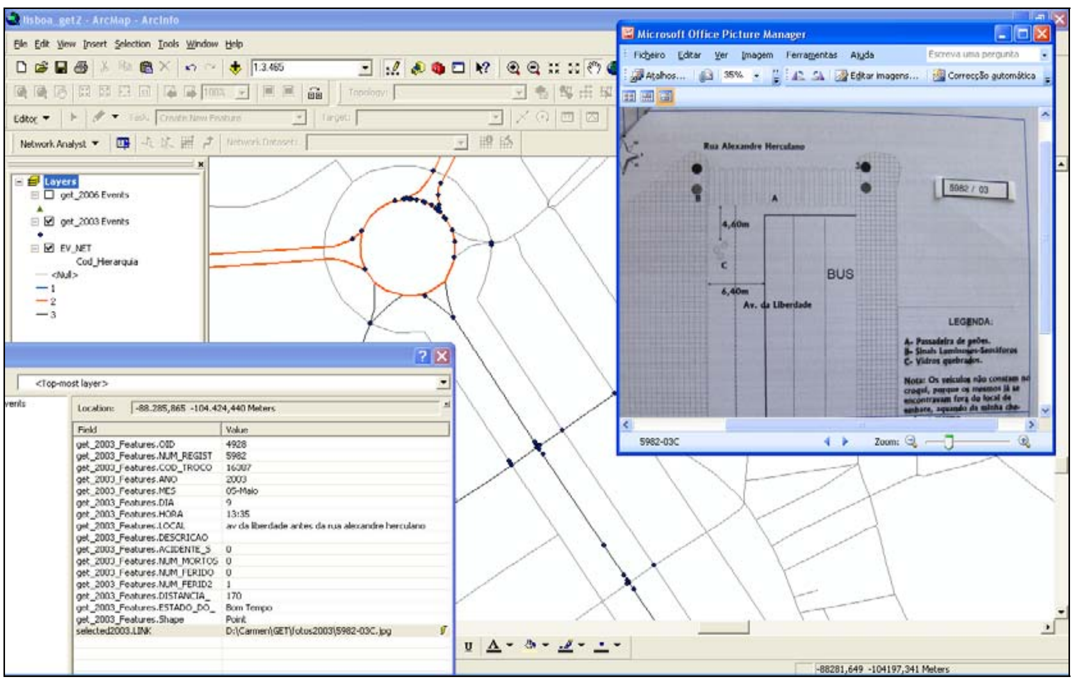

Figure 1 - *ArcGis* representing accidents in a junction in Lisbon network, and simultaneously it is possible to see the alphanumeric information for selected accidents and also the scheme accident done by the PSP

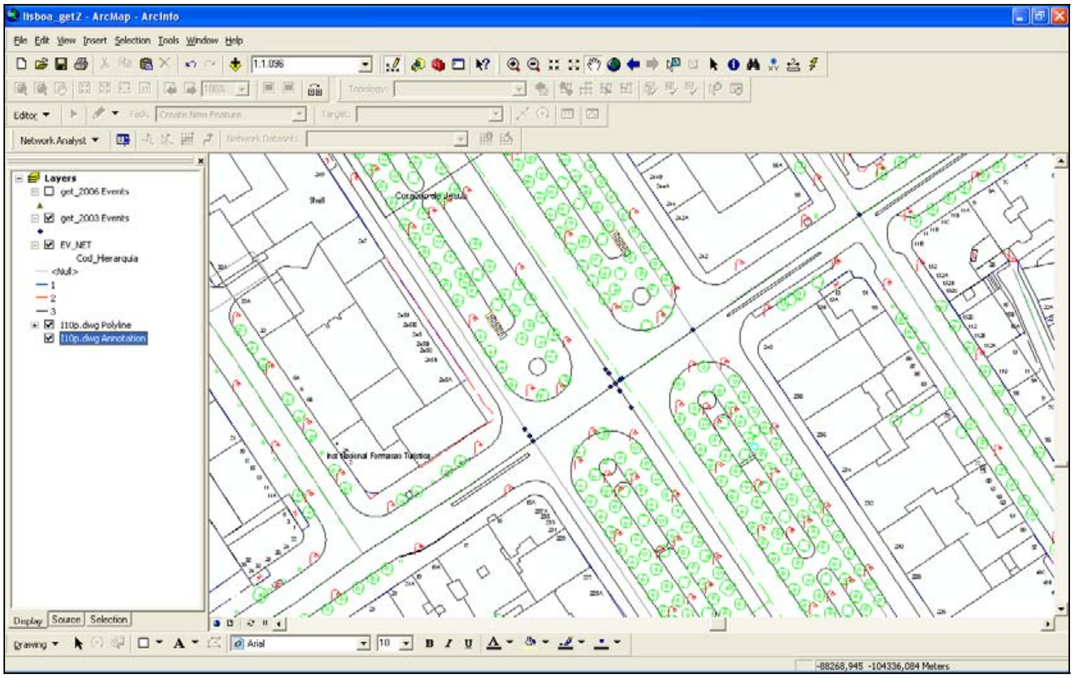

Figure 2 - ArcGis representing for the same place, a CAD drawing that is important to analyze possibilities to implement corrective measures

OBJECTIVES AND PRESENT WORK: ACCIDENTS ANALYSIS IN A GIS DATABASE AND A ROAD SAFETY MEASURES COLLECTION

Five years of accidents must produce effective propensities to a certain accident typology to happen in a place with a high level of occurrences. Accident analysis will be done focusing in all accidents registered for a place. When a typology of accident is identified is important to analyze the causes for those accidents to happen and all the possible interventions that can resolve or minimize those causes.

Once each accident has a scheme associated it is possible to identify the causes, and for that GIS is a powerful tool, because it enables to analyze all important occurrences in a selected place and to see all information in database trying to find the exact causes for those accidents. See Figures 1 and 2.

After the causes have been identified, the next step is to analyze all possible measures to correct the problem. For that it is important to look for the emergency in such implementation, the possibility for the implementation in financial terms and also in geographic and legal terms.

At the present time all accidents are being associated to GIS and at the same time a State of the Art about Road Safety Measures is being collected. The project´s final objective is to create a tool that can provide, for each cause identified, a group of possible corrective measures that can be implemented in the case study. This tool should also present a cost effective analysis for each measure proposed. All known corrective measures should be associated in this database to insure that all possibilities to correct problems are evaluated.

This paper is intended to present the results of the state of the art with all road safety measures for an urban environment. All measures presented here are measures that can be applied for the road infrastructure and only that. There are much more needed measures such as road safety education, and all measures that can be adapted to vehicles improving considerably safety in case of accidents and at same time the fundamental group of law enforcement measures. All of them have to be applied simultaneously, although this project is only centered in road safety engineering.

For some of the measures in this paper there are results of effectiveness studies that will be taken into account in this project, and namely in evaluation studies of cost effectiveness. However results for evaluation studies of cost effectiveness are not presented in this paper, because they are still being applied for Portuguese reality.

ROAD SAFETY MEASURES

Tracks for walking and Cycling

Statistical results for Portugal in 2006, demonstrate that 16,6% of total accidents are with pedestrians, and they represent 16,4% of deaths and 13,3% of total injuries. It´s important to emphasize that 70% of total accidents occur in urban areas. Usually pedestrian don't feel safe walking in public roads, and schools don't usually have separated way or areas to prevent some problems that may occur.

Portuguese people don't usually use bicycles as a way of transportation, it is more frequent to use the bicycles only for amusement, and for that, accidents with cycling are not very high. Although it must be considered that pedestrians and cyclists can usually share the same space when talking about separated lines.

These lines must be separated by physical barriers between pedestrians and motorized traffic and can be set up in a number of ways. Distinctions can be made between the following measures (R. Elvik, T. Vaa, 2004):
<u>Pavements</u>: pedestrians and cyclists are physically separated from motorized traffic by means of pavement, which is raised. 10-20cm in relation to the traffic lane and separated from it by kerbstones.
<u>Cycle Lanes</u> that are separated from motorized traffic by kerbstones.
<u>Tracks for walking and cycling</u> that are usually constructed on one side of the road only and have usually asphalt surface.
<u>Interchange crossing points</u> such as footbridges or pedestrians tunnels for crossing roads.

Figure 3 - Examples for Tracks for walking and cycling

Channelization of Junctions

From past experience in a project for Coimbra, most accidents in urban network occurred in junctions, and one good way to increase safety in intersections is channelization intending to (R. Elvik, T. Vaa, 2004):
- segregating traffic flows from each other and reduce the area of conflict between different intersecting traffic streams
- provide intersection angles which give good intersection
- define driving patterns and indicate which road has priority at an intersection.

Possible ways to Channelize Junctions:

1. Minor Road channelization using traffic islands or road markings
2. Left turn lanes also using traffic islands or road markings
3. Right turn lanes using traffic cones or road markings
4. Passing lanes that can allow vehicles to go straight ahead at an intersection, passing vehicles which are waiting to turn left
5. Full channelization using traffic lanes or road markings.

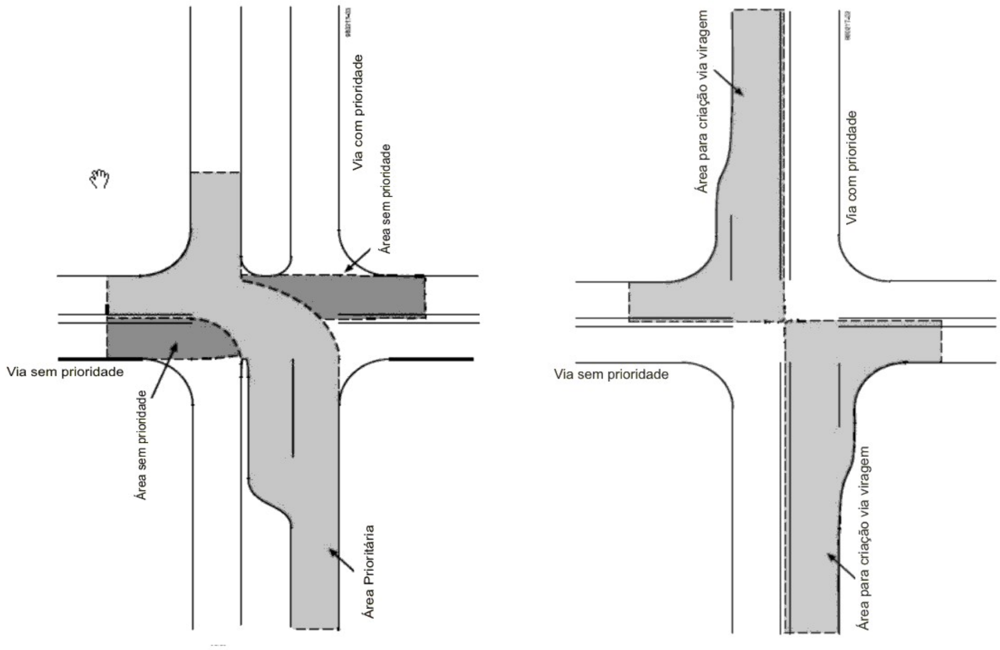

Figure 4 – Examples for Channelization of Junctions

Roundabouts

Converting one junction to a roundabout usually helps to minimize existing problems with left turns, also gives more visibility in all junctions' entries and always guaranties lower speeds. In Portugal, road safety studies show that usually roundabouts induce a large number of accidents but fewer injuries. Besides this, in Portugal there is no specific legislation for roundabouts and this may be one reason for a large number of accidents.

Figure 5 – Examples for Roundabouts

Figure 6 – Examples for Roundabouts

Redesigning Junctions

Redesigning junctions is intended to improve sight conditions at intersections, simplify turns and make the intersection more visible to road users who are approaching it. (R. Elvik, T. Vaa, 2004).This solution includes:

1. Changes to the angle between roads
2. Changes to the ingredients of roads approaching the intersection
3. Measures to improve sight conditions at intersections

Staggered Junctions (Reconfiguring Cross Roads to Two T-Junctions)

Intersections with four approaches demands higher alertness and behavior of the road user than intersections with three approaches. A four-leg intersection has 32 conflict points between the streams of traffic. Staggered junctions reduce the number of conflict points at intersections and thus make the task of crossing the intersection simpler for road users. (R. Elvik, T. Vaa, 2004)

Black Spot Treatment

In towns and cities there is a tendency for traffic accidents to cluster at specific places, often at intersections. (R. Elvik, T. Vaa, 2004) The study executed for Coimbra showed that in fact accidents occur especially in junctions and usually in specific places, and for most places, because Coimbra is a medium size town, traffic calming techniques can solve most problems. A database with information for three years of accidents can offer a solid propensity for some type of accident to occur in some place.

Traffic Calming

Traffic calming has been widely implemented in Europe. The purpose of traffic calming is to improve traffic safety for vulnerable road users. Traffic calming is the combination of mainly physical measures to alter driver behavior and improve conditions for vulnerable road users. Driving speed has a major influence on the probability of becoming involved in an accident and on the severity of injuries. A common problem for example in school zones is excessive vehicle speed and traffic volume in areas where children must cross streets and where they are picked up and dropped off. To avoid conflicts, traffic calming devices should be simple, self-enforcing and easy to modify to accommodate emergency and other service vehicles. Speed humps are frequently chosen as a typical solution when there is a need to reduce travel speeds on a local street and to provide the street with a calmer and safer character. The main advantage of speed humps are in their self-enforcing nature and in creating a visual impression that the street is not designated for high speeds or for passing traffic. The length is usually larger than the distance. (Rosebud, 2006) Other traffic calming techniques are:

1. Changing pavement color
2. Changing street geometry
3. Mini roundabouts
4. Speed control with traffic lights
5. Gates
6. Islands to allow pedestrians to cross in two times
7. Creation of pedestrians areas and streets where cars are not allowed

Obviously each one of these measures can be adapted to the specific characteristics of the place where it should be implemented.

Figure 7 – Examples of Traffic Calming Solutions

Figure 8 – Examples of Traffic Calming Solutions

Bypass Roads

Bypasses are designed to carry long-distance traffic outside towns and cities, so that conflicts between local traffic and long-distance traffic are avoided. The construction of bypasses makes it easier to introduce traffic calming measures on the main road through a town, when this road serves through traffic.

Bypass roads increase mobility for both long-distance traffic and local traffic. Bypasses can make it easier for pedestrians and cyclists to cross roads in towns, since less traffic reduces waiting times. On the other hand, an increase in speed may make it more difficult to cross the road. A bypass road can be a barrier to local travel. The analysis of Elvik and Vaa (2004) include amongst others reduced traffic volume on the old main road, reduced traffic noise, vibrations, local air pollution and estimates the costs of building a bypass around NOK 20 million per km road. (Rosebud, 2006)

Measures regarding skid resistance

Road surface characteristics and conditions can influence the occurrence of accidents. All road surface structures gradually deteriorate with time. This deterioration is normally evidenced by the appearance of various types of surface distress caused by a combination of environmental conditions and road use. If the road surface is not repaired, surface distress may become severe enough that road safety could be affected. Maintenance needs can be identified through pavement condition surveys. For example, skid resistance of the pavement surface must be maintained to provide safe braking. Some accidents happening on wet surfaces could be prevented if the road surface maintenance were carried out in time, assuming that wet weather crashes would increase with lower skid resistance. Therefore, one might consider that road surfaces in risky conditions should be rehabilitated in accordance with a fixed time schedule. When maintenance only is no longer effective, restoration should be required. (Rosebud, 2006) There were found some places in the study for Coimbra where accidents only occurred with wet pavement, and especially when there are some slope. For those places recommendations were to create a new bituminous surface.

CONCLUSIONS

The implementation of each of these road safety measures depends on several factors such as geometric characteristics, kind and traffic volumes, etc. So, each implementation requires a particular evaluation. For each possible measure in one place, there should be presented the cost effective analysis. Although this project intends to automate to where it is possible all of these proceedings. The final result must be a useful document for the person who has the last decision in the municipality entity.

REFERENCES

Carvalheira, C. (2002) -"Segurança Rodoviária em Meio Urbano: Metodologia para a Definição dum Sistema de Gestão" Dissertação de mestrado em Engenharia Urbana pela Universidade de Coimbra, Coimbra.

C. Carvalheira, L. P. Santos (2001), -"Sistema de Exploração dos Dados de Sinistralidade", 1º Encontro Nacional Segurança Viária em Meio Urbano, CD Edition, LNEC, Lisboa.

Elvik, R., Vaa, T. (2004). *The Handbook of Road Safety Measures*, Elsevier.

ROSEBUD (2006). "Examples of assessed road safety measures - a short handbook - Results from project ROSEBUB - Road Safety and Environmental Benefit-Cost and Cost Effectiveness Analysis for Use in Decision-Making".

TRL (J Barker, C. Baguley) "Road Safety Good Practice guide".