A decision support tool for evaluating mobility projects

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Abstract— Success is a European project that will implement several clean transport offers in three European cities and evaluate the environmental impacts. The goal of these measures is to improve urban mobility or the displacement of residents inside cities. For e.g. park and ride, electric vehicles, hybrid bus and bike sharing etc. A list of 28 criteria and 60 measures has been established for evaluation of these transport projects. The evaluation criteria can be grouped into: Transport, environment, social, economic and fuel consumption.

This article proposes a decision support system based that encapsulates a hybrid approach based on fuzzy logic, multicriteria analysis and belief theory for the evaluation of impacts of urban mobility solutions. A web-based tool called DeSSIA (Decision Support System for Impacts Assessment) has been developed that treats complex data. The tool has several functionalities starting from data integration (import of data), evaluation of projects and finishes by graphical display of results. The tool development is based on the concept of MVC (Model, View, and Controller). The MVC is a conception model adapted to the creation of software's which impose separation between data, their treatment and presentation. Effort is laid on the ergonomic aspects of the application. It has codes compatible with the latest norms (XHTML, CSS) and has been validated by W3C (World Wide Web Consortium). The main ergonomic aspect focuses on the usability of the application, ease of learning and adoption. By the usage of technologies such as AJAX (XML and Java Script asynchrones), the application is more rapid and convivial. The positive points of our approach are that it treats heterogeneous data (qualitative, quantitative) from various information sources (human experts, survey, sensors, model etc.).

Keywords— Decision support tool, hybrid approach, urban mobility.

I. INTRODUCTION

WITH the evolution of urban mobility, traffic engineers, specialists in territory management and local authorities agree on the need for efficient management of urban transport systems to assure good conditions of accessibility without neglecting the environmental constraints. Often the environmental constraints (reduction of local emissions, air pollution or traffic noise) imply the restricted usage of private vehicle which has led to great increase in development of public transport within the financial budget restrictions of the

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agglomerations. It clearly appears that all these transport measures aim the development of urban mobility solutions subject to environmental risks and long term impacts. Therefore, the growing need of decision-aid tools that could perform evaluation of environmental impacts related to measures of urban mobility.

There exist several tools for analysing traffic related to urban mobility [22] or eventually the environmental pollution. In general, these tools produce reports over a period (day, week...) and their diagnostics. They have a single user view for web based tools which are accessible to all users. They rely on historical data stored in the form of files which make these tools less adapted to further processing or dealing with complex user requests. Moreover, these tools have been in general developed for studying a single impact like road traffic or environmental criteria.

The approaches used in the decision aid tools in the domain of environmental management and evaluation of urban mobility can be classified into Life cycle analysis [10], cost-benefit analysis and cost-effectiveness [6] and multicriteria analysis [19]. The quantitative methods for evaluating the impacts often relate to a single aspect like the economy or the transport or the environment [6] [10-12] and rarely study all aspects. There is an evident scarcity of data or even when data exists, is often associated with uncertainties and imprecision.

In this context, we developed an evaluation aid tool based on a new hybrid approach comprising of fuzzy logic, belief theory and multicriteria analysis for evaluating the environmental and socio-economic impacts of urban mobility [16]. The evaluation of a measure is affected by several aspects which render the decision making complex: existence of various criteria more or less pertinent issued from incomplete data, intervention of several information sources with different reliability, the consideration of an expert opinion according to his expertise in the domain etc. The proposed tool is web-oriented [17].

Our work is based on the development of such decision support tool for project SUCCESS (Smaller Urban Communities in Civitas for Environmentally Sustainable Solutions), a pilot project of European program CIVITAS [23]. It involves three cities: La Rochelle-France, Ploiesti-Romania and Preston-UK. The objective is to implement several environment friendly measures of transport in the cities for improving urban mobility (for e.g. bike sharing, hybrid buses, real time information systems etc.) and evaluate their

impacts. Other than just investment planning, the decision makers should also consider evaluate other issues like security of transport systems and especially environment durability.

This article is structured as follows: Section 2 presents the evaluation approach used in DeSSIA. Section 3 presents the development and application of the decision support system DeSSIA. Finally, we present the conclusions and future work in section 4.

II. PROJECT EVALUATION APPROACH

The approach proposed for evaluating the impacts of urban mobility solutions [16] is diverse and heterogeneous in nature. It is based on the combination of multicriteria analysis and artificial intelligence techniques namely fuzzy logic [26] and the belief theory [7]. In fact, fuzzy logic and belief theory have shown their effectiveness is various domains of application [8] and mainly in recognising and analysing data (classification, clustering, identification etc.) but they have been less explored and applied in the domains of environment and transport.

The evaluation of transport projects is carried in three steps (Fig. 1):

1) Classification and selection of pertinent criteria;
2) Tracking the evolution of criteria as they pass through various evaluation phases;
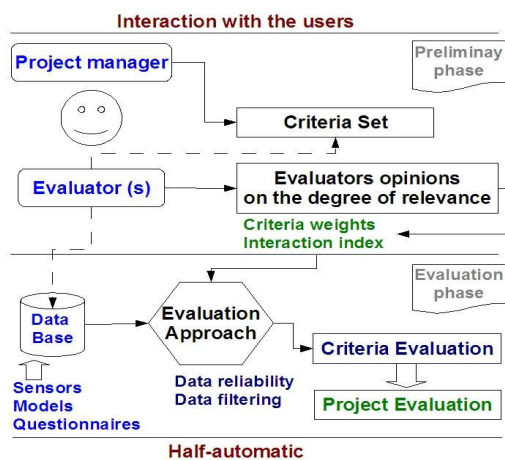3) Conduct the overall or global evaluation of the effectiveness of the project.

Fig. 1 Evaluation approach

These steps are described in detail as follows:

Step 1: Classification and selection of criteria

To measure the impacts of a transport project, the project manager generally has access to a long list of criteria (either imposed like project SUCCESS or obtained from literature). For example, for the category transport, we can describe traffic with the help of several criteria like the speed, degree of congestion, flow rate etc; all of these cannot be evaluated due to lack of time or resources from which arises a need for

having a method of grouping pertinent criteria which will allow the project manager to make a preliminary choice and if required find other criteria which are correlated.

Table 1 presents the list of these criteria proposed in project SUCCESS. The first indicator is the economy. This indicator can be further divided into costs and benefits. The operating costs and revenues will be used for measuring this indicator. These indicators are quantitative in nature and will be obtained from reports.

The second indicator is the energy. This indicator can be represented in terms of energy consumption. Fuel consumption will be used to measure this indicator. This indicator is quantitative in nature.

The third indicator is environment. This indicator can be represented via the sub-indicators Pollution and Noise. The sub-indicator pollution will be measured in terms of Air Quality and Emissions. The sub-indicator air quality and emissions is quantitative in nature and will be measured via models and sensors. The visual pollution indicator is qualitative in nature and will be measured by questionnaire surveys.

TABLE I
INDICATOR USED FOR IMPACT ASSESSMENT

Category	Sub-category	Impact
Economy	Costs	Operating costs
	Benefits	Operating revenues
Energy	Energy Consumption	Fuel consumption
Environment	Pollution, Nuisance	Air Quality
		Emissions
		Noise
Society	Acceptance	Awareness
		Acceptance
	Accessibility	Spatial accessibility
		Acceptance
	Security	Security
	Quality of Service	Service reliability
		Quality of service
	Safety	Transport Safety
Transport	Transport System	Traffic Levels
		Congestion Levels
		Freight Movements
		Modal Splits
		Vehicle Occupancy

The fourth indicator is society. This indicator can be divided into acceptance, accessibility, security, quality of service and safety. The acceptance indicator can be measured in terms of awareness and acceptance. The accessibility indicator can be measured in terms of spatial accessibility and acceptance. The security indicator can be measured in terms of security. The quality of service can be measured in terms of service reliability and quality of service. The safety indicator can be measured in terms of transport safety. All these sub-indicators are qualitative in nature and measured using experts opinions and questionnaire surveys.

The transport indicator is representative of the transport system. This can be measured in terms of congestion levels, traffic levels, freight movements, modal split and vehicle

occupancy. This indicator is quantitative in nature and will be obtained from traffic counts, models and experts opinions.

Step 2: Evolution of criteria

Following the evolution of each criterion will allow the tool user to find out if there is an improvement, degradation or no change. This offers the possibility to decision makers to take adequate measures for improving the city state at the given criteria level.

To do this, we define the complete processes, their structure and model the complex data for each criterion at a common level. This implies:

- Identification of pertinent criteria for measuring the project;
- Collecting criteria data from multiple sources (sensors, surveys, experts etc.);
- Development of a process for data fusion. If several data sources exist, then taking into account the reliability of sources.
- Definition of a performance indicator for evolution of the criteria.
- Observing the variation in the performance indicator that can increase, decrease or report no change with respect to the implemented measure.

Step 3: Evaluation of overall effectiveness of the project

This step conducts performance estimation and evaluation of the global effectiveness of transport projects. This will require:

- Knowledge on criteria weights:

We have proposed a method for estimating criteria weights based on expert judgements [18]. It takes into account the uncertainty or ignorance aspects related to expert opinions;

- Evaluation of interaction between criteria:

The interactions between criteria are difficult to estimate despite the presence of several methods [9]. These methods have been generally applied for the problems of clustering and they seem inapt to us for estimating the interaction between the environmental and socioeconomic criteria. As a result, we have proposed a method that estimates the interactions between criteria using expert knowledge in [19]. Our approach is based on belief theory and expert judgements and takes into account the uncertainty and ignorance aspects [16] [18].

- Definition of a performance indicator for measuring the effectiveness of transport project:

For a global evaluation, an aggregation method is applied. A simple method of aggregation is the method of weighted means [25] based on utility theory. This method takes into account only the degrees of importance of the criteria and combines then according to an additive operator.

The utility function is not necessarily additive, as in our application, since the criteria may be correlated (in synergy or redundant). Hence, for improving the processes of evaluation,

an aggregation method based on Choquet Integral function has been applied in order to take into account the interaction between criteria.

The Choquet integral function is an extension of weighted mean. This aggregation method considers at the same time the criteria weights and their interactions and models in a comprehensible manner the redundancy and complementarity between criteria.

The approach we propose in this section is a hybrid between the belief theory and multicriteria analysis. It takes into account the complex nature of traffic, environmental and socio-economic data. Multiple users (Evaluators, Project managers and citizens) and several information sources (sensors, surveys etc.) are involved in the evaluation processes. The proposed approach is capable of treating heterogeneous data (i.e. traffic, noise, pollution etc.) of varying type (quantitative and qualitative) associated with incertitude and imprecision.

By comparing our approach with others (see Table 2), we find that our approach has several advantages in terms of estimating criteria weights and their interactions namely:

- It is not necessary to have several alternatives (projects) for estimating the criteria weights which is the case for methods AHP (Analytic Hierarchy Process) [21] and MACBETH (Measuring Attractiveness by a Categorical Based Evaluation Technique) [1];
- The intensities of preferences take paired values for avoiding the choice « in between», often synonymous with indecision (for e.g. 4 levels are used namely not pertinent, less pertinent, pertinent and very pertinent), which is not the case with methods AHP and MACBETH ;
- If we change the granularity (for e.g. from 4 to 6 levels of evaluation) then the order of criteria remains unchanged, which is not the case with AHP [21] ;
- Managing the indecision and the ignorance ;
- Identifying the pertinent criteria and managing the criteria poorly known.

TABLE II
POSITION OF OUR APPROACH HA4IA COMPARED TO THE EXISTING HYBRID METHODS

Approach	Interaction beween criteria	Source	Reliability	Combinations	Alternative
AHP-Dempster [2]	No	1	No	Additive : Weighted average	Several
ER approach [25]	No	1	No	Additive : Weighted average	Several
HA4IA [16, 18]	Yes	Several	Yes	Non additive : Choquet Integral	1 and Several

Finally, note that these theoretical propositions can be exploited not only for evaluation of transport projects but also for all applications using multicriteria analysis, the phenomenon of interaction (evaluation of products or services, computer applications etc.), heterogeneous databases and diverse and heterogeneous information sources. Moreover, for the theoretical aspects proposed, a web-based interactive platform for collective decision making has been developed [18]. We will see in section 3 the steps and tools used for the implementation. We will also present the decision support tool «DeSSIA» which allows data collection and the expertise, treatment of information, data synthesis and the graphical and map representation of results issued from the evaluation processes.

III. DECISION SUPPORT TOOL: DeSSIA

The theoretical propositions used for evaluation were implemented using a software platform in order to propose a complete application for decision managers to create, manage and evaluate complex data related with urban mobility. The software developed is called DeSSIA (Decision Support System for Impact Assessment). It performs evaluations of mobility projects at various levels namely traffic, environmental, social and economic. The developed tool is illustrated in Fig. 2. It is based on a client server architecture which allows the evaluation of diverse impacts of urban mobility projects. This choice is justified by the fact that we involve multiple users and organizations which must interact for the purposes of evaluation or data collection.
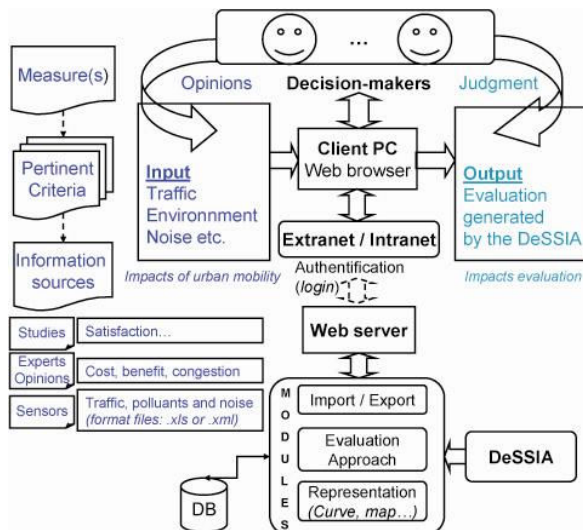

Fig. 2 General technical architecture: tools and environment of development

The developed tool allows constitution, management and the evaluation of complex data associated with urban mobility (Fig. 2). The conception of the decision support system is done in object oriented paradigm UML (Unified Modelling Language). The conceived database (DB) is quite large and

therefore we have grouped the various object classes into packages (See Fig. 3). In total, the application manages 40 tables inside the database, 50% of whom are in the package sources, which is a key point of our application.
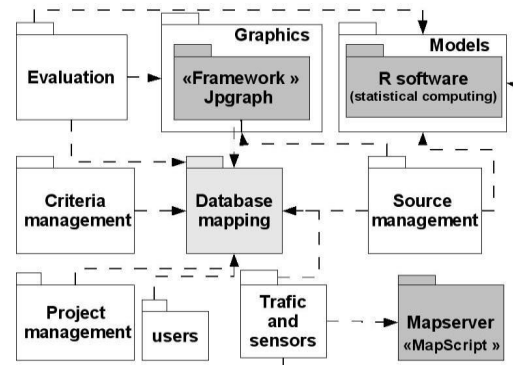

Fig. 3 Diagram of the package DB (package, group of classes)

Note that DeSSIA is not completely automated. It is characterised by 80% aspect tool, and 20% user aspect which assist the user in taking decisions in spite of taking the decisions themselves. Several actors (users) intervene in the evaluation of projects. As a result, we are interested in developing a web-based multi-user tool.

There exists several models for conception of information systems (Waterfall [23], V [4-5], Spiral [14], and Agile methods [13] etc.). Their objective is to organize different phases of life cycle, to guide and develop the technical activities and to furnish means for development and maintenance (resources, timelines, improvements, etc.). Two main types of approaches for conception are in general used: the waterfall approach which consists of linking the steps sequentially and the incremental steps which are iterated several times on the steps of specification, conception, implementation and testing. A comparative analysis of four principal types of conception models is presented in Table 3.

TABLE III
COMPARATIVE STUDY OF CONCEPTION MODELS POSITION OF OUR APPROACH

Model	Possibility of iteration	Return between phases and towards the user	Transmission of knowledge between the phases and their actors	Prototype
Waterfall	No	No	Very weak	No
V	Yes	Yes	Weak	No
Spiral	Yes	Yes	Average	Yes
RAD and agile methods	Yes	Yes	Strong	Yes

The iterative life cycle is often criticized because it gives an impression of lack of stability in the definition of user needs. In fact, there are not new needs, but especially there are the underestimated needs or those ill-identified during the exploratory phase. Therefore, this type of life cycle avoids the

change of thinking once the development takes place and allows to concentrate on the major needs on the first place for incorporating the secondary needs. [14].

To avoid the difficulties linked with the definition of needs, the usage of case brings a very good technique; its elaboration obliges to imagine how to use the future system. It will be difficult to do it in absence of concrete elements, which is not the case with spiral cycle. The life cycle of spiral model has several advantages and disadvantages (Table 3). We adapt this model with some modifications in order to cater to its certain weaknesses like absence of an efficient method for identifying the waiting of the users.

Our development model for DeSSIA is based on the following four steps:

- Identification of user needs (including identifying users, their objectives and tasks) ;
- Conception (with UML) ;
- Development (Prototype tool and implementation) ;
- Test and Validation (by users).

Several jumps (feed-back or suggestions) are done to and fro between the above steps in order to develop a tool that responds best to the user needs.

A. Tool Development

The developed tool is web-oriented (Fig. 4). The choice of web dynamic programming is motivated by following points:
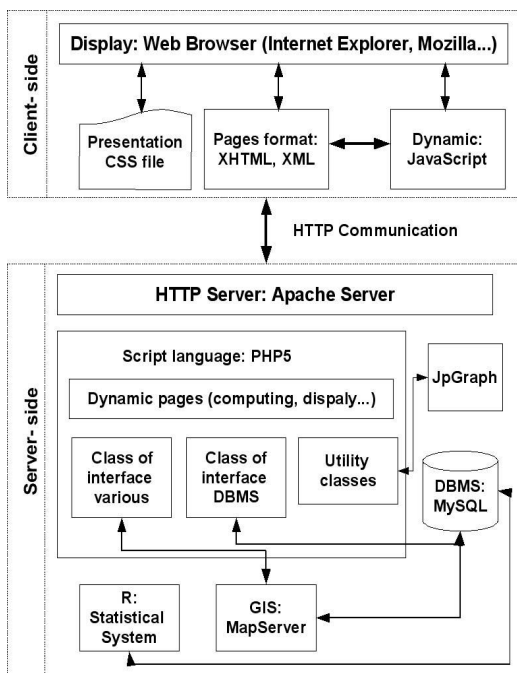

Fig. 4 General schema of the technical architecture: Tools and development environment

- The client-server architecture interacts between a client and a distant internet server. This centralizes and transfers all the treatments on a distant server. This architecture is also proper for integration with a statistical software for treating complex data and a Geographical Information System (GIS) for mapping the evaluation of the spatial and temporal impacts.
- The choice of web brings a huge number of responses (for e.g. from questionnaire surveys) and a wide range of users (like evaluators, traffic engineers, urban planners, environment experts). According to the profile and the nature of needs of each user, a right on restricted access is attributed.
- The web programming is blessed with powerful tools and adapted to the connectivity, reading and writing in all kind of data sources (Relational databases, servers, documents XML, Text file, Excel, etc.) and hence comes the possibility of presenting the evaluation results by graphical techniques (Curves, Histograms, etc.) and visualisation of the spatial measures through maps.

The developed platform uses the quadruple: Linux, Apache, MySQL and PHP (LAMP). It is web-oriented platform that collects «on-line» data from various information sources (sensors, surveys, experts, etc.). It includes varying interfaces described as follows:

- Web (HTML, Java Script, etc.);
- Linkage with statistical software R and the GIS Map-server which are both «open sources»;
- Client-server ;
- Microsoft Office (Word, Excel), Adobe PDF, Macromedia Flash, etc.

We will present in later paragraphs the software environment and the development tools used for the implementation of the evaluation platform «DeSSIA».

It is a three-tier architecture based on following principles:
- The data are always managed in a centralized way;
- The representation is always done by client side ;
- The application logic is taken care by the intermediate server.

This choice is justified by the fact that we have several interventions from evaluators/organizations which participate in evaluation and data collection.

The three-tier architecture, called client-server of second generation or distributed client-server, separates the application in three levels of distinct services:

- Presentation: It concerns the display and local treatment (control for obtaining data, data display etc.);
- Treatment: The global applications are taken care by the service application;
- Storage: The database services are taken care by a geographical database system.

B. Modelling the DeSSIA application for the web: Cadre MVC (CakePHP)

MVC (Model, View, Controller) is a conception model adapted to the creation of software's which perform data separation, their treatment and the presentation. The main

advantages of MVC come from the fact that it manages the usage of different views for a given application.

According to the concept MVC (Fig. 5), an application can be divided in three fundamental components: the model, the view and the controller. Each of these components has a well-defined role:

- The Model describes the data manipulated for the application and defines the access methods.
- The View defines the User Interface and the presentation.
- The Controller takes into account the management of synchronisation events for updating the View or the Model.
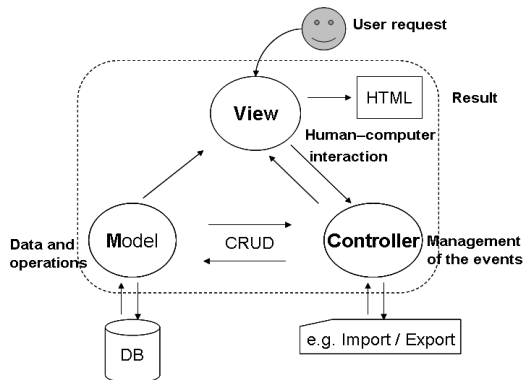

Fig. 5 Schema of the Model-View-Controller (MVC) diagram (CRUD means Create, Read, Update and Delete).

The user interacts with the Controller who uses the model data and returns the results to the View who sends it to the user screen. This concept exists since long times, but never has been really used for the Web applications using the language PHP.

C. Modules in DeSSIA

The tool DeSSIA is composed of several modules described as follows:

- User Module:

The management of users in such an application is fundamental. It allows knowing who uses the tool and controls the impact of certain users on the application by blocking certain functionalities. We have therefore defined certain class of users (Administrator, Project Manager, Evaluator and Invited User). The users belong to a particular class and have access only to pre-defined functions.

- Indicators Module:

This module manages the categories/sub categories / impacts / criteria of project Success. It manages the interaction between criteria and relates each source to one or more criteria. For example the criteria CO_2 will be related to one or more environmental sources of CO_2.

- Measures Module:

The measures (or projects) correspond to those applied at La Rochelle. For example, creation of a Park-and-Ride,

implementation of a new bus network etc. They form part of a work-package (group of projects), and have an individual project manager. The measures also have evaluators (or experts) which evaluate the pertinence of different criteria of a measure in accordance with the theoretical approach used for evaluation [18]. It is therefore important to relate each user to a project, either as an expert or as a project manager. This module also allows the management of work-packages.

- Data Sources Module:

This module includes all what is Addition / Deletion / Importing / Modification of sources (Vehicle counts, measures of environmental or noise pollution). We are convinced that it will be practical to export the results of different sources, whether it is for verifying the values contained in the database or for transferring data between different services (for e.g. between the transport service of La Rochelle and ATMO: the association for the measurement of quality of air in Poitou-Charentes region). The storage of these data is therefore storage in a database with tables attributed for different type of data sources.

- Graphics generation Module:

To do the graphics, we have used the graphical library «JpGraph» for PHP, entirely object programmed. It is one of the leader solutions in this domain (for PHP). It displays all kind of graphics for e.g. histograms, point curves, Gantt charts, Pie charts, Radars, etc.

This library recreates with PHP what can be done with Excel. The advantage lies in the fact that we use as source our database which allows the usage of a common source for various functionalities. With our tool we can for example import easily a file on traffic counts and represent graphically the number of vehicles/day over a selected period. A concrete example on this is presented in the following graph generated from our application.

Fig. 6 represents the number of vehicles on a road during the period from 24 October 2006 to 07 November 2006, measured with a traffic sensor.
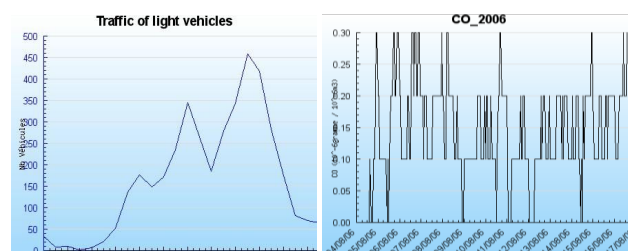

Fig. 6 Graphics generated from the tool: (a) Traffic flow representation (24 hours in 24/10/2006); CO concentration from 04/08/2006 to17/08/2006 (b)

- Mapping/Cartographic Module:

The Geographical Information System software Map-Server is used for the display of maps. Moreover, with Map-

Script, which is a programming interface for PHP (Application Programming Interface or API), we have created dynamic maps (Figs. 7 and 8).
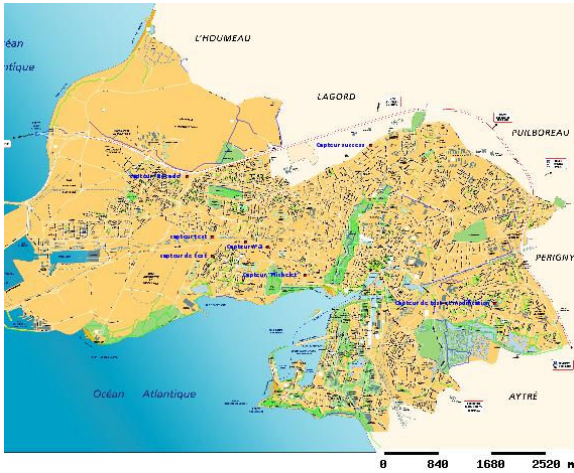

Fig. 7 Map generated by integrating the road pieces in the database DeSSIA (use of Map-server and Map Script)
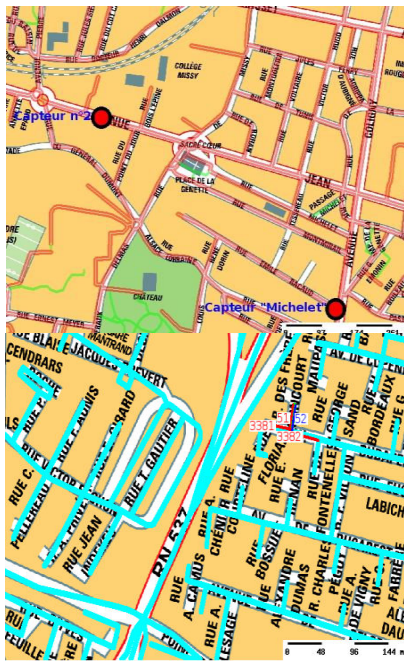

Fig. 8 Interface of sensor positions (a); configuration of road sections (# of lanes, width of lanes) (b)

We have implemented basic functions, such as «zoom in», «zoom out» and the selection of objects on a map. We have also improved the interface by creating an interface «AJAX» i.e. without any uploading of the page. With AJAX, the application is more reactive, and the quantity of data exchanged between the navigator and the http server is strongly reduced.

Definition – «AJAX» (Asynchronous JavaScript and XML) is a mechanism for running a page in background of the front page, and can receive the data results and update on the page. Various sites use this technology and it is considered as a pillar for Web 2.0.

The mapping/cartographic module has the following functions:

- Representing several count points (Add/Delete/Remove);
- Possibility of information and the list of traffic counts belonging to a sensor;
- Configuration of road sections, lanes (data necessary for the algorithm for distribution of vehicles);
- Display, according to the colour classes, of the flow of vehicles on road sections and lanes of a map on the periods defined by the user;
- Saving the created maps;
- Generation of flows on map from an algorithm on distribution of vehicle flows.

D. Evaluation Module

The goal of this module is to be able to observe for each measure of the project SUCCESS an «Evaluation» and compare these evaluations for various phases of implementation of the transport project. An evaluation takes into account only those criteria which are chosen by the project manager. A certain number of experts then evaluate the pertinence of these criteria, which is used to calculate weight for each criterion (According to the approach described in section 2).

The project manager must choose a year of evaluation and then for each criteria selects the data sources (environmental measures, vehicle counts, surveys) that evaluate the criteria. The data sources must be chosen during the same period (i.e. semester or yearly). At each selection of source, the application conducts an intersection of the periods of different sources in order to arrive at a final common period. The evaluation is done by the algorithms using statistical software «R». These algorithms are directly used with PHP and run in background (like basic task). The users can have access either to evaluation of a single criteria or global evaluation of the project. The results are displayed graphically in the form of radars or in the form of histograms. The examples are shown below (Figs. 9 and 10).
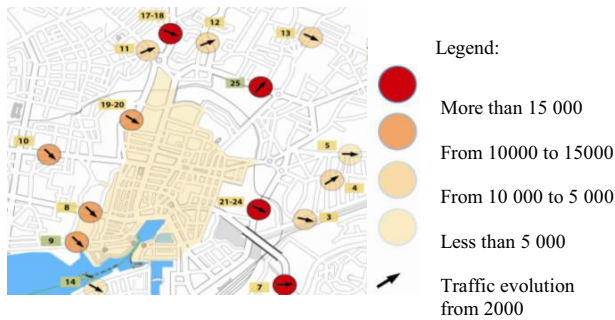
Fig. 9 2 screen of WDSS4IA: Pollution Map related to NO2 (after zoom) (a); Annual daily medium traffic (Traffic flow map) (b)
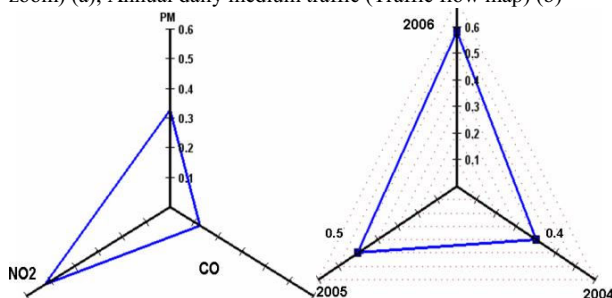

Fig. 10 Criteria evaluation, of urban mobility at La Rochelle city, according to three criteria: NO2, CO and PM, in 2006 (a); Evaluation Graph (for 3 years of studies, from 2004 to 2006); the evaluation criteria are the pollutants: NO2, CO and PM (b).

E. Human Machine Interface (HMI): Graphical aspects

The application is interactive and based on the trio: MySQL (like management system for databases), PHP (as script language) and Apache (as Web server). During the development of the application, we have followed a number of recommendations as follows:

- Compression of images in order to reduce the download time;
- Use of a simple language so that it can be understood by all users.

Moreover, we have followed the ergonomic recommendations in order to make the tool convivial and comfortable to users. The different ergonomic recommendations are described in following paragraphs.

We are interested in developing a dynamic application by implementing certain functionalities with the technology AJAX. In fact, the user sometimes needs very fast information and uploading all pages at that time will be time consuming. Therefore, firstly we have used the technology AJAX for all lists whether it is a list of users or measures. All these lists are generated each time in AJAX within a small form that has sorting options (increasing or decreasing).

We have also implemented the notion of an information window; which displays punctual information, not in a «pop up» form which can be blocked by anti-pop software's, but in a window inside the web page. This information window can

be displaced and closed. Note that all help aids are also launched in the same manner.

Concerning the structure of pages of the application, it passes the certification «XHTML 1.0 transitional» of the validator of W3C, in other words it has a proper structure. All the pages are constructed using the same model and the presentation of pages does not change from one to other, which allows the user to find it easily. We have made good use of titles in structuring the information. We have used either tables or the lists for the information requested. At the level of interactivity and presentation of information, the user is informed of success or not whenever a user performs an operation. Similarly, when there is even a small execution error on a page, the user is informed.

The functions which allow an «intelligent» management of errors, according to the importance of the message will allow:

- Either continue with downloading the page ;
- Or to change the «View» ;
- Or send to the navigator, information to download another page;
- Or to display an error page. This case being the most unfavourable case if an execution error has taken place.

F. Manual and Help on Tool/Application:

In order to add ergonomy to the application, a contextual aid as well as a manual are written in two languages (French and English) so that the partners of the project Success (French, English and Romaine), can be informed on the potential functionalities of the developed tool and if they want to install the application, it would be free and based on open source tools. For the manual or a contextual aid, we used the same XML file, which is read in a different manner. The «XML» file which we have used is structured with well defined elements in order to select any part using the technology «XPATH». When the user clicks on a button on contextual help, small window information opens and shows parts of the corresponding manual. It is equally possible to access the complete manual with the manual link on the application. The development of the evaluation aid tool follows 9 heuristic principles proposed in [15], which are described as follows:

1. Use a simple and natural language
2. Speak the language of the user
3. Minimize the mental stress of the user
4. Be assured of being coherent
5. Foresee the «feedback» of the user
6. Foresee the output of systems clearly indicated
7. Authorize the abbreviations
8. Foresee the error messages as clear and informative
9. Foresee the errors

When using the tool, clear and informative error messages are generated. The users can also inform themselves on a particular functionality using «a user guide» ergonomically established with the technology XML.

The developed tool possesses numerous advantages, as described below in the table 4, but it has several disadvantages too. The first weakness is that it can be slow and time consuming during uploading of voluminous data (import of traffic or environmental data. To overcome this limitation, we propose to optimize the computation code in order to reduce the uploading time for data.

TABLE IV
POSITION OF OUR TOOL DESSIA COMPARED TO THE EXISTING TOOLS

Tool	Olap & SIG	Multi-Users	Data Qt/Ql	Detail	Web	Approach
COPERT	No	No	No	+	No	Model
GESCONDA	No	No	No	+	No	Data mining
MITA	No	No	No	++	No	O-D matrix
DeSSIA	Yes	Yes	Yes	+++	Yes	Hybrid

Qt: Quantitative; Ql: Qualitative

Moreover, in order to improve the interface and usability of the tool, we conducted several meetings with users of the tool (experts, decision makers, transport and environment engineers on transport projects of city of La Rochelle or the ATMO of Poitou-Charentes) for evaluating the tool and collecting their points of view, remarks, and suggestions. The discussion with the working group (potential users of our tool and several technicians) has helped us in improving the tool in terms of interaction and usability.

IV. CONCLUSIONS AND FUTURE RESEARCH

In this article, we present a web based decision support tool called DeSSIA for evaluating the impacts of urban mobility solutions. The tool encompasses a module for visual representation of data allowing the user to follow the evolution of spatial and temporal data (like traffic, air pollution, noise pollution). The tool has been evaluated by a set of experts in order to improve its ergonomic aspect and ease of usage. The tool employs a hybrid approach based on belief theory and multicriteria analysis for project evaluation. This approach was applied on the Park-and-Ride module of project SUCCESS and the results seem promising. The future research will consist of evaluating several mobility projects with DeSSIA and results validation.

REFERENCES

[1] Bana e Costa, C.A., Vansnick, J.C., "General overview of the MACBETH approach", in P.M. Pardalos, Y. Siskos, C. Zopounidis (eds.), Advances in Multicriteria Analysis, Kluwer Academic Publishers, 1995, p. 93-100.

[2] Beynon M., Curry B., et Morgan P., The Dempster-Shafer theory of evidence: An alternative approach to multicriteria decision modeling. Omega, International Journal of Management Science, 28:37–50, 2000.

[3] Brebbia, Urban Transport and the Environment in the 21st Century, edit. CA Brebbia, LC Wadhwa, Witpress, 2005.

[4] Brenier H., Les spécifications fonctionnelles: automatismes industriels et temps réel, Editions Dunod, Paris 2001.

[5] Calvez J.P., Spécification et conception des systèmes: une méthodologie, Editions Masson, Paris, 1990.

[6] Chen M., Tzeng G., Liu D., Multi-Criteria Task Assignment in Workflow Management Systems, IEEE, Proceedings of the 36th Hawaii International Conference on System Sciences, 2003.

[7] Dempster A.P., A generalisation of Bayesian inference, Journal of the Royal Statistical Society, 1968, p. 205-247.

[8] Denoeux T. Reasoning with imprecise belief structures. International Journal of Approximate Reasoning, 1999.

[9] Grabisch M., évaluation subjective. In D. Bouyssou, D. Dubois, M. Pirlot, and H. Prade, editors, Concepts et Méthodes pour l'Aide à la Décision, IC2, pages 175-232. Hermès, 2006.

[10] Guinée J.B, Handbook on Life Cycle Assessment. An operational guide to the ISO standard. London: Kluwer Academic, 2002, 704 p.

[11] Guyonnet D., Bourgine B., Dubois D., Fargier H. Bernard Côme, J.-P. Chilès. Hybrid Approach for Addressing Uncertainty in Risk Assessments. Journal of Environmental Engineering V. 129 N. 1 , 2003, p. 68-78.

[12] Herrera F., and Verdegay J.L, Linguistic Assessments in Group Decision, Proc. of First European Congress on Fuzzy and Intelligent Technologies, Aachen, 1993, p 941-948.

[13] Martin J., Rapid Applicatiopn Development, MacMillan, New York 1991.

[14] Muller P.-A. (1997) – Modélisation objet avec UML. – Paris : Editions Eyrolles. – 421 p.

[15] Nielsen J., & Molich R. Improving a Human-Computer Dialogue. CACM, 33, 3, 1990, p 338-348.

[16] Omrani, H. and Ion-Boussier, L. and Trigano, P., A New Approach for Impacts Assessment of Urban Mobility WSEAS Transactions on Information Science and Applications, 2007a, vol. 4, num. 3, p. 439-444.

[17] Omrani, H., Ion-Boussier, L. and. and Trigano P., A Web-based Decision Support System For Impacts Assessment of urban mobility, AWIC2007 5th Atlantic Web Intelligence Conference, Fontainebleau, France, 2007b, p. 322-327, series: ASC 43.

[18] Omrani H., Awasthi A., Ion L., Trigano P., "Evaluation approach for impacts assessment of urban mobility", International Journal of Adaptive Infrastructures, to appear, 2008.

[19] Omrani, H. Ion L., Trigano P., "Une Approche hybride basée sur la logique floue et la théorie des croyances pour l'analyse des impacts liés à la mobilité urbaine", LFA'2006, Rencontres francophones sur la Logique Floue et ses Applications, Toulouse, les 19-20 Octobre, France.

[20] Roy, B., Méthodologie multicritère d'aide à la décision, Economica, Paris, or Multicriteria methodology for decision aiding, Kluwer, Dordrecht, 1985.

[21] Saaty T L, How to make a decision: the analytic hierarchy process. European Journal of Operational Research, North-Holland, 1990, 48: p 9-26.

[22] Scemama, G., A. Blaquière, et P. Olivero. CLAIRE++ Observatory: a new tool to know and assess congestion on road networks. In 7th World Congress on Intel. Transp. Sys., Turin (Italy), 2000.

[23] Site CIVITAS, http://www.civitas initiative.org

[24] Sommerville I., Le Génie Logiciel et ses applications. InterEditions, 1998.

[25] Yager R.R, Families of OWA operators, Fuzzy Sets and Systems, 59, p 125-148, 1993.

[26] Zadeh, L., Yager R.R, An introduction to fuzzy logic Application and Intelligent System, Kluwer Academic Publishers, 1991.

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