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A PROCEDURE TO IMPROVE SAFETY INSPECTIONS EFFECTIVENESS AND RELIABILITY ON RURAL TWO–LANE HIGHWAYS

Salvatore Cafiso[1], Grazia La Cava[2], Alfonso Montella[3], Giuseppina Pappalardo[4]

[1,2,4]Dept of Civil and Environmental Engineering, University of Catania,
Viale Andrea Doria 6, I-95125 Catania, Italy
E-mail: [1]dcafiso@dica.unict.it, [2]glacava@dica.unict.it, [4]giusy.pap@dica.unict.it
[3]Dept of Transportation Engineering, University of Naples Federico II,
"Luigi Tocchetti" Via Claudio 21, I-80125 Naples, Italy
E-mail: [3]alfonso.montella@unina.it

Abstract. Road Safety Inspections (RSI) are recognised as an effective tool for identifying safety issues. However, due to the subjective nature of the process, they may give rise to disagreements which limit their effectiveness. In the framework of the IASP research program sponsored by European Commission, which is focused on rural two-lane highways, a RSI procedure aimed at improving the effectiveness and the reliability of the methodology has been defined. For this purpose, the research has been pinpointed on the inspection framework, on the inspectors and client roles and, with special emphasis, on the methodologies used for identifying and ranking the safety problems. In order to test the reliability of the methodology, the agreement of the results of the safety issues ranks produced by different inspectors has been addressed. Specifically, the statistic kappa has been used. Results show that there is a statistically significant level of agreement among inspectors for the majority of safety issues. The reliability of the procedure is satisfactory, especially if it is considered that the identification of the safety issues is a very complex task based on human evaluations and expertise not supported by instrumental measures.

Keywords: road safety, inspections, ranking criteria, checklists, measures of agreement, reliability.

1. Introduction

An essential part of any safety management system is the network screening, that is the identification of sites where the greatest cost-effectiveness of the safety measures is expected. Several alternative ranking criteria are used in screening [1]. The more recently proposed procedures are based on the EB technique [2], which essentially aims to smooth out the random fluctuation in accident data by specifying the safety of a site as an estimate of its long-term mean. While accident data analysis is essential, it is well recognised that accident data suffer from a number of shortcomings [3] and that there are clues to hazardousness other than accident occurrence [4]. The need for further analyses stems from two main considerations. Firstly, accidents are a casual and rare event; if a site has not experienced a high-accident history or if there are not abnormal accident patterns, it does not mean that safety improvements cannot be performed in a cost-effective manner. Secondly, the success of the accident based reactive programs relies on the quality of accident data. Unfortunately, the quantity and quality of accident data are often very poor [5] and the reporting of injuries in an official accident statistics is incomplete at all levels of injury severity [6]. Moreover, an effective safety management system should look not only specific sites remedial actions but also at mass actions. This involves applying a particular, well-tried remedy to address an hazardous feature, at locations where the feature is present, irrespective of whether accidents have yet not occurred [7].

As a result of these considerations, it appears that the network screening can be better performed if a joint use is made of all important clues and not only of the accident history. With this aim in view, accident studies can be supplemented by Road Safety Inspections (RSI), which are also named differently as safety audit of existing roads and safety reviews. A safety inspection is a formal examination of an existing road, during which an independent, qualified team reports on the road's crash potential and safety performance.

The research has been performed in the framework of the IASP project [8], funded by European Commission (DG TREN) and Province of Catania (Italy) with the scientific coordination and operative support of the University of Catania. As part of the project, safety inspections procedures, which address rural two-lane highways, have been defined [9, 10]. Albeit many safety inspection procedures already do exist, the IASP procedures present some innovative elements [11–13]. The paper describes both the main features of the defined RSI procedure and the evaluation process which had been carried out to test the reliability of the safety inspection results.

2. Actors involved in the process

Actors involved in the process are the inspection team and the client.

The team must comprise three or more people because: 1) the road inspections, due to operative reasons, require at least three inspectors; 2) diverse backgrounds and different approaches of distinct people create cross-fertilisation of ideas and are beneficial in problems identification and analysis. Main requisites of the safety inspection team are independence and qualification. Independence from the design, maintenance and operation of the road to be inspected is needed since the team is to look only at safety problems applying "fresh eyes" to the task. Qualification is vital for the process to be effective, given that addressing safety problems and providing recommendations to eliminate or mitigate them do not give any real benefit in terms of accident reduction if the task is not based on sound road safety engineering experience and practice. Qualification requires both deep knowledge of the road safety principles and the familiarisation with the IASP procedures.

The client is the road agency. Before the inspection starts, the client selects the roads to be inspected and the team. After the inspection, the client decides upon implementation of safety measures recommended by the team. An innovative aspect of the IASP procedures is the active participation of the client in the inspection phase. The client participates as an observer to the site inspections and to the preliminary in office discussion about general safety problems.

3. Road inspections and problems identification

3.1. General aspects

More site inspections are required: preliminary inspections, in daytime, aimed at understanding the general road safety conditions and the relationships of the road segments with surrounding land use, terrain and road network; general inspections, in daytime, aimed at examining the general safety concerns along the road segments; detailed inspections, in daytime, aimed at examining in detail safety concerns of specific sites; night time inspections, aimed at analysing the road perception without natural lighting.

3.2. Preliminary inspections

Main objective of the preliminary inspections is trying to investigate how the road environment is perceived, and ultimately utilised by different road users. The analysis is to look not only the road, but also the environment which can interact with the road and the road users.

Any preliminary inspection should interest not more than three-four different roads of the same network, with a total length not greater than 100 km. At least three team members are needed: the driver, the inspector in front seat and the inspector in back seat. Recommended equipment are GPS receiver and digital video camera.

Each road is run in both directions at normal speed, that is the prevailing traffic speed. During the inspection a video recording is performed and inspectors comments are recorded in the same video-tape. The driver calls the travelled distance and refers about corrective maneuvers and driving perception of the road. Inspectors on front seat and back seat make safety comments. GPS receiver is used to locate useful points of the road such as mile stones and intersections.

3.3. General inspections

3.3.1. Checklists format

Main objective of the general inspections is to obtain the most important information about the safety issues and their location along the route.

Any general inspection can interest not more than 30 km. At least 3 inspectors are needed: the driver, the inspector in front seat and the inspector in back seat. Recommended equipment includes GPS receiver, digital video camera and checklists (Tables 1, 2).

The road is run in both directions at a very low speed (about 30 km/h): 1) the video recording is performed, 2) the driver calls travelled distance any 100 m, 3) inspectors in front and back seats compile the checklists. GPS receiver is used to locate the starting and the ending points of inspection.

Checklists are aimed at ensuring that important safety problems are not overlooked. Checklists are a prompt and not a substitute for knowledge and experience, that is, checklists should aid using safety engineering experience and judgment. IASP checklists are very synthetic, since they relate only to the main safety features which usually are present along two-lane rural roads. Moreover, only features which are easily detectable during inspections are to be inserted. Features which concern horizontal and vertical alignment (geometric alignment, design consistency etc) are not considered since in the IASP safety analysis alignment evaluation is performed as a separate quantitative procedure [8].

The following safety issues are assessed: accesses, cross-section, delineation, markings, pavement, roadside,

Table 1. Checklist for General Inspection: module for front seat inspector

		0,2		0,4		0,6		0,8		1,0	
PART A											
Roadside											
	Embankments										
	Bridges										
	Dangerous terminals and transitions										
	Trees, utility poles and rigid obstacles										
	Ditches										
Sight distance											
	Inadequate sight distance on horizontal curve										
	Inadequate sight distance on vertical curve										
PART B											
Accesses											
	Dangerous accesses										
	Presence of accesses										

Table 2. Checklist for General Inspection: module for back seat inspector

		0,2		0,4		0,6		0,8		1,0	
PART A											
Cross-section											
	Lane width										
	Shoulder width										
Pavement											
	Friction										
	Unevenness										
Delineation											
	Chevrons										
	Guideposts and barrier reflectors										
PART B											
Signs											
	Warning signs, regulation signs										
Markings											
	Edge lines										
	Centre line										

Table 3. Criteria for assessing safety problems related to roadside

High-level problems	Low-level problems
Embankments	
Unshielded or shielded with ineffective barriers embankments (h >5 m) Unshielded or shielded with ineffective barriers embankments with great slope (h>3 m) Embankments shielded with low containment safety barrier with great slope (h>3 m), if dangerous obstacles in the bottom are present	Unshielded or shielded with ineffective safety barriers embankments with a great slope (1<h ≤ 3 m) Embankments shielded with a low containment safety barrier (h>3 m), if high commercial vehicles traffic is present Embankments shielded with discontinuous barriers (h>3 m)
Bridges	
Ineffective barriers Low containment barriers if high commercial vehicles traffic is present	Incorrect installation conditions Medium containment barriers if the bridge overpasses roads or railways
Dangerous terminals and transitions	
Not breakaway terminals (fish tails, buried in the ground etc) Not connected barriers and walls Not connected roadside barriers and bridge rails Not connected roadside barriers Barriers and walls connected without transition Roadside barriers and bridge rails connected without transition Roadside barriers connected without transition	Inadequate transition between steel barriers
Trees, utility poles and rigid obstacles	
High-diameter trees less than 3 m from carriageway Concrete utility poles less than 3 m from carriageway High-diameter steel utility poles less than 3 m from carriageway Rigid obstacle with exposed front face or corner less than 3 m from carriageway	Low-diameter trees less than 3 m from carriageway High-diameter trees 3–8 m from carriageway Concrete utility poles 3–8 m from carriageway Low-diameter steel utility poles less than 3 m from carriageway High-diameter steel utility poles 3–8 m from carriageway Rigid obstacle with exposed front face or corner 3–8 m from carriageway
Ditches	
Rectangular or trapezoidal ditches less than 3 m from carriageway	Rectangular or trapezoidal ditches 3–5 m from carriageway

sight distance and signs. In order to improve safety issues evaluation, each item is divided in more detailed concerns (Tables 1, 2).

3.3.2. Checklists compilation criteria

Checklists must be filled in both directions. Front seat and back seat inspectors, which have different views of the road, compile different checklists (Tables 1, 2) filling the boxes with a step of 200 m (24 s at 30 km/h).

In order to simplify the inspector's task, any checklist is split in two parts: part A is to be compiled on site, part B can be compiled both on site and during the video examination performed in the office.

Safety issues are ranked as: high level problem, low level problem and no problem. Only the presence of problems is marked on the check list. If an high level problem occurs, the inspector fills the gray box, if a low level problem occurs, the inspector fills the blank box. Since a good friction evaluation requires instrumented measures, the friction problems are ranked with only two levels of judgment: problem and no problem.

In order to improve reliability and repeatability of the process, criteria for identifying and ranking safety issues have been defined. Criteria are concisely reported in Tables 3–10. Ranking criteria are based on the estimated road safety effect of each problem.

In the IASP manual detailed explanations and reference photographs are reported [9]. Ranking of safety issues can be used both as an aid for the prioritization of the safety measures and as an aid to road agencies in measuring the effectiveness over time of their safety improvement programs.

Table 4. Criteria for assessing safety problems related to sight distance

High-level problems	Low-level problems
Inadequate sight distance on horizontal curve	
Available sight distance less than 50 m caused by continuous visibility obstructions inside the curve	Available sight distance greater than 50 m but smaller than SSD or inadequate to give the correct road perception Discontinuous visibility obstructions inside curve
Inadequate sight distance on vertical curve	
Available sight distance less than 50 m	Available sight distance greater than 50 m but smaller than SSD or inadequate to give the correct road perception

Table 5. Criteria for assessing safety problems related to accesses

High-level problems	Low-level problems
Dangerous accesses	
Accesses on horizontal curves Accesses on crests Accesses on sites with poor visibility Accesses close to intersections	Narrow accesses Accesses without markings Accesses without delineators Unpaved accesses
Presence of accesses	
Three or more accesses in one stretch 200 m long	One or two accesses in one stretch 200 m long

Table 6. Criteria for assessing safety problems related to cross section

High-level problems	Low-level problems
Lane width	
L < 2,75 m	L > 4,50 m
Shoulder width	
2,75 ≤ L<3,25 m	3,75 < L ≤ 4,50 m

Table 7. Criteria for assessing safety problems related to pavement

High-level problems	Low-level problems
Friction	
Polished aggregate Bleeding Raveling Low-macro texture	
Unevenness	
Steel drains on carriageway Disrupted joints Potholes on curves or close to intersections Deep potholes on tangent Shoving on curves, approach to curves or close to intersections High-shoving on tangent Rutting on curve Patches on curve	Low-shoving on tangent Low potholes on tangent Rutting on tangent Patches on tangent

Table 8. Criteria for assessing safety problems related to delineation

High-level problems	Low-level problems
Chevrons	
Missing chevrons on severe curves Chevrons placement inadequate to give a correct perception of the total length of the curve Chevrons placed only in one direction Chevrons deteriorated Not-reflective chevrons Chevrons with arrows in the wrong direction Chevrons obscured by vegetation	Missing chevrons on moderate curves Chevrons spacing inadequate to give correct perception of the curve Low-reflective chevrons Local discontinuity of chevrons Partially obscured chevrons
Guideposts	
Missing guideposts Missing reflectors on guideposts, on roadside safety barriers or on roadside walls Missing reflectors Ineffective reflectors Guideposts with dangerous placement	Variable height of reflectors along the road Low-reflective guideposts Local discontinuity of guideposts

Table 9. Criteria for assessing safety problems related to signs

High-level problems	Low-level problems
Warning signs, regulation signs	
Missing curve warning sign Missing crest warning sign Not visible curve warning sign Not visible crest warning sign Missing warning sign in dangerous situations	Curve warning sign faded or with low visibility Crest warning sign faded or with low visibility Yield sign missing, faded or with low visibility Advertisement located so as to disturb road users Indication signs incomplete or with low legibility Not consistent speed limit Unclear signs Wrong height signs

Table 10. Criteria for assessing safety problems related to markings

High-level problems	Low-level problems
Edge lines	
Missing edge lines Very faded edge lines	Low-faded edge lines Edge lines partially obscured by the vegetation
Centre line	
Missing centre line Very faded centre line	Low-faded centre line

3.3.3. General problems and recommendations

After the preliminary inspection, in the office, the team analyses videos and (if wasn't done on site) compiles part B of the checklists. Checklists are compiled in both directions referring in particular to the right side. By brainstorming among the team members checklist results are examined and the final version of the checklists is edited.

Safety issues are classified as general problems if they are present along a substantial portion of the road. General problems require mass action safety programs. The IASP manual suggests for each general problem the recommendation typologies [9]. The checklists results, the safety comments recorded during the preliminary inspection and the manual suggestions are a valid support to formulate recommendations for general safety problems. Recommendations indicate the type of measures, without specifying detailed technical issues.

Problems and recommendations are disaggregated in order to highlight the safety issues of each road feature, but road safety improvement requires an integrated approach, where interaction among different measures must be taken into account.

As final result of the meeting, a preliminary report describing general problems and recommendations is edited. Moreover, some sites requiring specific inspection might be identified.

3.4. Site detailed inspections

The detailed inspection is aimed at a closer examination of sites which present specific safety issues.

The inspection is focused on specific sites. The number of the sites for each inspection is limited only by the available time. At least two inspectors are needed. Recommended equipments are: protective clothes with a high retro reflectivity, GPS receiver, digital video camera, digital photo camera, measuring wheel or laser measurer, inclinometer, inspection modules with rigid support (Tables 11, 12), stopwatch, laser gun (optional) and traffic counters (optional).

The road is run in both directions at low speed, stopping the car on sites which show the greatest safety problems or specific features which require investigation deepening. Other than those selected during the general analysis, more sites can be identified during the drive through. During the driving through photos related to general problems are taken. These photos can be added to the final report. On the selected sites, the team performs the inspections by walking and observing both the road features and the road users behaviour. Photos of identified problems and videos of dangerous behaviours are helpful both in the problem analysis and in the report writing. Compilation of the site inspection module (Table 11) is strongly recommend since it gives the following benefits: focuses the identified safety issues, gives a chance to record the concerns raised during the inspection and synthesises observation results simplifying the report writing. Inspection

Table 11. Road segments inspection module

Site general description	
Street name:	Problem number:
ID GPS waypoint:	ID first and last photo:
– Curve: ☐ Tangent: ☐ Longitudinal grade: level ☐ slope ☐ – Embankment: ☐ Cut: ☐ Cut and fill: ☐ Bridge: ☐ Tunnel: ☐	
Problems description	
Horizontal alignment problems – Curve preceeded by long tangent : ☐ – Series of curves: ☐ – Inadequate super elevation: ☐ – Super elevation measure: right lane ____ left lane ____ – Visibility obstructions: ☐ – Available sight distance: ___________ Notes:	Vertical alignment problems – Crest: ☐ – Inadequate visibility: ☐ – Available sight distance: – Sag: ☐ – High longitudinal grade: ☐ Notes:
Cross-section – Lane width: – Shoulder width: Notes:	Roadsides – Embankment inadequately shielded: ☐ Bridge inadequately shielded: ☐ – Dangerous terminals and transitions: ☐ Trees, utility poles, rigid obstacles: ☐ – Unrecoverable ditches: ☐ Others: ________________ Notes:
Presence of accesses: ☐	Notes:
Inadequate friction: ☐	Notes:
Pavement unevenness: ☐	Notes:
Inadequate markings: ☐	Notes:
Inadequate signs: ☐	Notes:
Inadequate delineation: ☐	Notes:
Road users dangerous behaviours High operating speeds: ☐ Queues: ☐ Wrong maneuvers ☐ Notes:	
Accident signs (damaged barriers, glasses on the pavement, braking marks etc): ☐	Notes:
Sheet 2 (not to scale)	
Site condition diagram:	Sketch of potential accidents:
Notes	Description of potential accident scenarios:

Table 12. Intersections inspection module

Intersection general description	
Intersection type: ☐ T ☐ X ☐ Y ☐ Roundabout ☐ Other (specify)	
Name of intersecting streets:	
ID GPS waypoint:	ID first and last photo:
Problems description	
Horizontal alignment – Intersection inside a curve: ☐ yes ☐ no – Intersection outside a curve: ☐ yes ☐ no – Curve in one of the approach legs: ☐ yes ☐ no Notes:	Vertical alignment – Intersection on a crest: ☐ yes ☐ no – Crest in one of the approach legs: ☐ yes ☐ no – High longitudinal grade: ☐ yes ☐ no – Intersection located on a sag: ☐ yes ☐ no – Continuity of the secondary road profile: ☐ yes ☐ no Notes:
Left turn and right turn lanes – Left turn lane: ☐ yes ☐ no Left turn volume count: – Too high left turn volume: ☐ yes ☐ no – Right turn lane.: ☐ yes ☐ no Right turn volume count: – Too high right turn volume: ☐ yes ☐ no Notes:	Channeling – Ghost island on secondary road: ☐ yes ☐ no – Curbed left turn lane: ☐ yes ☐ no – Inadequate canalisation islands: ☐ yes ☐ no Notes:
Visibility obstructions: ☐ yes ☐ no	Notes:
Presence of accesses: ☐ yes ☐ no	Notes:
Roadside obstacles: ☐ yes ☐ no	Notes:
Inadequate friction: ☐ yes ☐ no	Notes:
Inadequate notice signs: ☐ yes ☐ no	Notes:
Inadequate direction signs: ☐ yes ☐ no	Notes:
Inadequate regulatory and warning signs ☐ yes ☐ no	Notes:
Inadequate markings: ☐ yes ☐ no	Notes:
Inadequate delineation: ☐ yes ☐ no	Notes:
Road users dangerous behaviours High approach speeds: ☐ yes ☐ no Long queues: ☐ yes ☐ no Wrong manoeuvers Late braking: ☐ yes ☐ no Poor compliance of traffic regulations: ☐ yes ☐ no Invasion of opposite lanes: ☐ yes ☐ no Short gap acceptance : ☐ yes ☐ no	
Accident signs (damaged barriers, glasses on the pavement, braking marks, etc.): ☐ yes ☐ no	Notes:
Sheet 2 (not to scale)	
Intersection condition diagram:	Sketch of potential accidents:
Notes	Description of potential accident scenarios:

module has some similarities with general checklists but contains more information which are acquired by detailed observations and are integrated by further information, such as: available sight distance, lane and shoulder widths, road users' behaviours and accident signs. Road users' behaviour analysis is one of the main task in the investigation. If critical traffic conditions occur, traffic counts (in the rush hour) and speed measurements can be acquired. If speed measurements are not carried out, sight distance adequacy evaluation can be performed by the stopwatch method [14].

3.5. Nighttime inspections

Nighttime inspections are focused at understanding how the road is perceived at night. Consequently, main focus is on markings, delineation and legibility of the road alignment.

Any nighttime inspection should interest not more than 100 km. At least three team members are needed: the driver, the inspector in front seat and the inspector in back seat. Recommended equipments are GPS receiver and digital video camera.

Each road is run at normal speed in both direction. Videos of the road and comments of the inspectors are recorded. Location of specific nighttime problems may be carried out by using the GPS receiver in cinematic modality. The day after the inspection, a meeting in the office is carried out. Videos are examined and identified problems are annotated in the report.

4. Final report

For each road, a specific inspection report is written. The report is written in "problem/recommendation" format, where the problem is described in terms of safety issues and accident risk to a road user, and the recommendations are engineering solutions to the reported problem. After discussion among the inspectors, the final report is edited and signed. The report describes the analysis procedure and contains the study results, which are detailed and explained.

It contains the following sections: 1) introduction, 2) segment general problems, 3) segment specific problems, 4) intersection problems, 5) synthesis, in tabular format, of problems and recommendations, 6) concluding statement and signatures of the inspectors.

5. Reliability of the procedure

In order to test the reliability of the methodology, the agreement of the results of the general safety issues ranks produced by different inspectors for the road segments has been addressed. Specifically, with the aim of checking the consistency of the risk assignment between different inspectors, the statistic kappa has been used.

The kappa coefficient (k) provides a measure of agreement among a set of inspectors, who have rated a set of objects using a nominal scale with M different category judgments, correcting for expected chance agreement:

$$k = \frac{P - P_e}{1 - P_e}, \quad (1)$$

where P – proportion of times that the inspectors agree ($0{,}00 \div 1{,}00$); P_e – proportion of times that agreement by chance is expected ($0{,}00 \div 1{,}00$).

If there is total agreement k is equal to 1. If there is no agreement other than that which would be expected by chance k is equal to 0. A negative kappa value indicates disagreement between inspectors. There are several variants of the kappa coefficient in the literature, the multirater kappa for category data proposed by Siegel & Castellan [15] provides an adjustment for bias and was applied. The values of the k statistic were calculated by using the GenStat 7.2 software.

Moreover, it is possible to test whether the level of agreement is statistically significant. When N is large (> 30), the sampling distribution of kappa is approximately Normal. Therefore, under a test hypothesis of no agreement beyond chance, the level of significance α of the agreement can be determined evaluating the probability of $k/\sqrt{\text{var}(k)}$ for a standard Normal distribution. An α of 10 % can be used as level of significance. The k statistics have been performed with reference to different combination of inspectors and different category judgments with the aim of testing the reliability of the procedure.

First, the comparison of checklists filled by two group of safety specialists has been carried out. The checklists were compiled with respect to three different two lane rural roads with a total length of 40 km (200 segments). Each group was composed by two inspectors: one in front seat and the other one in back seat. Safety issues have been ranked with three categories of judgment: high level problem, low level problem and no problem.

Results reported in Table 13 show that there is a significant level of agreement for the majority of the safety issues. For some issues (terminals and transitions, presence of accesses, unevenness, chevrons and markings) the level

Table 13. *K* statistics and level of agreement between two inspectors with a nominal scale of three judgments

Safety issues / Calculated values	P	P_e	k	var(k)	Significance level (%)	Significance (α = 10 %)
Roadside						
Embankments	0,753	0,721	0,117	0,0177	18,8	No
Bridges	1,000	1,000	–	–	–	Insignificant data
Dangerous terminals and transitions	0,623	0,478	0,278	0,0063	<0,1	Yes
Trees, utility poles and rigid obstacles	0,324	0,368	–0,041	0,0040	74,2	No
Ditches	1,000	1,000	–	–	–	Insignificant data
Sight distance						
Sight distance on horizontal curve	0,630	0,552	0,174	0,0062	1,3	Yes
Sight distance on vertical curve	0,955	0,951	–	–	–	Insignificant data
Accesses						
Dangerous accesses	0,515	0,482	0,063	0,0047	17,7	No
Presence of accesses	0,595	0,360	0,367	0,0028	<0,1	Yes
Cross-section						
Lane width	0,603	0,524	0,165	0,0075	2,9	Yes
Shoulder width	0,534	0,456	0,144	0,0057	2,9	Yes
Pavement						
Friction	0,905	0,909	–	–	–	Insignificant data
Unevenness	0,675	0,542	0,291	0,0059	<0,1	Yes
Delineation						
Chevrons	0,655	0,519	0,283	0,0054	<0,1	Yes
Guideposts and barrier reflectors	0,890	0,895	–	–	–	Insignificant data
Signs						
Warning signs, regulation signs	0,835	0,791	0,212	0,0189	6,2	Yes
Markings						
Edge lines	0,570	0,421	0,258	0,0036	<0,1	Yes
Centre line	0,735	0,401	0,558	0,0034	<0,1	Yes

of agreement is very satisfactory ($\alpha \leq 0,1\,\%$). For bridges, ditches, sight distance on vertical curves, delineation guideposts and friction the collected data were not significant for the test because the judgment expressed by both the groups assumed an almost constant value along the entire roads. This circumstance, generally, derives from a substantial homogeneity of road features (both for good and bad conditions). When this condition occurs, both P and P_e assume a value equal or very close to one. It means that the proportion of times that the inspectors agree is very high, even if the agreement is not statistically significant. A specific consideration can be made with respect to friction. Both the observers rarely filled the relevant boxes in the checklist assigning a value equal to good for almost the entire roads. Instead, during site inspections, poor friction conditions were often identified. These results stem in the main from the inspectors inability in recognizing the friction state when running the road at normal speed. Safety issues where there is not a statistically significant level of agreement are embankments, roadside obstacles and dangerousness of accesses. As far as embankments is concerned, there is indication of a slight level of agreement, since k is greater than 0 and inspectors' ranks agree in 75 % of the evaluations ($P = 0,753$). A good evaluation of embankments dangerousness is not an easy task without stopping the car. As far as dangerousness of accesses ($k > 0$) and roadside obstacles is concerned, it must be remembered that they are isolated elements.

In order to check if the disagreement can be reduced considering a simpler identification of the safety issues, the checklists were compiled using a nominal scale of two categories of judgment: problem (which includes low level and high level problems) and no problem. A general improvement of the agreement is observed, but it appears that the advantage arising from the greater level of detail reached by the three level judgment overcomes the reduced level of agreement in comparison with the two level judgment procedure.

6. Conclusions

The proposed procedure has shown positive features. It gives a detailed inspection framework, an innovative definition of team and client relationships and a clear definition of objectives, team composition, required equipments and procedures of each phase of the process, thus improving the global effectiveness of the safety inspection process. Proposed checklists can result helpful since they are not overwhelming and at the same time they give constructive support to the inspectors. The ranking of the safety issues is performed according explicit criteria and is useful to allow the inspection results to be used in a comprehensive road safety program.

The RSI carried out according to the defined procedures showed that there is a statistically significant level of agreement of the safety issues ranks produced by different inspectors for the majority of the safety issues. As a result, the reliability of the procedure is satisfactory, specially if it is considered that the identification of the safety issues is a very complex task based on human evaluations and expertise not supported by instrumental measures.

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