

CRITERIA ELABORATION TO CONSIDER INDIVIDUAL ACCEPTANCE OF THE VARIABLE ROAD SIGNS

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Abstract

The purpose of this paper is to apply a step construction where it is possible to work out a whole of criteria, which would consider individual acceptance of a driver with regard to road signs. This step is based on multicriterion aspects within the framework of a decision-making aid. This methodology will initially establish all the ideas and try all to clarify in order to emphasize the maximum of information. It will try in the second time to consolidate them in order to be able to justify the decisions that will be taken.

Keywords: Multicriterion decision aid, cognitive criteria, automobile driving, safety roads, road signs

1 Introduction

This research fits within the safety road framework and more particularly in the system design of variable road signs for the driver in potentially dangerous situations. It has the ambition to inform better them in giving a better legibility and foreseeability of the state of the roads and difficulties that result from it. It more precisely aims at conceiving a judgement method intended to assess such systems by taking into account the legal insurance, individual driver, social driver and economic manager point of view. The multicriterion disposition of this problem comes from what is acceptable according to a point of view it is not inevitably according to another. However it is not possible to separate the judgements. Then it appears necessary to structure this community of acceptabilities. The MMCADⁱ Methodology (Roy 1985, Roy et al. 1993, Vincke 1993, Mousseau et al. 2000) integrates these problems in a context of decision-making, in order to design aid. The source of this methodology remains in the judgement depth of each decision considered. The best decision is entirely justified. We initially will expose the fundamental concepts of this methodology, and then, in the second time, we will apply it to the individual driver acceptance. This second phase, thereafter, will be reiterated towards the other acceptances in order to conceive a homogeneous judgement between the various acceptabilities.

2 Fundamental concepts of the MMCAD

This methodology is structured in four levels. The first level, heading “the decision object and the recommendation spirit”, mainly seeks to identify the decision-making

ⁱ Méthodologie MultiCritère d'Aide à la Décision, Bernard Roy, 1985

process and to define the potential actions. The decision-making process aims at directing the decision-making aid by defining the objectives and the results to reach. This last can be a choice, a sorting, an arrangement or a description. A potential action indicates what constitutes the decision object or on what the decision-making aid is related. In practice, this term can be replaced, according to cases, by scenario, program, project, alternative, solution etc. The “action” concept incorporates no feasibility idea or execution possibility of what the action covers. An action is described as potential when it can be executed or simply interest worthy for the decision-making aid. A potential action can be fictitious.

The second level, heading “the consequence Analyzes and the criteria elaboration”, aims at defining the elements by which the decision makers evaluate the potential actions. The decision maker is the intervening one in the decision-making process, which the implemented models seek to clarify. To appreciate the value of the potential actions, several concepts are used. Initially, it is a question of listing the whole of the “elementary consequences”. Those represent effects or attributes which are, on the one hand, correctly identified by its contents so that the various people, included in the decision-making process, understand the significance ; and which are on the other hand, sufficiently perceived to allow a precise description by what they appear concretely after the execution of a solution. In the second time, these elementary consequences are equipped with a scale of values representing the whole of their possible states in order to make them “dimensions”. These last can be abundant and it is not possible any more in this case to have a synthetic vision of the evaluation of the potential actions, which will have been considered. Then it is a question to work out a family of “criteria” which will be built. Formally, a criterion is a function with actual values, which is definite on the whole of the solutions so that it is possible to reason or to describe the result of the comparison of two solutions. This concept must go until a mathematical formalization. These criteria will be equipped with a scale giving an account of their various possible states and apprehend the concepts of uncertainty, inaccuracy and indetermination. The criteria family will have to respect the principles of exhaustiveness, cohesion and not-redundancy.

The third level, heading “the global preference modelling and operational approaches for the aggregation of the performances”, aims to take into account the organization of the criteria between them to decide. Thus, this level also integrates the concepts of indifference and incomparableness, and preferably breaks up the concept into strict preference and weak preference.

And finally the fourth level, heading “investigation procedures and recommendation preparation”, relates to the technical aspects of methodology. The aspects of validity of the results produced by the assistance are also approached. After having exposed the basic concepts concerning the methodology, we will try, in the continuation of the study, to apply the second level to the cognitive aspect of the drivers about his variable road sign individual acceptance.

3 Application of the MMCAD to individual acceptance

3.1 Decision problem

The fundamental question in this decision problem is as follows : how to judge, from a cognitive point of view, the informative technology impact on degraded driving situations ? It acts, according to the first level of the MMCAD, to provide a lighted judgement, without continuing until the selection and the application of a decision. We are within the framework of a “description problem” : it helps to describe the actions and their consequences formalized in order to be able to help the decision maker. The characteristic of the study also relates to the potential actions, which are perfectly identified since the three answers obtained to the invitation to tender of the project. Let us note that the methodology admits that its relevance is reduced if the number of potential actions would be reduced. That reinforces the fact that a description of the actions is then enough to clarify the decision. The small number of solutions and the type of selected problems also come from the particular context of the research project : it is specific to campaign roads, by variable signs on the bottom side way of the roads. Nevertheless, since we will evoke more generally only of the individual acceptability of the road signs in this article, it will not be conceivable to try to evaluate the three offers of the manufacturers. This last task could be carried out when all acceptabilities are treated then gathered. It is a question here of flat putting all the ideas and concepts which the psychologists use and measure. From the point of view of the implementation, we will carry out extractions of expertises by interview techniques (Dunne 1995). These techniques make it possible to carry out faster and more excavated extractions, and give the possibility of the interactivity. Beyond the only extraction, the capitalization of information, their synthesis and the guarantee of completeness must be the main subject.

3.2 Criteria elaboration

Within the framework of the second level of the MMCAD and thanks to the talks, we initially questioned the expert to compare to several important points allowing us to list the whole of the elementary consequences. We questioned it on the cognitive factors which he studied in the context of the automobile driving ; on the impact which could have these factors with respect to the driver ; if there were factors without impacts for the driver and if there were factors which they did not study. We also tried to widen the field of questions by evoking fictitious or unreal situations in order to know if there would not be a factor to study in a completely idealized situation. Indeed, it is necessary to justify and look further into the various concepts with the expert with an aim of raising what is implicit. With this basic list of elementary consequences, we questioned the expert on the way in which the factors were measured and how they appeared at the driver so that it is possible to approach the concepts of scales as well as the various values, which they could take. We could relative extract finally 37 dimensions exposed on the figure 1 of the next page. Each dimension was a binary evaluation, except the age, because it is not possible to evaluate a part of each one.

In the majority of the cases, measurements of these dimensions can be carried out after the event by questionnaires and scales, which concern the subjectivity of the users. In certain cases as the tiredness, the attention, the visibility, the legibility and the taking risk can be measured at first sight, by oculometry, but it is difficult to measure them all at the same time : too many information would be likely to deteriorate the situation of

1	Age	16-100	11	Control of the situation	yes-no	21	Monotony	yes-no	31	Attention rhythm	yes-no
2	Aggressiveness	yes-no	12	Distance from establishment	good-bad	22	Relevance	yes-no	32	Sex	man-woman
3	Ambiguity of the situation	yes-no	13	Distraction	yes-no	23	Pleasure	yes-no	33	Stress	yes-no
4	Anticipation	yes-no	14	Cognitive effort	yes-no	24	Taking risk	yes-no	34	Surrounding traffic	high-weak
5	Anxiety	yes-no	15	Tiredness	yes-no	25	Acquisition of information	yes-no	35	Type of vehicle	Powerful-of base
6	Attention	yes-no	16	Taste of the danger	yes-no	26	Prudence	yes-no	36	Type of the other drivers	favorable-unfavourable
7	Certainty	yes-no	17	Legibility of the message	yes-no	27	Quality of information	good-bad	37	Visibility of the message	yes-no
8	Coherence with environment	yes-no	18	Manage of the situation	yes-no	28	Quantity of information	good-bad			
9	Confidence	yes-no	19	Weather	good-bad	29	Reactivity	yes-no			
10	Constraints legal	yes-no	20	Moment of the day	day-night	30	Compliance with the rules	yes-no			

Fig. 1 : dimension list

driving of the subjects. It acts now, in accordance with the MMCAD, to train an exhaustive family of criteria, which would allow the decision maker to clarify synthetically its point of view. The handling of the 37 dimensions, taken as criteria, is too difficult to manage : the general vision of the problem is still too confused and this list should be simplified. With the expert, we tried to organize various dimensions in the shape of a tree structure in order to categorize them (fig. 2 p. 4). We can find in this tree all dimensions worked out in the previous figure, gathered by category. Initially, a distinction was done between those, which were internal with the driver compared to the external ones.

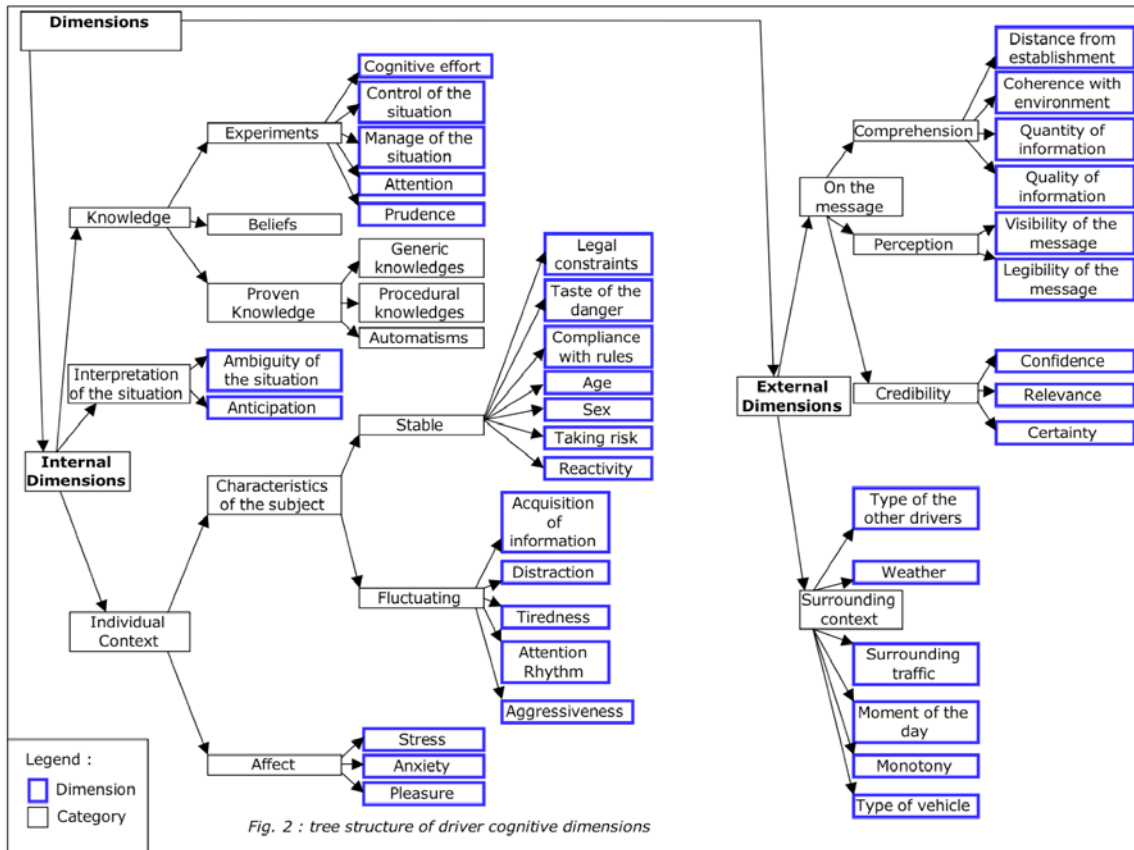


Fig. 2 : tree structure of driver cognitive dimensions

Among external dimensions, it is possible to distinguish 2 categories at the right of figure 2. The first, suitable for the message, gathers dimensions in direct bond with comprehension (the distance from establishment, the coherence, the quantity of information and the quality of information), perception (the visibility and the legibility) and credibility (the confidence, the relevance and the certainty). We noticed in this part of the tree structure, that chronological aspect could follow one another. Indeed, the message starts first of all by being visible, then readable, the quality and the quantity of information which it delivers are good, its distance from establishment is correct, it is coherent in the context of the situation, the driver admits a relevance then a certainty and finally a confidence with respect to this one. When all the stages are reached, the driver is in a situation where it adheres to this indication. The adhesion of the driver to the message can constitute the first criterion. The second category of external dimensions, at the right bottom of figure 2 is specific to the surrounding context. It is composed of the weather, the surrounding traffic, the moment of the day, the monotony, the type of vehicle and the type of the other drivers. By evaluating each one of these dimensions, the ones after the others and in an unspecified order, it is possible to characterize the precisely state of the surrounding context and it can constitute a criterion with whole share.

Concerning the internal factors, at the left of figure 2, we can categorize them in 4 parts. The first part relates to the knowledge sphere with dimensions relating to the experiment, the beliefs and proven knowledge: the effort, the control of the situation, the manage of the situation, the attention, the prudence, the ambiguity and the anticipation. These dimensions present great dispersions inter-individual because of the random diversity of the situations, which the drivers knew and it is impossible to try experiments on the level of knowledge of the drivers. Nevertheless it is possible, according to the expert, to restrict this branch of the tree structure with 3 criteria : the seniority of the driving licence, the number of kilometres per annum and highway types which he borrowed. It remains in this part to seek their various possible values what will make it possible to conform to the MMCAD. The second part relates to the interpretation of the situation. It is composed of 2 dimensions, which are ambiguity and anticipation. With respect to the driver, these dimensions are internal and in difficulty to measure at first sight. It thus seems, for the moment, more opportune not to take account of this branch and to return there in the continuation of the study if needed. The third part includes, on the one hand, the taking risk, the reactivity, the constraints legal, the taste of the danger, the compliance with the rules, the age and the sex which constitute the stable characteristics of the driver ; and in addition, the acquisition of information, the distraction, the tiredness, the attention rhythm and the aggressiveness which constitute his fluctuating characteristics. It is more easily possible in this case, like in the case of external dimensions and more particularly on the surrounding context, to evaluate various dimensions in order to be able to apprehend the criterion showing the characteristics of the concrete subject. The last part of internal dimensions is represented by the stress, the pleasure and the anxiety in driving and evokes the affect of the driver. According to recent studies and in particular according to last ARCOSⁱⁱ

ⁱⁱ ARCOS : projet de recherche, Action de Recherche pour une Conduite Sécurisée

report (Millot et al. 2004), we can find strong bonds of correlation between the stress in driving, the anxiety and the pleasure of driving. It proved that a more anxious person at the wheel is more predisposed with the stress and that this situation is the reverse of a situation of pleasure. The anxiety in the activity of driving thus is conversely correlated with the pleasure of driving and correlated with the stress. In our case and in order to avoid the redundancy of various dimensions, it would be judicious to select the dimension, which is the most measurable to be the criterion. We will thus choose the anxiety in driving like criterion. Finally we succeeded in drawing up a list of 7 criteria which can allow us to better apprehend the decision. The 7 are as follows : the anxiety of the subject in driving, the adhesion of the subject to the message, the context surrounding the subject, the personal characteristics of the subject, the seniority of the driving licence, the number of kilometres per annum and the highway types borrowed. It remains nevertheless to adjust the criteria in order to introduce all the concrete values which they can take and to evoke the concepts of inaccuracy, uncertainty and indetermination.

4 Conclusion

The bibliographical study of the MMCAD made it possible to understand how to convey the demonstration and how to formulate the concepts of criteria in the case of a cognitive acceptability. It was possible, starting from 37 dimensions, to obtain a more synthetic vision of this acceptability so that the decision maker is more enlightened and effective when it has to make the decision. It will be a question thereafter of building a total system of preferences compared to these 7 criteria in order to be able to emphasize a step of judgement. It is the description of a system of preferences, often carried out by means of a digital representation, which leads then to the establishment of a recommendation. This first work will locally be carried out in all the acceptabilities through various expertise extractions. And the final objective will take into account all acceptabilities at the same time.

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