



## CONTEXT SENSITIVE SOLUTIONS IN ROAD DESIGN – CASE OF VIETRI SUL MARE INTERSECTION

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**Abstract.** Context Sensitive Solutions (CSS) is an approach to transportation decision-making and design that takes into consideration the needs of the community as well as the sensitivity of the area for which the infrastructure proposal has been planned. Successful CSS is the result of a collaborative, multidisciplinary approach to transportation planning and project development. A model is presented in order to support the CSS planning approach, it is a hierarchy model that aims to improve the plan performance by means of a series of evaluation criteria and attributes classified under 2 categories: technical and environmental macro-criteria. The model was applied to a case study developed regarding the improvement of an intersection situated in the South of Italy. The alternatives developed by planners with the support of stakeholders were assessed according to the synthetic index performance and subsequently it was processed through the proposed model. The application of the model allowed the selection of the best solution for a sensitive area and the results confirm the suitability of both the model developed and the procedure performed. It is a useful tool to support CSS and by means of which to overcome the operational difficulties that emerge from the interaction carried out between the planning and evaluation activities.

**Keywords:** context sensitive solutions (CSS), transportation planning, roads design aesthetic and visual quality.

### 1. Introduction and objectives

Context sensitive design (CSD) has been described as being among the most significant concepts to emerge in highway project planning, design and construction in recent years (Jones 2004; NCHRP 2002).

It is fundamental in transportation project to assess community acceptance according to purpose and need with project features equally relating to safety, mobility as well as the preservation of scenic, aesthetic, historical and environmental resources. It involves policy judgments in the balancing of competing interests (Beukes *et al.* 2011). The concept has also been described using alternative terminology: “flexibility in design,” “place-sensitive design” and most recently, “context-sensitive solutions” (CSS). Today’s state of practice in highway planning, design and operations reflect an appreciation of the importance of context and the demand in order to find appropriate solutions for the local environment. CSS consists of a collaborative, interdisciplinary approach in which citizens become part of the design team according to Stamatiadis (2006) and Ewing (2002).

CSS within the transportation planning or project development process identifies objectives, issues and concerns based on interlocutor and community input at

each stage of the planning process. The application of this approach at the initial design phase is fundamental for the evaluation of foreseeable impacts of both a positive and a negative nature (Vieira *et al.* 2011).

The final result of the CSS approach should be a better understanding of the links between our society, our natural environment and the sustainable use of our resources.

This paper presents a model aimed at supporting this activity as regards the achievement of acceptance and so as to help the planners consider the need of the community whilst preparing the technical proposal. The model was built based on the concepts of the general context in order to identify a potential key strategy for the design proposal within sensitive areas and subsequently balancing interaction between technical choices, aesthetical and environmental values.

In order to obtain this balance, it has been necessary to reach the following objectives:

- community acceptance;
- environmental compatibility;
- engineering and technical functionality;
- financial feasibility;
- timely delivery.

The application of model to the plan relating to the Vietri sul Mare intersection has been an opportunity to develop a possible integration strategy between road design and a context sensitive approach in order to identify how a road proposal may be integrated at best with the environmental context and how to overcome the operational difficulties that emerge from the Environmental Impact Analysis (EIA) study or landscape assessment process.

In order to successfully integrate a road proposal into its environment, a number of factors needs to taken in account and they must be summarized as the following general fields:

- environmental aspects;
- visual/landscape aspects;
- ecological aspects;
- cultural aspects;
- community-related aspects;
- interpretative aspects;
- aspects relating to safety/mobility;
- economic aspects.

The strategy was prepared with the aid of the Public Administration and a multidisciplinary team in order to identify all possible critical elements which provide the direction and guidance regarding the project’s management and design.

The particularity of the area made it necessary to characterize the main citizen associations towards which select a series of evaluation criteria focused and in order to harmonize the entire decisional process. The interaction



Fig. 1. The intersection subject of the study

between planners, public administration and stakeholders has been conclusive in the composition of the model’s elements and in their relative application, since this represents the strategy needed in order to obtain the balance from different points of view.

**2. Context sensitive solution approach – the case of the Vietri Sul Mare intersection**

The Vietri Sul Mare intersection is the first exit of the Naples – Salerno highway heading towards the Amalfi coast that is also a UNESCO world heritage site. As shown in Fig. 1, this intersection is characterized by two meeting lanes for turning left and by the presence of the highway S.S.18 Salerno – Cava dei Tirreni and the S.S. 163 Amalfi State Highways. This intersection is very complex due

Table 1. Points of conflict

Secondary flows	Secondary flows											Primary flows		Number points of conflict for turn	Number points of conflict primary flows	Number of total points of conflict		
	Vietri S. M. to Salerno	Vietri S. M. to Cava D. T.	Vietri S. M. to Napoli	Napoli to Vietri S. M.	Napoli to Salerno	Napoli to Cava D. T.	Salerno to Napoli	Salerno to Vietri S. M.	Cava D. T. to Vietri S. M.	Cava D. T. to Napoli	Cava D. T. to Salerno	Salerno to Cava D. T.						
Vietri S. M. to Salerno				•	•	•	•			•	•		5	1	6			
Vietri S. M. to Cava D. T.									•		•	•	2	2	4			
Vietri S. M. to Napoli							•			•			2		2			
Napoli to Vietri S. M.	•	•					•	•		•			5		5			
Napoli to Salerno	•										•		1	1	2			
Napoli to Cava D. T.	•	•					•	•			•	•	4	2	6			
Salerno to Napoli	•			•		•			•	•			4	1	5			
Salerno to Vietri S. M.		•		•		•			•	•	•		5	1	6			
Cava D. T. to Vietri S. M.				•									2		2			
Cava D. T. to Napoli	•	•	•	•									5		5			
													<b>Total</b>	6	2	35	8	43

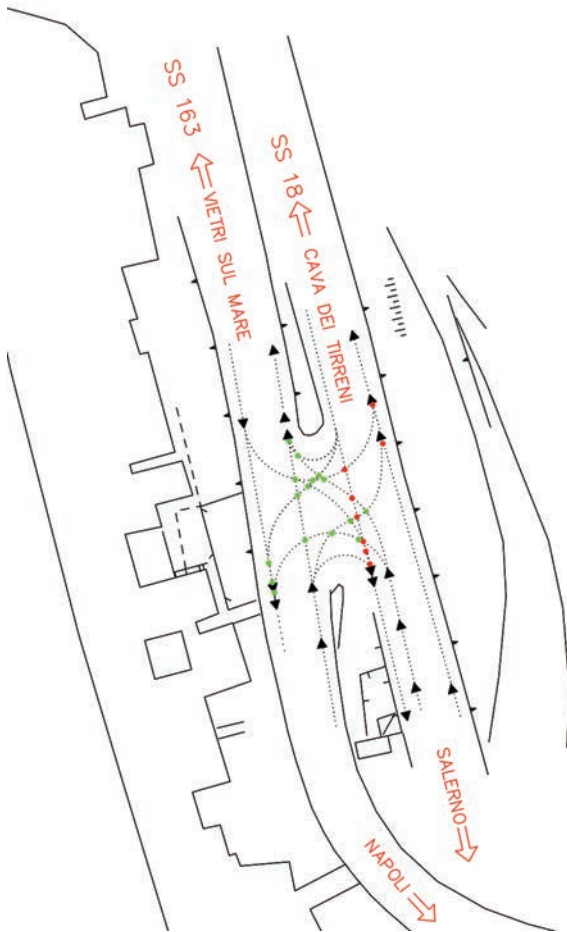


Fig. 2. Manoeuvres and points of conflict

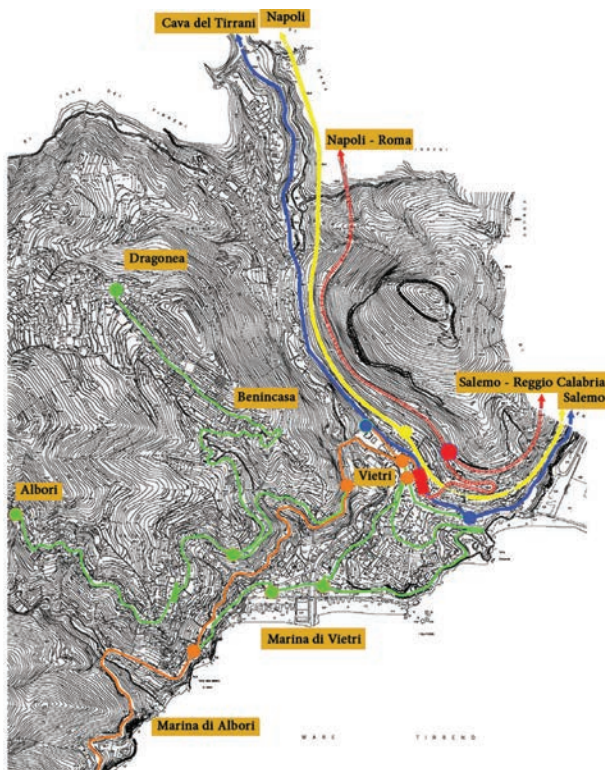


Fig. 3. Location

to the particular geometry and orography of its territory causing unavoidable problems for mobility and safety especially during the summer period with an average traffic flow in each direction of 660 vph. In this study pedestrians and bicyclists are not considered.

In order to study a possible solution, it has been necessary to calculate the traffic flow in each direction and to reconstruct it in function of the different manoeuvres at the points of conflict as shown in Table 1 and Fig. 2. The authors have evaluated also the trajectories according to Dragčević *et al.* (2008).

The analysis was carried out by a traffic counter used at different times of the day and it also calculated the lengths of the queues as well as the level of service.

Some photos and schemes of the manoeuvres were selected in order to understand the problems and explain them to stakeholders as shown in Fig. 2, the green point represents the conflicts between the secondary flows while the red one represents those between the primary flows from Cava dei Tirreni to Salerno and back.

In order to improve the intersection, it is necessary to make adjustments to both the mobility and economical system of the entire coastal area as this is a fundamental gate.

The accessibility just as the functionality of the road system of the entire coastal area is subordinated to the correct functioning of the intersection in question, by in fact optimizing the manoeuvres, travelling time towards the more internal areas is also reduced or rather, essential requirements for the re-launching of the local economy are created. The central position of the intersection as shown in Fig. 3, or rather its strategic position with respect to the road system (red box), also considering the presence of only one railroad station for the entire Amalfi area which is highlighted in Fig. 3 where the Naples-Salerno railway in yellow, the Naples-Salerno highway is shown in red, the S.S. 18 state highway connecting Salerno and Cava dei Tirreni in blue, the S.S. 163 State access road to the Amalfi coast in orange and the local viability in green.

The intersection improvement project and therefore the different alternatives were developed by planners who had to take into consideration the followings aspects:

- safety – concerns various elements of road design such as: min lane width, speed limit, min clearance, sidewalk width and road offset according to the study of Vorobjovas and Žilionienė (2008);
- mobility – concerns vehicular traffic flow conditions as well as the support needed by drivers, pedestrians and bicycles during all maneuvers regarding safety in order to reduce accidents and their seriousness;
- environment – concerns the different contributions to road design in the context in terms of air and noise pollution. Well-designed intersections and adequate markings will enhance driving experience and generally tend to reduce noise pollution;
- aesthetics – concern elements needed in order to safeguard or the compensation measures required

so as to guarantee a high aesthetic quality especially in particularly important sites;

- economics – regards the total economical effort made in order to sustain the road construction and maintenance. Often funding is not sufficient for its realization taking into consideration the consequent difficulties for the planners, contractors and the citizens that negatively judge this as these expenses have come from public resources.

As a result of these considerations, the planners developed a series of alternatives in order to improve the safety and mobility of the intersection and these were initially introduced to the local citizens by the public administration by means of posters sessions in local offices and in order to comply with the needs of the community a CSS approach was carried out. The authors did not take part in the design phase but they had access to the design documents as well as to a comprehensive series of other documents related to the project specifications however they encouraged the public administration for its application.

Generally the consultation activity as shown by El-Gohary *et al.* (2006) is an important part of a CSS study and in order to achieve acceptance and to simulate the entire decisional process, the authors proposed an interactive consultation of two stratified samples consisting of thirty people each.

The first sample was composed of people who were not experts in any particular field yet who had a high level of education, the second group was composed of experts in various fields such as: civil engineering, landscape and context design, economical, environmental and construction managers as well as different stakeholders.

The stakeholders' choice was made with the objective of harmonizing the implementation process as much as possible. With the aim of reducing the time needed to obtain authorization for the carrying out of the works.

Italian law foresees recourse to a collegial meeting called a service conference between the proposing party and the several public and private authorities interested in the works such as: the Regional Board, the road governing authority, the waterworks and gas governing authorities, the Cultural Heritage Department etc. This meeting represents an important activity in order to harmonize the project and acquisition consensus on it. All managers of the several authorities interested in the realization of the intervention and the managers of the numerous citizen trade associations were identified as stakeholders in the implementation of the process and these were legally authorized to take part in the service conference and these were invited to take part directly by giving them a great deal of notice.

A key component of the approach is that citizens play an active role in the planning, design, and construction phases of the intersection process. The proposed approach included extensive and continuous dialogue with the stakeholders as well as in-depth technical analysis of alternative improvement strategies, known as planning concepts.

In particular, two surveys were developed and the initial phase was carried out in order to identify the general plan and existing conditions. In this phase an analysis of the set alternatives developed by the planners was carried out and the following tasks were considered in order to take any comments into consideration:

- the study of existing and future conditions in order to identify existing and future deficiencies;
- the identification of intersection improvement opportunities;
- the analysis of economical and environmental links;
- the analysis of alternative solutions defined by planners and the stimulation of new alternatives;
- the development of the model costs for any alternatives;
- the assessment of alternative design concepts for the implementation of the preferred solution;
- the identification of the assessment process and the selection of alternative solutions.

These tasks are very important and they must be inserted as a basis for the decisional process in order to improve the responsibility and the sharing of the project by the citizens involved.

The area studied is very particular due to the presence of different environmental emergencies and it is controlled by a specific government agency called S.B.A.A.S. the activity of which includes also the verification of the plan regarding the area's context and scenic beauty. However, the limits of the funding available are often incompatible with project adaptation needs required by S.B.A.A.S. and therefore it is of fundamental importance to make both the superintendence and the community aware that it is not always possible to carry out every request made. In fact it is often found that the contrast is so strong that the planning and construction procedures are consequently suspended.

In order to overcome this difficulty, the authors proposed the calculation of the synthetic index  $I_p$  (Index of Pleasure) in the second phase of the first survey; this considers the environmental suitability and the scenic beauty compared to economical limits. By using this index, it has been possible to select the alternatives and then to develop them in further detail.

Each sample of stakeholders involved in the process was subdivided into different sub-groups according to Discetti and Lamberti (2007; 2009a; 2009b) and a focus group was created in order to explain the importance of the index.

Based on the different project alternatives developed by the planners and presented to the stakeholders involved during poster sessions, for each of these, 5 photos were chosen illustrating the environmental insertion of each alternative into the context as well as the relative improvement brought to the intersection together with renderings as shown in Fig. 4.

A detailed photo program was elaborated in order to consider the landscape and visual features of the entire area, or rather of the intersection. Numerous photos were

taken from certain points of view considering therefore the insertion of the works in that particular setting, both directly from the road and depending on the different route directions.

Due to the fact that the specialists are dealing with a one-off structure, the planned program did not foresee the subdivision of the interested area into macro-zones, the perspective view of which should have been evaluated or rather, several photos should have been taken along a specific route of the road axis; instead the identification of the main panoramic points and those relating to visual perception were carried out in order to produce different alternatives. The objective was that of choosing an adequate number of photos to submit to the several stakeholders involved by eliminating therefore the possible subjectivity that the photographer had whilst taking the photos.

A focus group was created by submitting the photos taken to the several stakeholders involved, according to the alternatives proposed together with the relative renderings; they chose 5 photos of which they had to assess the visual quality. The authors were inspired by the S.B.E method (Scenic Beauty Estimation) studied by Daniel, Boster *et al.* (1976) that however had certain applicative differences. Once the photos had been selected, an anonymous questionnaire was given to the stakeholders avoiding that their decision relating to the visual quality and seriousness of the impacts was influenced.

A questionnaire was completed anonymously and an opinion was requested for each photo.

In particular, a synthetic index composed of two sub-indexes was calculated. The index  $I_s$  a measure of satisfaction and a scale of judgment was proposed: 1 (no satisfaction) and 5 (total satisfaction). The index  $I_i$  represents a measure of the level of environmental impact. Also in this case a scale of judgment was proposed: 1 (low impact) and 3 (high impact). For each photo the average and the variance of judgment was calculated assuming the average value as the index of pleasure.

These two indexes were combined and compared to the model of cost for each alternative. In this way it was

possible to edit a classification and to select alternatives for the following evaluation model.

$$I_p = \frac{(I_s + I_i)}{\text{Model Cost}} \quad (1)$$

The model cost developed for all alternatives referred to the total economical effort: project, acquisition area, construction and maintenance and it was compared to the max limit of funding (€ 3.5 Ml). The model cost of the alternatives that were greater than such limit was eliminated. The final score for the 4 alternatives developed by the planners in relation to  $I_p$  is shown in Table 2.

This approach is one way of balancing conflicting project goals with environmental and economical aspects.

In the second survey, the methodology used for the construction of the estimation model in compliance with Italian law provisions was illustrated. In fact, with the purpose of obtaining construction authorization, it was necessary to conduct an EIA study. This is an evaluation of foreseeable positive and negative impacts. It is intended to help reveal mitigating measures as well as alternatives so as to optimize positive impacts while reducing or limiting negative ones. The end result of the EIA process should be a better understanding of the links between our society, natural environment and the sustainable use of our endowed resources.

For this reason, in this study the authors proposed a hierarchic model the weights of which have been determined by availing the same, previously described samples. Each sample consisted of 30 people, for the convenience of data management and based on successful past experience

**Table 2.** Performance of each alternatives compare to  $I_p$  index

Alternatives	$I_p$	$I_s$	$I_i$	Cost, Ml€
A. 1	2.90	3.0	2.0	1.73
A. 2	2.66	2.7	2.3	1.95
A. 3	3.30	1.7	2.1	1.15
A. 4	2.48	1.1	1.0	0.85



**Fig. 4.** The area and alternative photogram

(Discetti, Lambert 2009a; 2009b), these were subdivided into 5 groups of 6 people each. Each group was characterized by the presence of 2 experts in various technical disciplines: engineering, environmental science, economics etc. This formula was communicated to the stakeholders without being influenced at all; each group freely chose its experts.

This operation was fundamental in order to stimulate and put the interested sample into action. In this way they felt an integrated part of the plan.

The objective of this survey was the identification of key weight criteria as well as model decision-making factors and their relative importance. In fact, a questionnaire was prepared and different activities such as focus group discussions and interactive meetings were conducted during the study.

The Saaty scale for pair-wise comparison was the method used by the authors. The results of the questionnaire were analyzed in terms of average and variance results and the results that were more than three times the variance value were eliminated.

The rating was performed in 2 phases. In the 1<sup>st</sup> phase, all experts and non-experts completed the questionnaire. In the 2<sup>nd</sup> phase, the same questionnaire was submitted again but only to the people whose answers were outside the confidential interval (average ± variance) calculated with reference to the panel of experts. A confidential interval of the answers was shown to the people interviewed and they were asked to answer the questionnaire again. Following the conclusion of the second phase, a new confidence interval was calculated and answers outside the interval were removed. These values were removed by new confidential interval, because after the 2<sup>nd</sup> phase, the 85% of the answers were inside the average ± variance. Substantially, the contribution of experts has conditioned the sample interviewed.

The analysis also calculated the evaluation of errors in weight judgment using the Saaty Eigenvector scaling method (1980).

### 3. Model

A model to support the CSS study in the road plan was presented referring to a hierarchy model that aimed to improve the intersection performance via a series of 8 evaluation criteria and 19 attributes under 2 macro-criteria of a technical and environmental nature as shown in Table 3.

The model was created according to the general Italian law provisions and basic CSS principles.

The hierarchic framework has 3 levels under the general objective and initially this was larger including other sub-levels and further sub-criteria, then during meetings where the principles were illustrated, according to which we intended to construct the model, some of the sub-levels and sub-criteria were eliminated both due to problems of redundancy and to facilitate data management.

Therefore the authors proposed the model shown in Table 3 with a simple, easy-to-manage framework.

The model used to evaluate the best alternative is a hierarchical system which subdivides larger impacts of the project into smaller elements called sub-criteria and indicators. The indicators are very important as they must be:

- manageable;
- independent;
- measurable.

They are qualitative and/or quantitative, but it is necessary that they are representative of the performance level measurement of the road proposal compared to the sub and model criteria.

The indicators employed in the model were selected on the base of stakeholder's preferences according to technical needed. In particular the technical criteria were selected to represent the social and economical impacts as because there aren't other roads around, as because an improvement of the intersection gives opportunity to the

**Table 3.** Check indicator symbols

Goal	Cri- teria	Sub- criteria	Attributes	Indi- cator	Value, min–max		
Select the best alternative	Environmental	Air	Sensitivity to harmful dust and gas	$N_g$	50.0–98.0		
			Sensitivity to noise	$N_r$	230–325		
		Water		Deep stratum pollution	$I_d$	1.80–4.00	
				Physical interference with deep stratum	$G_f$	0.0–0.8	
				Superficial water pollution	$R_e$	12.0–22.0	
				Physical interference with superficial waters	$N_i$	3.0–7.0	
				Consumption of materials and entropic impact on areas	$V$	0.04–0.08	
		Soil		Noise and vibrations	$I_v$	40.0–52.0	
				Land erosion	$E_r$	0.00–95.0	
				Landslides and landslide risks	$F_r$	1.30–1.85	
		Natural resource		Flora and biodiversity	$L_e$	0.00–0.20	
				Fauna	$L_f$	6.50–7.20	
		Aesthetic		Environmental value of the area	$L_v$	0.70–0.85	
				Level of environmental impact	$I_i$	1.00–2.3	
		Technical		Level of satisfaction	$I_s$	1.10–3.00	
				Safety	Drivers' safety	$N_a$	11.0–31.0
				Mobility	Local net connection	$C_n$	0.55–0.95
					Level of comfort while travelling	$D_h$	2.18–4.2
				Time of travel	Travelling time	$T_p$	4.0–15.0

citizens the area to increase their activity and their travelling time.

This model was also developed, with the objective of achieving acceptance as well as stimulating the entire decisional process, in fact, an interactive consultation was proposed of 2 stratified samples of 30 people each.

The model supports the planner during the selection of the alternative with the best performance whilst respecting the environmental and technical elements of the project. Each alternative previously selected by means of  $I_p$  was developed in detail, and for each of these, the relative performances were measured by using indicators compared to the criteria and sub-criteria shown in the previously introduced model.

In order to measure the performance of different alternatives, maps were used for both collecting and presenting information. Besides general topographic maps, more information is needed in environmental studies concerning geology, land use, hydrology, road and railroad networks, vegetation, agriculture, etc. Consequently the use of specific maps called thematic maps are of particular interest for the evaluation of interferences relating to the project. Thematic maps are in a conventional form or in the form of Geographical Information System (GIS).

In this work different maps were used referring to:

- geology;
- ecological sites;
- vegetation;
- historical sites;
- water;

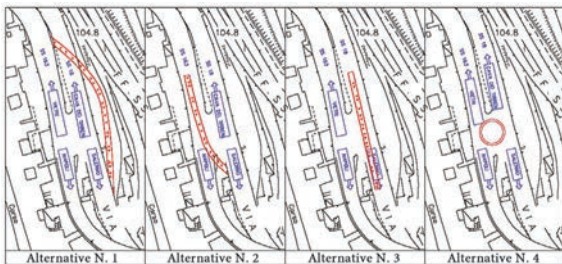


Fig. 5. Alternative schemes

Table 4. Criteria and sub-criteria weights

Criteria	Weights		Sub-criteria	Weights	
	Local	Global		Local	Global
Environmental	0.61		Air	0.15	0.097
			Water	0.20	0.116
			Soil	0.20	0.116
			Natural resources	0.25	0.150
			Aesthetic aspects	0.20	0.120
Technical	0.39		Safety	0.550	0.175
			Mobility	0.240	0.77
			Travelling time	0.210	0.060

- settlements;
- severity.

Others maps were specially constructed in order to identify the feasibility of the alternative, in particular each area of the territory was subdivided in areas of 200×200 m in which some details were homogeneous such as: soil, drainage, vegetation etc. For some model indicators a specific map was elaborated or alternatively, the actual value was calculated as in the case of indicator Ng. It represents the number of citizens affected by harmful dust and gas. Its value was calculated as the number of equivalent citizens compared to the surface of a standard building measuring 40.0 m<sup>2</sup> with an offset from the ramp or road axes measuring 150 m and 200 m and used for urban purposes (housing, hospitals, industries etc.). The data collected for each alternative were processed by the mode. The performance of each alternative was calculated compared any single contribution to the criteria and sub-criteria. The model was applied to the alternatives illustrated in Table 2 and shown in Fig. 5. The 1<sup>st</sup> (A. 1), 2<sup>nd</sup> (A. 2) and 3<sup>rd</sup> (A. 3) alternatives as shown in Fig. 5 illustrate tunnels with similar features (length: ~130 m – section 5.5 m including sidewalk) to overcome the problem of turning left, the 4<sup>th</sup> (A. 4) alternative illustrates a roundabout but, this alternative doesn't reduce the congestion problem in the intersection.

All alternatives were analyzed by the previously mentioned model, the weights of which were determined by involving the stakeholders in the decisional process. Table 1 shows, the local and global weights of only the criteria and sub-criteria based on the Analytic Hierarchy Process (A.H.P.) (Saaty 1980) while, in Table 4 the final classification is shown calculated in comparison with the interviewed people's system of preferences.

The A.H.P. is a useful method in multi-criteria decision making problem. It is structured hierarchically as criteria and alternatives and proposed to determine the priority weights of alternative which are called global weights. From a pair-wise comparison matrix for criteria, the referenced priority weights are obtained by eigenvector method. In the same way from a pair-wise comparison matrix for alternatives under each criterion, the local weights for the criterion are obtained. The elements of two types of comparison matrices are relative measurements given by a decision maker.

The best alternative: A. 1 → A. 2 → A. 4 → A. 3.

A. 3 shows a discrete level of pleasure as previously illustrated due to low construction costs, however, it is at the bottom of the classification shown, most probably because of the low value of its technical indicators, in fact, due to its particular shape, this solution does not solve the conflict between the traffic flows; it also has a negative effect on the level of comfort and travelling time. The best solution was A. 1, but in reality the hybrid solution consisting of A. 1 and A. 2 as shown in Fig. 6 produced the best results. It is the preferred solution but its cost is not compatible with the financial budgets (3.5 Ml €).

However this solution (A. 1 + A. 2) that considers two tunnels to resolve the conflict between the main traffic flows towards Cava dei Tirreni to Salerno and the two lanes for turning left, it presents also, different problems with the viaduct foundation of the Naples-Salerno highway.

Finally, a sensitivity analysis of weight factors was developed varying the macro-criteria weight values, the objective was the simulation of all possible scenarios that could then be presented to the decision-maker as represented in the Table 5.

In particular, as shown in Table 5, 3 scenarios were considered.

Scenario No. 1 – Rational Decision Maker – attributes the same importance to evaluation macro-criteria.

Scenario No. 2 – Environmentalist – Decision Maker – attributes greater preference to environmental policy compared to the technical one;

Scenario No. 3 – Technical Decision Maker – attributes greater preference to technical macro-criteria compared to the environmental.

The sensitivity analysis confirms the feasibility of the model, in fact by simulating the system expressing preferences this has, on one hand, allowed the determination of the new order of alternatives, on the other, the identification of the variability of the fields of judgment. Apart from this a sturdiness analysis was also performed.

The sturdiness was calculated by varying the macro-criteria weights individually by leaving the proportion between them unaltered and identifying in this way the range of values inside which the result variations are not recorded.

The results confirm the feasibility of the model and the criteria weights; in fact, A. 1 is the best as regards the variability of environmental weight ranging from 0.0% to 57.9%, while as for technical weights it ranges from 23.0% to 100%.

#### 4. Conclusions

A hierarchy model was presented to overcome the operational difficulties emerging from the interaction between planning and estimation activities. A group of experts in different disciplines and all stakeholders interested in the project were involved in order to estimate the degree of pleasure relating to the different alternatives proposed, by means of a synthetic index measuring the level of conflict between the project goals and its environmental and economical aspects.

In the 1<sup>st</sup> step of alternatives analysis is very important to use the photograms and renderings of each alternative, in order to carry out an evaluation of their visual quality and to discuss the positive and negative impact. The  $I_p$  index is extremely simple and intuitive, in fact, the  $I_p$  has made it possible to illustrate the alternatives and at the same time to estimate the following level of acceptance A. 4, A. 3 A. 1 and A. 2. However, this ranking expresses a judgment of visual quality of each alternative compare to costs and if the values are examines:  $I_i$  and  $I_c$  individually, it seen between them a compensation so, the cost value empowering the final choice.

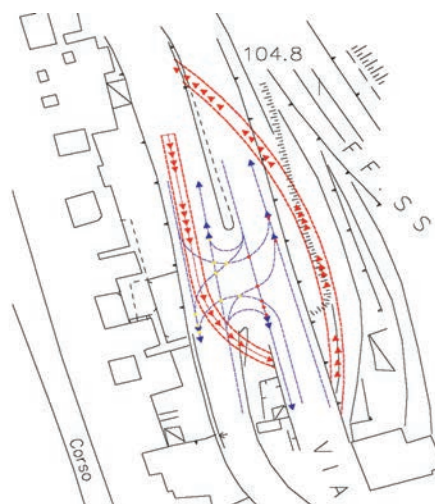


Fig. 6. Hybrid alternative

Table 5. Final performance of each alternative compare to different decision maker scenarios

Possible scenario	Decision-makers	Criteria weight, %		Final order
		Environment	Technical	
Scenario No. 1	Rational	50	50	A. 1 → A. 2 → A. 4 → A. 3
Scenario No. 2	Environmental	70	30	A. 1 → A. 2 → A. 3 → A. 4
Scenario No. 3	Technical	30	70	A. 1 → A. 4 → A. 2 → A. 3

This concept is very important, in fact during the study the cost of each alternative and the limit of the funding was presented after that the people involved have assigned the score to  $I_i$  and  $I_s$ , consequently the 75% of sample wanted to reassign the ratings. Probably, they have tried to balance the interaction between the project goals with environmental and economical aspects.

Therefore, it was of paramount importance the identification of a non-excessive number of photograms to be submitted to the sample of stakeholders.

At the same time, a hierarchic model was built in order to transpose the level of preference expressed by the stakeholders and to estimate the performance of each alternative compared to the evaluation criteria generally used in the EIA study.

In the construction of model, it was also necessary to explain the importance of the participation in the decision-making process intended as a contribution made to an integrated planning scheme capable of understanding community needs and therefore an aggressive criticism of the project alternatives was not requested. For this reason, each decision-making group was asked to nominate private experts who had carried out a strategic function within the project communication phase, the study of the alternatives and the attribution of weights to the different criteria. This procedure has allowed reducing the distance



between the general opinion of people and stakeholders and the technical aspects. Substantially in the discussion it was possible to create a positive relationship with stakeholders and to introduce same criteria that have given them the opportunity to check the alternatives performance.

In conclusion the consultation activity is fundamental to achieving consensus determinations and in simulating the whole decision making process based upon the preferences of the stakeholders and the local community in terms of consequent benefits:

- public acceptance, trust and support;
- positive relationships with stakeholders;
- create partners rather than opponents;
- timely decisions;
- improved project process;
- decisions that last.

The model is presented in order to support the CSS planning approach, it is a hierarchy model that aims to improve the plan performance by means of a series of evaluation criteria and attributes classified under two categories: technical and environmental macro-criteria. The model was applied to a case study developed regarding the improvement of an intersection situated in the South of Italy.

A. 1, A. 2, A. 3 and A. 4 alternatives were developed in order to optimize the intersection according to the limit of founding and each of them was evaluated by the criteria and macro-criteria models. The application of the model allowed the selection of the best solution for a sensitive area. The final ranking A. 1 → A. 2 → A. 4 → A. 3 was calculated and this result was accepted as it represents the best combination between needs and performance compare to the costs.

The application model and the procedure performed in order to assess community need via criteria weights represented a key strategy in order to support the planners and the governments during the planning phase and whilst achieving acceptance when public funding is used.

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### References

- Beukes, E. A.; Vanderschuren, M. J. W. A.; Zuidgeest, M. H. P. 2011. Context Sensitive Multimodal Road Planning: a Case Study in Cape Town, South Africa, *Journal of Transport Geography* 19(3): 452–460. <http://dx.doi.org/10.1016/j.jtrangeo.2010.08.014>.
- Daniel, C.; Boster, R. 1976. *Measuring Landscape and Aesthetics: the Scenic Beauty Estimation Method*. Research paper RM-167. USDA Forest Service Research – U.S. Dept of Agriculture.
- Discetti, P.; Lamberti, R. 2009a. Value Engineering for Context Sensitive Solutions, *Transportation Research Board 88<sup>th</sup> Annual Meeting*.
- Discetti, P.; Lamberti, R. 2009b. Context sensitive solutions in Practical Design, *Transportation Research Board 89<sup>th</sup> Annual Meeting*.
- Discetti, P.; Lamberti, R. 2007. I metodi di supporto alla valutazione di impatto ambientale, *Strade ed autostrade* 4/2007.
- Dragčević, V.; Korlaet, Z.; Stančerič, I. 2008. Methods for Setting Movement Trajectories, *The Baltic Journal Bridge Engineering* 3(2): 57–64. <http://dx.doi.org/10.3846/1822-427X.2008.3.57-64>.
- El-Gohary, N.; Osman, H.; El-Diraby, T. E. 2006. Stakeholder Management for Public Private Partnership, *International Journal of Project Management* 24(7): 594–604. <http://dx.doi.org/10.1016/j.ijproman.2006.07.009>.
- Ewing, R. 2002. Impediments to Context-Sensitive Main Street Design, *Transportation Quarterly* 56(4): 51–64.
- Jones, R. 2004. Context Sensitive Design: Will the Vision Overcome Liability Concerns?, *Transportation Research Record* 1890: 5–15. <http://dx.doi.org/10.3141/1890-02>.
- NCHRP. 2002. *A Guide to Best Practices for Achieving Context Sensitive Solution*. NCHRP Report 480 TRB, National Research Council.
- Stamatiadis, N. 2006. Context-Sensitive Design Around the Country, *Transportation Research E-Circular*. 2006.
- Saaty, T. L. 1980. *The Analytic Hierarchy Process*, McGraw-Hill, New York.
- Vieira, V.; Tedesco, P.; Salgado, A. C. 2011. Designing Context-sensitive Systems: an Integrated Approach, *Expert Systems with Applications* 38(2): 1119–1138. <http://dx.doi.org/10.1016/j.eswa.2010.05.006>.
- Vorobjovas, V.; Žilionienė, D. 2008. Evaluation of Shoulders Functions on Lithuanian Regional Roads, *The Baltic Journal of Road and Bridge Engineering* 3(4): 213–218. <http://dx.doi.org/10.3846/1822-427X.2008.3.213-218>.

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