EXPERIMENTAL EVALUATION
OF A MULTIOBJECTIVE
LINEAR PROGRAMMING SOFTWARE

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EVALUATION D'UN LOGICIEL INTERACTIF DE PROGRAMMATION LINEAIRE MULTICRITÈRE PAR EXPERIMENTATION EN LABORATOIRE

RESUME

Le niveau de la recherche empirique en matière de logiciels d'aide à la décision multicritère est relativement faible comparativement au taux de développement de nouvelles méthodes d'analyse multicritère.

Ce cahier présente la méthodologie et les résultats d'une étude empirique ayant pour but l'évaluation de la capacité d'un certain logiciel interactif (il s'agit du logiciel ADELAIS pour microordinateur) de fonctionner comme un instrument efficace d'aide à la décision pour des problèmes de programmation linéaire multicritère.

Le cadre méthodologique de l'étude comprenait une expérimentation systématique du logiciel sur un problème tricritère de gestion agricole. Le rôle des décideurs a été joué par une population d'étudiants qui ont utilisé le système ADELAIS de façon individuelle pour soutenir leur propre processus de décision.

Les résultats de l'étude ont été obtenus par: (1) évaluation de quelques indices de performance de ADELAIS, comme la capacité de converger, le volume d'information, la possibilité de modéliser les préférences du décideur et le temps de calcul; (2) recensement des avantages et des faiblesses des diverses composantes du système au cours du processus de décision pour chaque utilisateur; (3) dépouillement des questionnaires auxquels ont répondu les utilisateurs concernant quelques caractéristiques spécifiques du logiciel.

Mots-clés: Programmation Linéaire Multicritère; Recherche Empirique; Logiciel Interactif.

EXPERIMENTAL EVALUATION OF A MULTIOBJECTIVE LINEAR PROGRAMMING SOFTWARE

ABSTRACT

The level of empirical research activity in multicriteria decision-aiding software is relatively low with respect to the rate of development of new multicriteria decision making methods.

This paper presents the methodology and the results of an empirical study which was conducted for the investigation of the capability of a certain software package (the ADELAIS microcomputer software) to operate as an effective decision supportive tool for multiobjective linear programming systems.

The methodological framework of the study included systematic experimentation on a three-criteria agricultural management problem. The role of the decision makers was undertaken by a population of undergraduate students who used individually the ADELAIS system in order to support their decision process.

The results of the study were obtained: (1) by measuring some performance indices of ADELAIS, such as its convergence capability, the information load, its capability in assessing the DM's preferences and the computer effort; (2) by monitoring and recording the extent to which the users took advantage of the various components of the system during the decision process; (3) by recording some specific characteristics of the system as they were evaluated by the users with the help of a questionnaire.

Key-words: Multiobjective Linear Programming; Empirical Research; Microcomputer Software.
1. INTRODUCTION

Empirical research in decision support systems (DSSs) and in decision-aiding software in general mainly concerns the investigation of the degree to which the use of such decision tools improves the effectiveness of the decision making processes. One major class of empirical DSS studies is based on the experimental approach, according to which the performance of a DSS is tested in laboratories over simulated decision environments and controlled populations of decision makers (DMs). Representative works on this field have been recently reviewed by *Sharda, Barr and McDonnell* [15].

Empirical research in multicriteria decision support systems and multicriteria decision-aiding software in general is relatively sparse with respect to the rate of development of new multicriteria decision making (MCDM) methods. This is unfortunate as such research could provide strong inferences and help users in choosing among methods and software for handling real-world problems. Empirical studies in this area follow two different approaches:
- Comparative evaluation of methods/software on a set of predefined criteria;
- Tests on the performance of a certain method/software in order to distinguish and to evaluate its characteristic properties.

Some representative works of the first approach are the studies conducted by *Tell* [17], *Kok* [9] and *Wallenius* [18]. Tell applied four different methods, which used the notion of utility on a budget formation problem and compared their
The work presented in this paper can be listed in the latter category of empirical studies. Its purpose is twofold. First, to evaluate the performance of the ADELAIS multiobjective linear programming (MOLP) software as a decision-aid tool. Second, to outline a general framework for relative experimental tests. A comparative study of ADELAIS with other relative MOLP softwares was avoided for two main reasons: First, a software permitting the use of different MOLP methods, including the ADELAIS underlying methodology, in a homogenous computer environment was not available. Existing MOLP softwares differ in their design philosophy and show many particularities in operation. These factors were expected to influence undesirably the results of a comparative study. Second, many interesting, from the methodological aspect, MOLP algorithms have not been as yet integrated into interactive computer programs.

The paper is organized as follows. In section 2 the operational principles of ADELAIS are outlined. Section 3 presents the criteria which were used for the evaluation of the performance of the system. The experimental procedure is presented in section 4. In section 5 the results of the study are presented and discussed in some detail. Finally, some suggestions for improvement, which was deduced from the study, are given in the conclusion.

2. OPERATIONAL PRINCIPLES OF ADELAIS

ADELAIS is a fully interactive and menu driven computer program which is designed to support decisions in MOLP problems of the general form:

\[
\begin{align*}
\text{[max]} & \quad g_1 (x) = c_1^T x \\
& \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldOTS
\end{align*}
\]

subject to

\[x \in \mathcal{A} = \{x \in \mathbb{R}^m : \mathcal{A} x \leq b, x \geq 0\}\]

where \(x=(x_1, \ldots, x_m)\) is the vector of the decision variables, \(\mathcal{A}\) is the matrix of the technological coefficients, \(b\) is the right-hand side of the constraints and \(c_j = (c_{j1}, \ldots, c_{jm})\) are the coefficients of the objective \(g_j\).

ADELAIS consists of twelve independent modules, which as a whole support extensive data management and realize a coherent MOLP methodology. Detailed information about the underlying methodology of ADELAIS, which is also presented briefly in the rest of this section, as well as its software structure and the user interface are given in two papers, respectively Siskos and Despotis [16] and Despotis and Siskos [3].
The MOLP method incorporated in ADELAIS operates in four stages. (An interesting three-stage method has been proposed by Jacquet-Lagrèze, Meziani and Slowinski [7]).

**Preliminary stage**

In this stage upper and lower bounds for the objectives (say $g_i^*$ and $g_i^*$ respectively) are obtained by maximizing and minimizing respectively each objective on the feasible set $A$. Particularly, if all or some of the minimization problems are unbounded, and this may happen even though the original MOLP problem has been well formulated in order to have a finite maximum, the lower bounds are computed with a heuristic (cf. [16]). Afterwards, an initial efficient solution (i.e., a solution which is not inferior to any other feasible solution) is estimated in a way similar to that in Step Method (STEM) of Benayoun [1]. This technique suggests that the objective values which correspond
Stage II

Stage II implies a learning process of the DM’s preferences. At first, a simple technique is set up to build a reference set of decision profiles (i.e. a set of n vectors that might be assumed by the n objective functions). These reference alternatives are presented in pairs to the DM, who is asked to rank order them according to his/her preferences. Then a concave additive utility function, which is as consistent as possible with the DM’s ranking, is assessed by a modified version of the UTA ordinal regression algorithm (cf. Jacquet-Lagrèze and Siskos [8] and Despotis and Yannacopoulos [4]). The system plots the curves of the assessed marginal utilities and then analyses the inconsistencies that may appear between the DM’s preference ranking and the ranking rendered by the utility model on a utility-ranking regression curve. The DM then is invited to interact with the model in order to remove all or part of these inconsistencies. The utility assessment process is terminated by the system when full consistency is achieved or by the DM himself when acceptable consistency is achieved.

Stage III

The DM’s utility function is maximized over the set A of the acceptable solutions, a new efficient solution is obtained and the process is repeated from stage I. For the maximization of the DM’s utility function, a piecewise linear programming technique is used.

3. EVALUATION CRITERIA

Wallenius [18], Hemming [6], Larichev and Nikiforov [11] and Roy [14], among others, have extensively discussed the properties which must characterize the interactive MCDM methods and softwares. The investigation of the degree to which the methods meet these properties composes an operational framework to evaluate and probably to compare the interactive methods.

In this study the properties of ADELAIS were investigated within a wide framework including on the one hand evaluation of the system on some quantitative and objectively measurable criteria, on the other hand subjective evaluation of its performance by the users. The criteria used in the former case were the convergence capability, the information load, the consistency achieved between the users and their utility models and the computational times.
Convergence

An iterative procedure is said to have good convergence properties if it is able
to approach some final solution in a finite number of iterations. This means that
the investigation of convergence is directly related to the definition of the final
solution. However, in decision problems involving multiple objectives, there is no
solution which could be objectively judged as the final one. Particularly, in MOLP
problems the final solution (i.e., the "most satisfactory" solution) is exclusively
defined by the DM's individual preference system and not by mathematical con-
ditions. Thus, mathematical convergence is not easy to investigate in MOLP
methods. Moreover, requiring "absolute" convergence from interactive methods
seems to be against the principle of the "learning mechanism" on which these
methods are based.

In multiple objective interactive methods it is more convenient to investigate
"requisite" convergence (Phillips [12]). This property reflects the capability of an
interactive method to model progressively the preference system of an individual
in such a way that he himself be able to reach a satisfactory solution. However,
it seems reasonable to assert that requisite convergence can be investigated
only in real-world decision tasks directly concerning the DMs who participate in
the decision process. In such cases the DM's participation is intentional and,
moreover, intensive and this fact gives substantial meaning to the development
of preferences.

In experimental studies the above presumptions are not fulfilled. Therefore a
somewhat "mixed" approach was used to investigate convergence in this study.
The convergence capability of ADELAIS was tested by asking each participant to
work with the system on a particular MOLP problem and to try to approach a
given efficient solution with some acceptable accuracy. Therefore, maximum al-
lowable deviations from the given solution were initiated, with respect to the
objective values, by taking \( \varepsilon_s = \pm 10\% \) for the most "sensitive" objective \( g_s \) (i.e.,
the objective \( g_s \) for which \( (g_s^- - g_s^*)/(g_s^* - g_s^-) = \max \{(g_i^- - g_i^*)/(g_i^* - g_i^-), \ i=1, \ldots, n\} \))
and \( \varepsilon_i = \pm 10g_s^* (g_i^- - g_i^*)/g_i^* (g_s^- - g_s^*) \) \% for all the other objectives \( g_i \) with \( i \neq s \).

Although this approach does not carry any information about absolute conver-
gence, it can provide interesting inferences about requisite convergence. In fact,
the number of system iterations carried out by a DM to reach the given solu-
tion can be considered as an index of whether and how fast the system can
model and direct the DM's preferences toward the final solution.
Information load

The information load is a considerable factor that influences the general performance of an interactive method and more precisely its applicability. As the interactive MCDM methods differ in the way they assess the DM’s preferences, the information processing operations performed by the DM vary from one method to another.

Larichev and Nikiforov [11] identified eleven information processing operations, which are widely employed in the interactive MCDM methods, and assigned to each of them a general estimate reflecting their complexity. Some of these operations are elementary (i.e., they can not be broken into other operations) while others can be analyzed in a sequence of elementary operations.

The requirements of ADELAIS in information processing operations are limited. In fact, in stage I the DM must discriminate between satisfactory and not satisfactory objective values, with respect to the solution obtained at each iteration. This operation involves comparisons of the obtained objective values against the respective upper bounds and is sufficiently reliable as it can be performed by the DM without many contradictions. Following Larichev and Nikiforov's terminology the operation employed in stage I can be judged as "admissible" and easily performed. Thus, it is assumed that this operation does not increase the information load. On the contrary, the operations which must be performed within stage II are more complex and need to be investigated. Actually, in stage II the DM is invited to define a preference ranking on some reference alternatives. For this purpose the DM compares two alternatives at a time and chooses the one preferred. If k is the number of the reference alternatives then the number of pairwise comparisons that the DM should perform is bounded by \( k(k+1)/2 \). But the comparisons that the DM actually makes are in general less, as the system disregards the pairs of alternatives for which the choice is suggested by the transitivity of preferences. Obviously, the number of comparisons performed by each DM is not constant but depends on the structure of his/her preference system. Therefore, the mean number of pairwise comparisons needed for the elicitation of the DMs' preference rankings on a standard number of reference alternatives (8 in the case of the experiment) was taken as an index of the information load.

Man-model consistency

One of the major operations of ADELAIS is the assessment of an analytical utility model capable of representing the DM's preferences. The input of the utility assessment process is a preference ranking on the reference alternatives. Thus, the ability of the utility model and consequently of ADELAIS to represent the DM's preferences can be expressed by the degree to which the model
can reproduce the DM's subjective ranking. This latter is easily obtained by
Kendall's $\tau$, whose value results from the number of violations caused by the
model on the input ranking ($\tau=1$ for full consistency and $\tau=-1$ for complete in-
consistency).

**Computational time**

The time spent by an interactive system in computations is a considerable factor
that influences its applicability. In fact, this time determines how long the user
should wait until the system responds to his inquiries. In the case of interactive
MOLP systems, in which the information-retrieval operations are limited, the
computational time is the most considerable factor that influences the response
time of the system. The computational time is a function of the computational
load of the system but depends also on other factors such as the efficiency of
the algorithms and the computational speed of the computer on which the sys-
tem is implemented.

In MOLP methods the computational load is a function of the number and the
dimensions of the linear programs solved at each iteration.

The computational load of ADELAIS is accumulated in stages II and III (see [16]
for a detailed analysis of the dimensions of the linear programs solved).

**Additional indices**

Some other features of ADELAIS, such as its factionality, the ease of use and
its applicability were evaluated by using the subjective judgments of the partici-
pants after the experience they had with the system. All relative data were re-
corded with the help of a questionnaire.

4. **THE EXPERIMENT**

**Subjects**

Participants in the study were 20 students of the Piraeus Graduate School of
Industrial Studies enrolled in a game theory and business policy course. In the
framework of this course students had the opportunity to become familiar with
decision making in simulated business environment by working on business simu-
lation games via microcomputer. Furthermore, all participants showed some ho-
mogeneity with respect to their academic background relative to the study, as all
had been taught subjects on multiple objective mathematical programming.
The decision problem

The decision problem which was used in the study concerned the planning of an annual cultivation program for a Spanish agricultural cooperative. The case study was initially presented in Romero, Amador and Barco [13] as an application of
was assigned at random to each one. These solutions had been calculated prior to the experiment by applying the first step of the algorithm by Choo and Atkins [2] to the data of the MOLP problem under consideration. For the conduction of the experiment, each participant was invited individually to assume the role of the DM within the farm planning problem and to reach the efficient solution assigned to him/her by modeling his/her preferences to this direction with the help of ADELAIS.

5. RESULTS AND DISCUSSION

The results of the study are classified in three categories:

- results obtained from the measurement of the basic performance indices of the system (convergence, information load, consistency and computational time);
- results obtained by recording the extent to which the various components of the system were used;
- results obtained from the analysis of the questionnaires.

Basic indices

The results concerning the basic performance indices (extreme and mean values) are summarized in table 2.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>values</th>
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<tr>
<td></td>
<td>minimal</td>
</tr>
<tr>
<td>Convergence (number of iterations)</td>
<td>2</td>
</tr>
<tr>
<td>Information load (number of pairwise comparisons)</td>
<td>11</td>
</tr>
<tr>
<td>Consistency (Kendall's ( \tau ))</td>
<td>.714</td>
</tr>
<tr>
<td>Computational times(*</td>
<td></td>
</tr>
<tr>
<td>Comput. time for the assessment of the utility function (sec)</td>
<td>4</td>
</tr>
<tr>
<td>Comput. time for the determination of an efficient solution of maximal utility (sec)</td>
<td>3</td>
</tr>
<tr>
<td>Total time spent with the system (min)</td>
<td>59</td>
</tr>
</tbody>
</table>

(*): Reported on an IBM 8580-111/80386-20Mhz microcomputer.
Convergence

All participants reached the final solution within acceptable accuracy after a small number of iterations (mean number equal to 3.4). Participants carried out at least two iterations until to reach the final solution but 95%, 40% and 5% of them proceeded to a third, a fourth and a fifth iteration respectively.
The revisionary operations referring to the formulation of the MOLP problem were excluded from the experiment and consequently are not included in table 3 as no modification of the MOLP model was assumed during the decision process. Among the revisionary operations provided by the system the one most used was the operation related to the revision of the preference ranking during the assessment of the DM's judgment policy. This fact may be rendered to the ability of the system in persuading the user of his/her judgment errors.

The operation which is related to the revision of the satisfaction levels and which in fact permits the dilation of the decision space was first used during the third iteration by the 21% of the participants who proceeded to this iteration. This operation was exclusively used in cases where the reduction of the decision space in the first two iterations caused the omission of the efficient solution which was supposed to be reached. For the same reasons this operation was also used in the fourth iteration by 25% of the participants who proceeded to this iteration.

Finally, during the first three iterations, 15%, 20% and 5% of the participants respectively proceeded to a trade-off analysis in order to modify directly their utility model and to preserve their subjective preference ranking against the suggestions of the system.

Users general estimations

The users estimations with respect to the general performance characteristics of the system can be summarized in the following.

-The software interface of the system provides a robust and operational framework

Users did not meet difficulty in controlling the system operations. They were easily oriented and navigated through the components of the system. Internal checks prevented the users from making mistakes in operation on the one hand, on the other hand prevented them from getting senseless messages or output. Besides, users seemed to comprehend and manipulate without difficulty the information provided by the system. Particularly, the graphical representation of the results during the utility assessment process helped the users to digest concepts, such as "criteria weights", "marginal and global utility" and "consistency-inconsistency".

- The response time of the system is satisfactory

Recall here that the system was tested on a high speed microcomputer IBM 8580-111.
- Information processing requirements are limited

Participants did not meet difficulty in discriminating between satisfactory and not satisfactory objective values when they evaluated a new compromise solution. Indeed, such an operation does not show in general any innate difficulty but it is simplified more when facilitated, as in ADELAIS, by auxiliary elements concerning the attained solution, such as the satisfaction levels, the upper bounds of the objectives and the rates of achievement with respect to the upper bounds. Contrarily, the definition of a preference ranking on the reference alternatives is not an easy task to go through as it includes pairwise comparisons among the reference alternatives. However, 35% of the participants did not meet difficulty in performing pairwise comparisons. This fact may be rendered to the relatively small number of objectives considered in the decision problem, as well as to the way the system brings together the reference alternatives. Indeed the system, in order to facilitate the DM to exteriorize his judgment policy, does not simply puts side by side the alternatives to be compared but underlines the pros and cons of preferring one than another.

-The system permits the DM to revise and to realjust his/her preferences

The free readjustment of the preferences, according to their consequences in the course of the decision process, is an innate property of ADELAIS which is promoted in two levels: Globally, by means of the revisionary operations which permit the re-examination of solutions excluded in previous iterations and locally, during the assessment of the utility function and the analysis of inconsistencies where the DM can revise his judgment policy and thus to alter the search direction.

- The system helps the DM to improve his/her knowledge about the decision problem

In the course of the decision process participants showed progressively greater facility in expressing their preferences as the trade-off analysis provided by the system helped them perceiving more and more the relation between the objectives and what was feasible and what was not. This fact may be correlated to some extent with the declining tendency of the mean duration of the iterations (fig. 1)
6. CONCLUSION

A framework for testing interactive MOLP softwares is outlined in this paper. The empirical study conducted within this framework showed that the ADELAIS software package succeeded satisfactorily in its role as a decision-aid tool for multiob-
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