AN INTEGRATED SYSTEM FOR TRAFFIC AND INFORMATION TO USERS MANAGEMENT DURING RESURFACING WORKS ON A DUAL CARRIAGEWAY

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ABSTRACT

Province of Florence, in view of the necessity to improve the pavement structural conditions of the dual carriageway "Firenze-Pisa-Livorno" open to traffic, considered several available technical solutions in order to maintain its accessibility to motorists during construction phase. Traffic discomfort minimizing -in terms of queue time and user safety- and information on the works maximizing –in terms of traffic condition in a real-time- were made possible thanks to the experience of a contract responsible for both road design, operation and management. This allowed the implementation of a traffic information service associated to a communication campaign known as "Fipilissima". The results of the activity of this service (patrolling, fast operation, information management), have been evaluated in terms of performance obtained. Vehicles that carry out the road patrolling are equipped with video cameras and variable message panel so that accidental events or queue can be signalled closer to the place where they happened, integrating dynamic message signs positioned along the road and at the interchanges.
This comprehensive system was completed with a protocol carried out in conjunction with the police force for the joint management of emergencies -due to traffic queues at road works- based on alarm thresholds and intervention codes.

1 – MAINTENANCE WORKS ON A DUAL CARRIAGEWAY: STRATEGIES FOR OPTIMIZING RESULTS AND MINIMIZING IMPACTS

The "S.G.C. Firenze-Pisa-Livorno" is a dual carriageway about 100 Km in length with two lanes in each direction. It is characterised by a section in common that begins from Florence and after about 60km splits into two branches, one towards Pisa and the other towards Livorno. The road directly links Florence and the "A1" highway with the port of Livorno, Pisa airport, and the "A12" highway. The road is accessed via interchanges (grade separated intersections), while accessing the several service areas located along the road is possible through acceleration and deceleration lanes (fig.1). Among light vehicles, one of the major components of the traffic is represented by commuters.

"Figure 1 – S.G.C. Firenze-Pisa-Livorno"

However, heavy vehicles, that are a large fraction of total vehicle flux , often travel up and down on longer journeys and take advantage of the link provided by the “S.G.C. Firenze-Pisa-Livorno” both through the highway interchanges and towards the port of Livorno and viceversa., Over some sections of the road, total daily vehicle flux may be above 40,000 units.
When this road was assigned to the Tuscany Region during the re-assignment process of the entire national road system, the chosen strategy for improving overall conditions of the road selected by the authorities involved (the Tuscany Region and the Provinces of Florence, Pisa and Livorno) ,was to find innovative forms of management (by entrusting it to a “global road service”) to both optimise the management-maintenance aspects and plan a series of interventions aimed at improving structural safety.
Planning extensive maintenance work (costing more than 100 million Euros) that involved a strong impact on the possibility of actually travelling up and down the road during the maintenance period, was a challenge for the managing authority, requiring detailed analysis of all the possible solutions for limiting inconvenience while maximising the effectiveness of management systems, road patrolling, traffic control and emergency response services. The Province of Florence, by outsourcing the operation and management but keeping the functions of policy development and control, provided an interesting experience in global road service. In fact, the maintenance and the management of this infrastructure was assigned to a temporary contractor partnership headed by the major Italian motorway concessionary “Autostrade per l’Italia” through a performance-based specification. Its presence on the territory enables integration of information management into the context of the surrounding network, configuring the same infrastructure as a part of the motorway net mesh.
Therefore, by taking advantage of an integrated manager as is the “global service provider”, services dedicated to managing both emergencies and queues close to the location of extensive maintenance works was carefully developed. The organization of this service was included in a communication framework called *Fipilissima* that, among others things, has promoted the official presentation of certain vehicles in Florence and Pisa (fig. 2).

“Figure 2 – Truck used for road patrolling”

2 – OBJECTIVES OF THE “FIPILISSIMA” SERVICE

The objective was to provide structures to improve services like traffic control and emergency response, in terms of both timeliness and capillarity, as well as management of

queue evolution in terms of safety. This is obtained by patrolling large sites with suitably equipped vehicles, installing safety signs and implementing tools for video-monitoring, with monitoring and remote control from a station, as well as data availability, news and inquiries from the sites and near the sites themselves not to mention setting up a well-equipped rapid intervention system suitable to the structural conditions of the road.

"Figure 3 – Detail of the dynamic message panel on a truck"

Patrolling is guaranteed for nineteen hours a day (with availability for the remaining five hours) by authorised trucks and by motorcycles equipped with a ready-intervention fire system, especially suited for moving easily in case of a long queue in an infrastructure without emergency lanes. The trucks are equipped with variable message panels *(fig. 3)*, video-cameras able to send images to the information centre and to the call centre (as well as to the Province of Florence, when required), emergency signs for defining a single lane or deviation (for deviations, with the help of two trucks), absorbent substances, cold bituminous conglomerate, materials and tools for small repairs and fire extinguishers for emergency purposes.
In every large construction site (and in all directions) a new sign system has been added to the one strictly referring to the site, consisting in:

- one or two rotating panels with LED lights, to be positioned at a suitable distance for visibility, to signal queues, with a video-camera powered by solar energy panels. The rotating panel is also useful when signalling a queue ahead of a bend or in the presence of an obstruction to the visual field (fig. 4);
- an additional rotating panel with LED lights, to be located ahead of the last exit previous to the road works site to indicate an exit via an alternative route if necessary;
- fixed road signs to indicate alternative routes.

Besides, it will be possible, through appropriate messages, to manage the fixed installations with variable message panels positioned along the way and close to junctions; it will also be possible to integrate them with mobile installations mounted on trucks operating road patrolling, traffic control and emergency response services.
The global service provider, in line with the organizational independence characterizing the global service system, is authorised to modulate team set-ups depending on needs when

dealing with emergencies , allowing means to be modified in respect of their composition and arrangement over time and also enabling the organisation, if the need arises, of teams over partial shifts. Both the global service provider and the road administration can put forward proposals in relation to utilisation of means and resources as long as they have a similar undertaking.

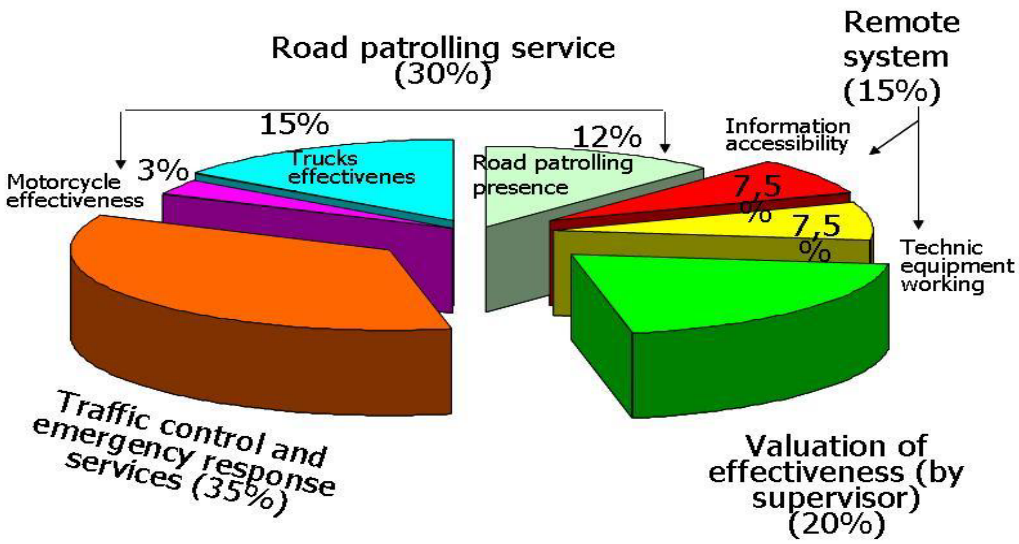
"Figure 4 – Signalling queues: rotating panels that can be utilised by remote control and equipped with video-cameras"

Basically, although unable to actually improve traffic flow, this programmed activity, aims at surveillance of critical traffic conditions by continuous patrolling to inform travellers, and operating a rapid system for events concerning road conditions (accidents, load losses, vehicles on fire etc..) in the briefest possible time, despite queues originated by road works, in order to minimise any possible further inconvenience.

3 – PERFORMANCE EVALUATION OF SERVICE "FIPILISSIMA"

Management of emergencies and evolution of traffic queues around road works is conducted by evaluating performance criteria for which a premium- and penalty-based system is applied with respect to a pre-specified service level.
The overall activity is assessed with reference to three different aspects: road patrolling services, traffic control and emergency response services, and a remote control service system with, lastly, the aggregate service efficiency (fig 5).
In relation to surveillance services the evaluation parameters refer to: a) the actual occurrence of the patrolling activity via random inspections to assess the effective presence of the foreseen teams; b) surveillance service effectiveness in raising alerts concerning emergency situations (the percentage of emergency situation calls originating from surveillance service warnings is contrasted against that from external alerts); c) the real development of interventions through special vehicles even in presence of queues (there is no emergency lane): properly equipped motorbikes, fitted city cars, etc..
However, with respect to traffic control and emergency response services, the most

important evaluation parameter is the promptness of intervention. The fundamental objective is to acknowledge the situation in the shortest time possible and to be able to implement appropriate safety measures.
Assessment of the remote control system is conducted along two lines: verifying the effective functioning of equipment (rotating panels, videocameras etc) and actual access to information received.
Lastly, since it is an complex integrated system, the overall service efficiency needs to be verified in relation to the predetermined objectives. This valuation is conducted qualitatively by the road administration supervisor and is based on the elements stemming from control activity, from Road Police reports and from road users complaints.
Survey examinations were conducted, at the end of the first contractual service year, in order to determine premiums and penalties to be assigned. Data analysis confirms a truly positive trend in carrying out the service and provokes some interesting considerations.
First of all we must highlight the high percentage of emergency operations starting from "internal" notifications: above 60% of the warnings received by the emergency operation system are generated by the road patrolling implemented through “Fipilissima operation”. This is a very important step forward, with respect to the previous situation, in the aim to improve the speedyness both of corrective interventions in case of an event and for the information flow towards users in order to redirect them, if required, towards alternative routes.



“Figure 5 – Service evaluation parameters”

Traffic control and emergency response services too have experienced very comforting results: the percentage of interventions within half an hour is close to 100%. Signalled events concerned multifarious situations: road accidents, spills of various substances on the roadway, stray animals on the road, breakdowns, floods, fires etc.. On the whole the integrated road patrolling/rapid operation system has enabled the onsite presence of dedicated personnel in emergencies in a very short time. Such results have been achieved despite substantial delays incurred during the implementation of the remote control system (indeed the evaluation of this particular issue has been negative). Therefore a further improvement is expected since at the moment the control system is working full scale and the video information can enhance ad hoc intervention capacity.

4 – INTEGRATION OF “FIPILISSIMA” SERVICE WITH A SYSTEM OF DYNAMIC MESSAGE SIGNS DISLOCATED ALONG THE ROAD

It is also worth mentioning that the information service to users implemented is able to exploit panels with variable messages (dynamic message signs) located both along the infrastructure path and in proximity of access junctions. This system, denominated "Infosistema" is the result of integrating four elements: variable messages panels (fig. 6), traffic surveillance sensors, video-cameras and the control centre.
Installation is now almost complete as is the utilisation of most of the panels, in place for quite some time. Infosistema consists in “peripherals”, that is portals supporting three devices (panels, traffic sensors and cameras), arranged along the road and at junctions, and finally by the Control Centre.
Infosistema mainly accomplishes the following tasks:

- information towards users, via variable messages panels, in relation to current and expected road conditions (traffic situations and road works sites);
- traffic surveillance by registering all information on a database to be used as the basis for statistical analysis on traffic flow and on road paving stress;
- direct road surveillance in real time using video-cameras

“Figure 6 - Variable messages panels located along the infrastructure”

The peripherals are also equipped with “smart” local units which allow activation of the three functions even without direct intervention from the operator: for example if the sensors spot a flow anomaly (slow down or halt).
The variable messages panels, compliant with prEN 12966-1 regulations, are characterised by alphanumerical panels to display text and by graphical panels to display pictograms.
On top of spotting unusual slowdowns, sensors are able to count passing vehicles and determine their speed and dimensions. Should the sensors notice heavy traffic, a queue or a traffic standstill, dedicated software will generate an alarm signal at the Control Centre and subsequently activate the video-cameras so that the operator can assess the real situation and send the most appropriate messages to the panels along the route and at entries to the system.
About twenty dynamic message signs have been located along the road and almost thirty at the entry points of the S.G.C. Fi-Pi-Li.
The presence of a call centre and a traffic operation centre has enabled a protocol to be stipulated with the police and all public institutions involved,, to manage emergencies,

generated by queues close to road works, which is based on alarm thresholds and intervention codes. Alarm thresholds are related to the condition of traffic and to the possibility of supervising the situation by video-cameras positioned on the rotating panels. Alternative routes (and relative procedure for use and control) have been defined with the collaboration of all local public institutions involved.
Overall, the system, although unable to increase receptive capacity of the infrastructure during rehabilitation work, has limited inconvenience to motorists by, on the one hand giving priority to speedy intervention in cases of accident and on the other, to a smooth flow of information for motorists, authorities and the institutions in charge of road safety control.
The effort to base the contractual relationships with the subject offering the required services on a performance basis has been able to involve the management of global service provider not simply in executing according to the predefined procedures but rather in aiming to get closer to the agreed objectives.