A Multicriteria Methodological Framework for Portfolio Selection Utilizing Stochastic Data

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Abstract

The projects portfolio effectiveness evaluation is a complex and diverse topic which is linked to the strategic planning, the efficiency of project implementation teams, the social and economical environment, the availability of the resources etc. The appropriate projects selection constitutes one of the key points to ensure the total portfolio success. This research work proposes an approach for the selection of projects portfolio based on two methodological frames: a) The Multi Criteria UTA(*) method of Disaggregation - Aggregation approach (D-A) with which the alternative actions are evaluated according to the business strategic objectives and b) the Multi-objective (0-1) Linear Programming techniques, which are utilised to select a subset of the alternative projects considering the estimated with the D-A approach multicriteria global values of the alternative projects, additional objectives related to the external environment, internal and external policy restrictions, the availability of resources and the specific market conditions. The incorporation of stochastic criteria into the analysis to evaluate the alternative projects under uncertainty is also presented in this paper. The proposed approach is illustrated through a case study concerning the projects portfolio selection of a contraction firm. One more feature of this research work is the utilisation of previous implemented projects in the reference set for the estimation of the Additive Utility Model with UTA(*) to support the Decision Maker expressing more efficiently his global preferences.

Keywords: Multicriteria Decision Aid, Projects Portfolio Selection, Multi-Objective Linear Programming.

1. Introduction

The project management together with an efficient projects selection is important for the competitiveness of organizations within the today's dynamic and unpredictable environment. The last decades, firms and organizations, which are projects process organised, are focusing on the effective projects portfolio selection in order to group them together for their direct alignment with the organizational strategic objectives and for an effective allocation of the available resources (human, material, cash flow).

The effectiveness of the projects and their success is related not only to the implementation factors (Atkinson, 1999; Ika, 2009; Patanakul and Milosevic, 2009; Westerveld, 2003; Yu et al., 2005) but also to parameters measured mainly after the project's completion. The performance on these parameters is influenced by the portfolio selection as every project contributes to the firm's wealth either short term or long term. The selection of the projects portfolio (APM, 2012; PMI, 2008) constitutes an unstructured decision problem as:

- The outcomes of projects cannot be precisely predicted due to the uncertainties characterizing the operational environment.
- The undertaken projects reserves resources resulting to availability limitations and leading to the exclusion of other projects.
- There are a lot of conflicting and competitive factors to be taken into consideration for the selection of the projects (income, quality, preparation for the future, etc.).
- There is no a step by step procedure that can fit to all cases for the total projects evaluation by taking into account different point of views without compromises among the selection criteria.

Also, the business strategic goals need to be included in the portfolio selection process conforming to the new trends in the project management discipline. The project management is becoming more strategic and business oriented (Shenhar, 2015) and the project managers have been characterized by Shenhar et al. (2001) as the new strategic leaders. Therefore, the linking of the available projects to the strategy and the management of the complexity of projects selection process are vital points, which require further research.

This research work proposes a methodological approach for the selection of projects' portfolio which on the one hand links the selection criteria to the organizational strategic objectives and on the other supports the handling of factors influenced by the external environment and business restrictions. The proposed

methodological approach is based on a synergistic exploitation of the Multicriteria Disaggregation - Aggregation UTA (*) method (Siskos, 1980, 1983; Siskos et al., 1993) and the Multi-objective Linear Programming techniques (Ehrgott and Wiecek, 2005; Evans and Steuer, 1973; Korhonen, 2005; Korhonen and Wallenius, 1990; Zeleny, 1974). Also, special treatments are applied in order to handle the uncertainty on project parameters and outcomes.
The paper consists of an introduction and three more sections. The proposed methodological framework for projects portfolio selection is presented in the second section of the paper. Then, in the third section an illustration example is developed for the analytical presentation of the methodological framework. Finally, some concluding remarks together with further exploitations are presented in the last section.

2. Methodological Framework for Projects Portfolio Selection

The proposed methodological framework is based on two Multicriteria Decision Aid approaches: a) the Disaggregation - Aggregation UTA methods with which an additive value system is estimated linking directly the potential outcomes of alternative projects with the business strategic orientations and b) the Multi-Objective (0-1) Linear Programming techniques (MOLP) which allows the projects selection by taking into account the decision maker's preferences, parameters related to the external environment (e.g. economical risk, political uncertainty, market competitiveness, social needs) and the constraints due to resources availability, policy restrictions or business situation. The phases of the proposed framework for the projects portfolio selection together with the respective outcomes are presented in figure 1.

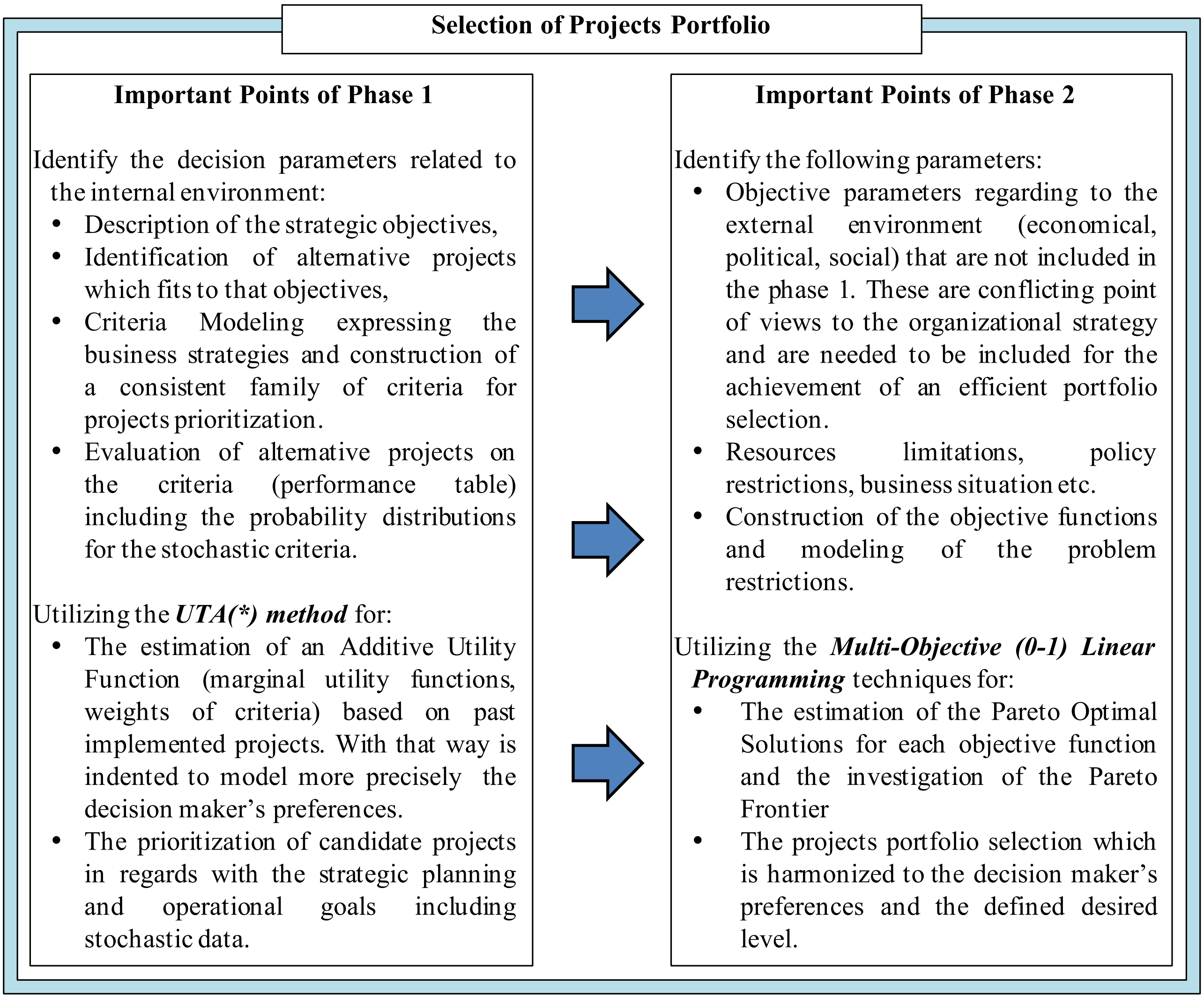


Figure 1: Illustration of the important points of the proposed approach for Projects Portfolio Selection

In the first phase of the proposed approach the UTA(*) is utilized in order to achieve the assessment of a value system encapsulating the evaluators' preferences that is described in the following formulae:

$$U(g) = \sum_{i=1}^{n} p_i u_i(g_i)$$

$$u(g_{i*}) = 0, \ u(g_{i*}) = 1, \ \text{for } i = 1,2,\ldots,n$$

$$\sum_{i=1}^{n} p_i = 1, \ p_i \geq 0, \ \text{for } i = 1,2,\ldots,n$$

where g = (g_1, g_2, ..., g_n) is the performance vector of an alternative project on the *n* criteria; g_{i*} and g_i^* are respectively the least and most preferable levels of the criterion g_i; $u_i(g_i)$ and p_i are the value of the performance g_i and the relative weight of the *i*-th criterion (Keeney, 1996; Keeney and Raiffa, 1976). This value system can be obtained utilizing the MINORA system (Siskos et al., 1993) the spine of which is the disaggregation-aggregation UTA (*) method. In Figure 2 the major steps of the methodological frame are presented, which are described in the following:

a) Criteria Modeling: Criteria Modeling is crucial for the evaluation process resulting in a consistent family of criteria (Bouyssou, 1990) so as to provide a supplemented view of the alternative projects regarding its performance. This set of criteria allows us, to measure the consistency and appropriateness of the alternative projects with respect to the three principles that ensure the consistency of the criteria family (Roy, 1985).

b) Projects evaluation on the criteria: The evaluation of the projects on the consistent family of criteria takes places into this procedure. A set of rules and techniques, designed during the criteria modeling procedure, has to be followed in order to assign the corresponding values of the projects for every criterion.

c) Selection of the reference set: From the total number of the alternative projects a small number is selected (reference set). The members of the reference set have to be representative of the whole set of alternative projects in order to take into account the different aspects of them. Also, they have to be known to the DMs so as to express their preferences fluently. In order to ensure the above mentioned requirements in this proposed approach we use a set of previous implemented projects which constitute the reference set for the assessment of the additive value which will be further used for the evaluation of the alternative projects under consideration.

d) DMs' pre-ranking of the reference set: The DMs express their global preferences by rank ordering (weak order) the alternative projects of the reference set.

e) Assessment of the Evaluation Model: The UTA (*) method estimates the weighting factors p_i as well as the value functions *u(g)* (piecewise linear) of the criteria using special linear programming techniques. Suppose a ranking (weak order) is given on a set of reference projects A_r = (a_1, a_2, ..., a_k), where the objects are rearranged in such a way that a_1 is the head and a_k is the tail of the ranking and for every pair of consecutive projects for evaluation (a_m, a_{m+1}) holds either $a_m P a_{m+1}$ (preference) or $a_m I a_{m+1}$ (indifference).

UTA(*) solves the linear program below which, because of the transitivity of the (P,I) preference system has k constraints only. Special post-optimality analysis techniques are also applied to test the stability of the estimated weights (Grigoroudis and Siskos, 2002; Jacquet-Lagreze and Siskos, 1982; Siskos and Yannacopoulos, 1985):

$$\begin{cases} [\min]F, \ F = \sum_{i=1}^{k} (\sigma^+(a_i) + \sigma^-(a_i)) \\ \textit{Subject to:} \\ \sum_{i=1}^{n} p_i u_i[g_i(a_m)] - \sigma^+(a_m) + \sigma^-(a_m) - \sum_{i=1}^{n} p_i u_i[g_i(a_{m+1})] + \sigma^+(a_{m+1}) - \sigma^-(a_{m+1}) \geq \delta \ \textit{if} \ a_m P a_{m+1} \\ \qquad\qquad \textit{or} \\ \sum_{i=1}^{n} p_i u_i[g_i(a_m)] - \sigma^+(a_m) + \sigma^-(a_m) - \sum_{i=1}^{n} p_i u_i[g_i(a_{m+1})] + \sigma^+(a_{m+1}) - \sigma^-(a_{m+1}) = 0 \ \textit{if} \ a_m I a_{m+1} \\ \text{for } m = 1, 2, \ldots, k-1 \\ \sum_{i=1}^{n} p_i = 1, \quad p_i \geq 0, \ \text{for } i = 1, 2, \ldots, n \\ \sigma^+(a_j) \geq 0, \quad \sigma^-(a_j) \geq 0, \ \gamma\iota\alpha \ j = 1,2,\ldots,k \end{cases}$$

where δ is a small positive number; $g_i(a_m)$ the evaluation of the am object on the *i*-th criterion and $u^i[g^i(a^m)]$ the corresponding marginal value; and $\sigma^+(a_j)$, $\sigma^-(a_j)$ the under (over)estimation errors concerning the *j*-th object.
The additive value model is applied into the reference set for the estimation of the marginal values, the global values of the alternative projects and the produced ranking by the global values.
f) Feedbacks: The final accepted additive value model is assessed through iterative procedures. During this process the current additive value model is presented and analyzed to the DMs as well as the inconsistencies (over and under-estimation errors). Every iteration leads to a modification of the parameters influencing this parameters related to the additive value model (criteria, evaluation of the alternative actions on the criteria, reference set, pre-ranking). Finally an acceptable additive value model is assessed. Also, through trade off analysis procedures, the evaluation model can be modified so as to eliminate specific and crucial over and under–estimation errors.
g) Extrapolation: The assessed additive model is used in order to assign a value (utility) to the alternative projects under consideration. The utility of every project constitutes the sum of the marginal utilities of the criteria for this object. This value system is used in order to rank order the whole set of evaluation projects. Also, the ordinal regression curve is designed, providing a visual way to picture the results.
If there is a significant uncertainty on at least one of the criteria, the evaluation of the alternative projects will be achieved by transforming these criteria into stochastic ones in the extrapolation step. In that case the marginal utility of the criterion g_i for the project a will be estimated from the following formulae:

$$u_i(g_i(\alpha)) = \sum_{T=1}^{q_i} d_i^\alpha(g_i^T)u_i(g_i^T)$$

$$d_i^\alpha(g_i^T) \le 1,\ \ d_i^\alpha(g_i^T) \ge 0,\ \ \text{for } T = 1,\ 2,\ ...,\ q_i$$

$$\sum_{T=1}^{q_i} d_i^\alpha(g_i^T) = 1$$

where q_i and d_i^α are respectively the number of possible values and the distributional evaluation of the alternative project α on the *i*-th criterion, $d_i^\alpha(g_i^T)$ is the probability that the performance of project a on the *i*-the criterion is g_i^T and $u_i(g_i^T)$ is the marginal utility function estimated with UTA(*) previously.

In the second phase the selection of projects portfolio is achieved with the utilization of the Multi-Objective (0-1) Linear Programming techniques (MOLP)(Ehrgott and Wiecek, 2005; Evans and Steuer, 1973; Korhonen, 2005; Korhonen and Wallenius, 1990; Zeleny, 1974). The purpose of implementing MOLP is to identify those projects which are closest to the desired objective goals given by the decision maker for both internal and external environment. The major steps of this methodological frame are described below:
a) Construction of the objective functions: The first objective goal is the maximization of the global utilities estimated in the previous phase of the proposed methodological frame. Other objective functions related to the external environment (economical, political, social, etc.) are identified by taking into account the firm's nature and activity.
b) Modeling the restrictions of the selection problem: In this step the resources requirements and the policy restrictions of the alternative projects are identified. The linear functions related to these constraints are also constructed.
c) Calculation of the pay-off table: The aim of this step is to estimate the projects that optimize each objective function under the portfolio restrictions. The extreme pareto (Ehrgott, 2012) optimal solutions are identified by solving the h linear problems presented below:

$\text{Max } (Z_1 = U\ (a_1)x_1 + U\ (a_2)x_2 + ... + U_\lambda\ (a_\lambda)x_\lambda)$
$(\text{Min/ Max})\ Z_I = g_I(x) = c_{I1}x_1 + c_{I2}x_2 + ... + c_{I\lambda}x_\lambda\ ,\ I = 2,\ \dots,\ h$
subjected to
$a_{11}x_1 + a_{12}x_2 + ... + a_{1\lambda}x_\lambda\ (\ge)\ (\le)\ (=)\ b_1$
$a_{21}x_1 + a_{22}x_2 + ... + a_{2\lambda}x_\lambda\ (\ge)\ (\le)\ (=)\ b_2$
.....
$\alpha_{\zeta1}x_1 + a_{\zeta2}x_2 + ... + a_{\zeta\lambda}x_\lambda\ \ (\ge)\ (\le)\ (=)\ b_\zeta$
$x_j = \{0,1\},\ j = 1,\ 2,\ ...,\ \lambda,\ I = 1,\ 2,\ \dots,\ h$

where λ the total number of the alternative projects, I the number of the objective functions, ζ the number of the restriction functions, $U(a_j)$ the global utility of the alternative project a_j, c_{Ij} the performance of project j on the I-th objective function. The values of $x_j=\{0,1\}$ are indentified, where $x_j=1$ if the project is selected and $x_j=0$ if the project is not selected.

From the solution of the above linear problems a pay-off table(figure 2) is created which includes, for each linear problem solved (optimizing the corresponding objective function), the vector x (indicate the selected projects for each solution), the values of the objective functions g_I (x), and the equivalent maximum - minimum of the objective functions.

MIN/MAX	$g_1(x)$	$g_2(x)$	...	$g_h(x)$	$X=\{x_1,x_2,..x_\lambda\}$
$g_1(x)$	$g_{11}(x)$	$g_{12}(x)$	...	$g_{1h}(x)$	x_1
$g_2(x)$	$g_{21}(x)$	$g_{22}(x)$	...	$g_{2h}(x)$	x_2
⋮	⋮	⋮	⋮	⋮	⋮
$g_h(x)$	$g_{h1}(x)$		...	$g_{hh}(x)$	x_λ
MIN	$g_1'(x)$	$g_2'(x)$	...	$g_h'(x)$	
MAX	$g_1''(x)$	$g_1''(x)$	...	$g_h''(x)$	

Figure 2: General form of the pay-off table

d) Define the desired levels for each Objective function: The decision maker is asked to determine the desired levels $Z_{I\text{-target}}$ for each objective function (Z_I) within the range of maximum and minimum values estimated in the previous step ($Z_{I\text{-min}}$, $Z_{I\text{-max}}$).

e) Implementation of the desired goals technique for the portfolio selection: In this step the optimal pareto solution closest to the desired goals defined previously by the decision maker is investigated. Therefore, a 0-1 LP is formed where the objective functions become restriction functions and the variables d_i^+, d_i^-, i = 1, 2, ..., h are additionally introduced. These variables represent the difference of the values on the objective functions from the desired ones. The aim of solving this linear program is to achieve the smallest overall deviation from the defined targets. The errors are normalized by the factors:

$$r_I = \frac{\max Z_I}{Z_I}$$

The following Linear Problem is solved:

$$(\text{Min})\ \Sigma = r_1 (d_1^+ + d_1^-) + r_2 (d_2^+ + d_2^-) + ... + r_h (d_h^+ + d_h^-)$$

Subjected to

$$c_{11}x1 + c_{12}x_2 + ... + c_{1\lambda}x_\lambda - d_1^+ + d_1^- = Z_1$$

$$c_{21}x1 + c_{22}x_2 + ... + c_{2\lambda}x_\lambda - d_2^+ + d_2^- = Z_2$$

...

$$c_{h1}x_1 + c_{h2}x_2 + ... + c_{h\lambda}x_\lambda - d_h^+ + d_h^- = Z_h$$

$$a_{11}x_1 + a_{12}x_2 + ... + a_{1\lambda}x_\lambda\ (\geq)\ (\leq)\ (=)\ b_1$$

$$a_{21}x_1 + a_{22}x_2 + ... + a_{2\lambda}x_\lambda\ (\geq)\ (\leq)\ (=)\ b_2$$

...

$$a_{\zeta 1}x_1 + a_{\zeta 2}x_2 + ... + a_{\zeta\lambda}x_\lambda\ (\geq)\ (\leq)\ (=)\ b_\zeta$$

$$_{xj}=\{0,1\},\ j = 1, 2, ..., \lambda\ \text{και}\ d_I^+ \geq 0,\ d_I^- \geq 0,\ I = 1, 2, ..., h$$

$$c_{11} = U(a_1),\ c_{12} = U(a_2),\ ....,\ c_{1\lambda} = U(a_\lambda),$$

The results are presented to the decision-maker and if he is satisfied, then the procedure is finished. If he is not satisfied or the errors are significant, then the decision-maker may proceed to revisions of the desired goals until a satisfactory and acceptable solution is calculated.

3. The Case Study

The above described Multi-criteria approach was used for the projects evaluation of a small Greek construction company which intends to design the bidding plan for the next year. The decision maker indentifies a set of 10 alternative projects that fits to the company's profile and business plan, while a set of 12 previous implemented projects had been selected for the estimation of the additive utility model in order to provide projects with known results to the DM for the easier expression of his preferences. The crucial aims of this case study are the projects prioritization, the projects selection and the portfolio optimization in accordance with the strategic objectives, the internal - external environment and the resources restrictions, respectively.

The criteria used had been divided into two categories. The one category is related to the internal environment points of view and includes the following criteria:

- Expected net income (K€, increasing preference), which is a stochastic criterion that takes into account uncertainty on the estimation of a precise value for the net-income. For the net income of every project a Gaussian distribution was estimated with a mean value and a standard deviation (see table 1).
- Knowhow (scale 1-5, increasing preference), which is a qualitative criterion indicating the level of firm's existing knowledge and specialization about each project.
- Future perspectives (scale 1-5, increasing preference), which is a qualitative criterion specifying the potential opportunities that could be produced from the undertaken of each project under consideration.
- Additional Strategic Elements (scale 1-5, increasing preference). It is a qualitative criterion, which measures the projects correlation to the firm's strategy excluding the above three point of views.

The second category is related to the external environment and includes the following two criteria:

- Business Risk (scale 1-5, decreasing preference), which is a qualitative criterion measuring the risk not to achieve the expected project outcome and the possible influence of the external environment to project execution.
- Competition (scale 1-5, decreasing preference). It is a qualitative criterion indicating the competitiveness in the market from other construction companies which could bid for the same projects.

Important parameter for the selection of the projects is the capability to implement them efficiently. The main restrictions are related to the available resources (human and material) and cash flow limitations, which border the number of projects to be selected for implementation. The decision maker defines three key resources categories for the achievement of an effective project management and efficient portfolio implementation. These categories are the following:

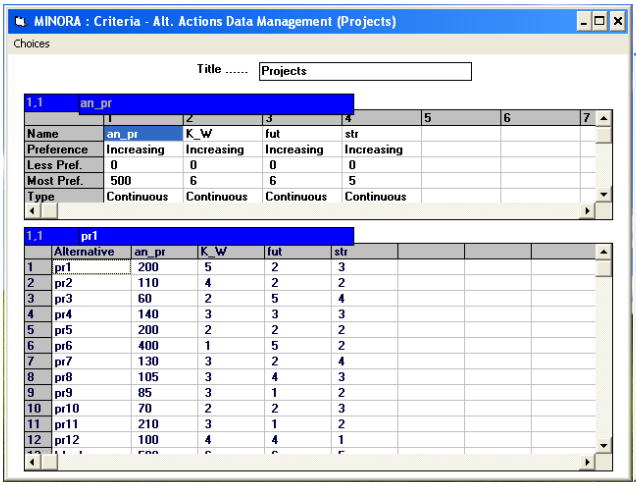
- Type A – Average monthly work load (man/months). The accepted total monthly workload is varied between 40 and 50 man/months.
- Type B – Required equipment and machinery, which are distinguished into three categories. For the category B1, B2 and B3 the maximum availability for the year is five, four and three, respectively. Also, for the rational utilization of the available resources a minimum value of three, two and one is correspondingly indicated to the three categories.
- Type C – Cash flow monthly restriction (K€). This restriction is direct related to the required liquidity for the projects implementation. The decision maker indentifies a maximum available cash flow to 220K€ according to the additional firm's liabilities.

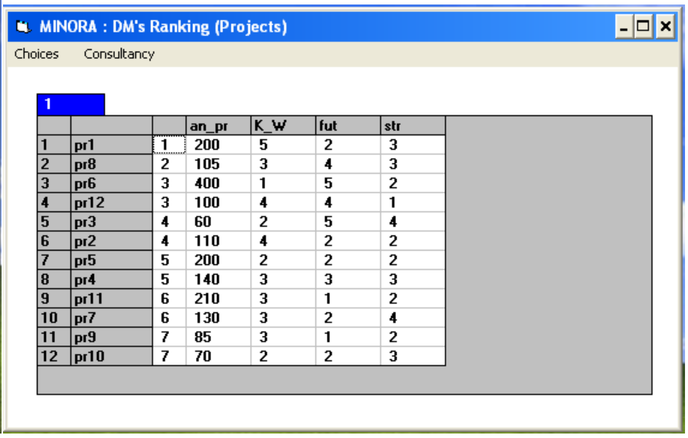
The decision maker had indentified an additional policy restriction that the total expected net income (mean value) and the average standard deviation for the undertaken projects shall be more than 750K€ and less than the average standard deviation of all alternative projects, respectively.
The rating of the potential alternative projects (referred with code names p1, p2, …, p10) together with the resources requirements are presented in table 1. A set of iterative procedures has been implemented for the construction of a consistent family of criteria according to the strategic planning (internal environment) and for the representative modeling of decision maker's preferences. The additive value model was assessed by utilizing the UTA(*) method in the MINORA system and was based on DMs pre-ranking of 12 past projects (referred with the code names pr1, pr2, …, pr12). The performance table of these projects to the consistent

family of criteria and the decision maker's ranking are illustrated in Figures 2 and 3, respectively. The final accepted value model is presented in Figures 4 to 9 (marginal utility functions, weights of the criteria and ordinal regression curve). This assessed additive utility model was used for the evaluation of the 10 alternative projects according to the firm's strategy. The marginal utility of the stochastic criterion Expected Net Income together with the Gaussian distribution of each project and the global utilities are presented in Figure 10 and 11, respectively.

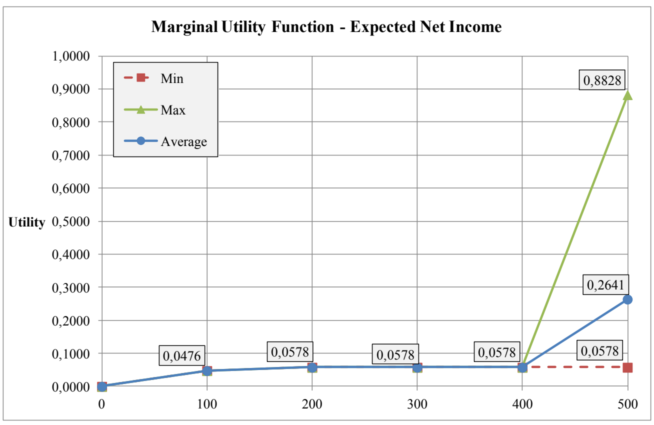
	Internal Environment				**External Environment**		**Resource Type**				
Projects	**Expected Net Income $N(m_j,\sigma_j)$**	**Knowhow**	**Future**	**Strategy**	**Business Risk (R_j)**	**Competition (C_j)**	**A (a_j)**	**B1 (b_{1j})**	**B2 (b_{2j})**	**B3 (b_{3j})**	**C (c_j)**
p1	N (130,10)	3	2	2	2	4	11	1	0,5	0	25
p2	N (420,15)	2	3	3	4	2	18	0	1	1	80
p3	N(80,7)	4	1	2	3	3	5	2	0	0	15
p4	N(200,10)	1	5	3	1	5	12	1	1	0	50
p5	N(300,9)	3	2	2	5	1	15	0	1	0	90
p6	N(170,5)	4	3	3	3	2	13	0	1,5	0,5	32
p7	N(350,20)	5	3	2	2	3	21	1	0	0	40
p8	N(230,18)	1	2	5	2	2	7	1	0	0	22
p9	N(95,12)	4	5	1	3	4	8	1	0	1	15
p10	N(145,10)	2	2	2	1	3	11	0	1	2	18

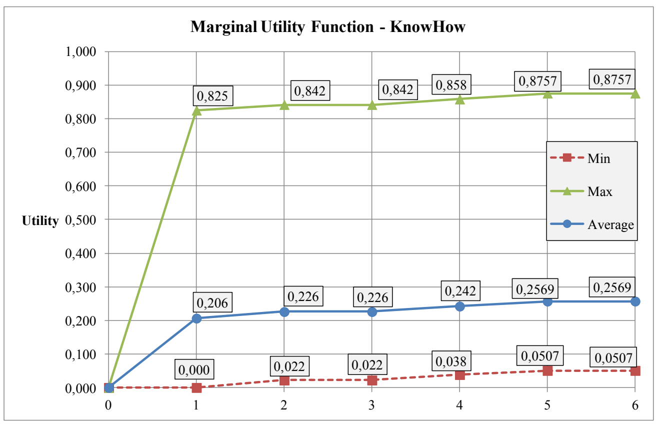
Table 1.Rating of potential alternative projects to the selection criteria and resources requirements



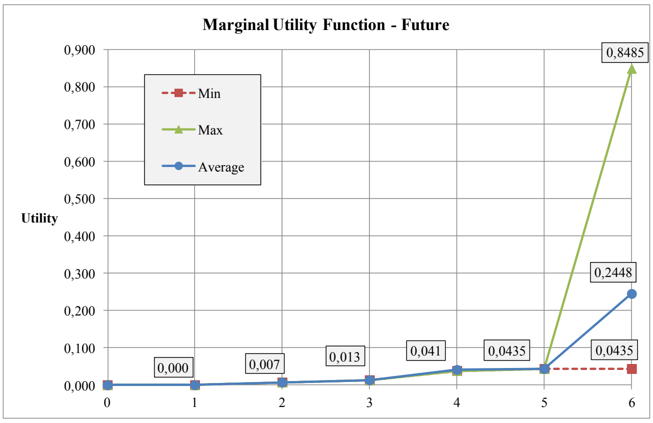


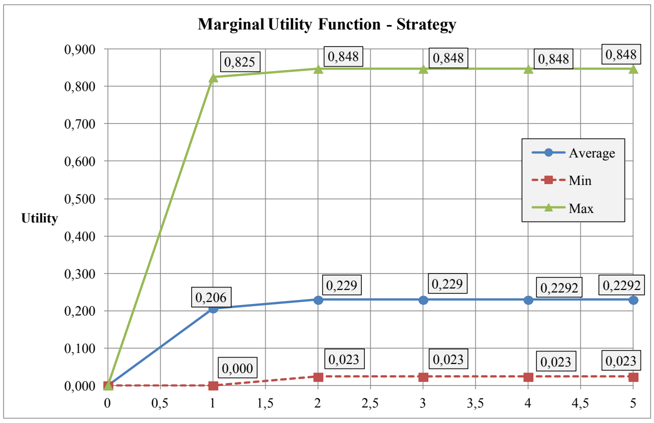
Figures 2 & 3: Past Projects Performance Table and DM's Ranking



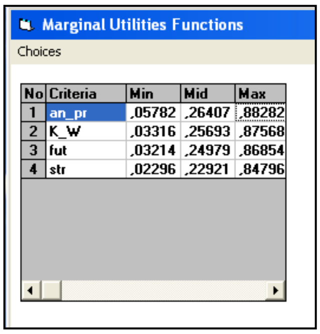


Figures 4 & 5: Value function of the criteria "Expected Net Income" and "KnowHow"





Figures 6 & 7: Value function of the criteria "Future" and "Strategy"



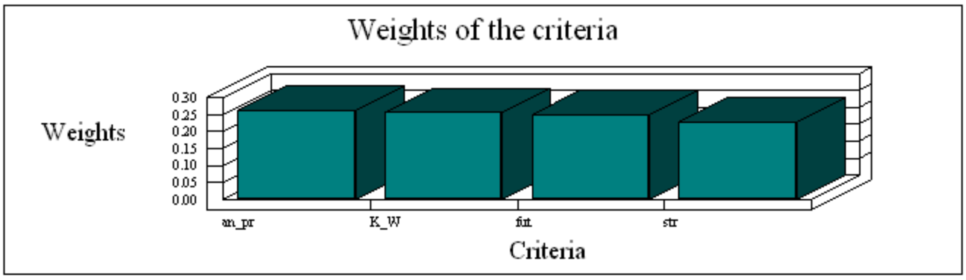
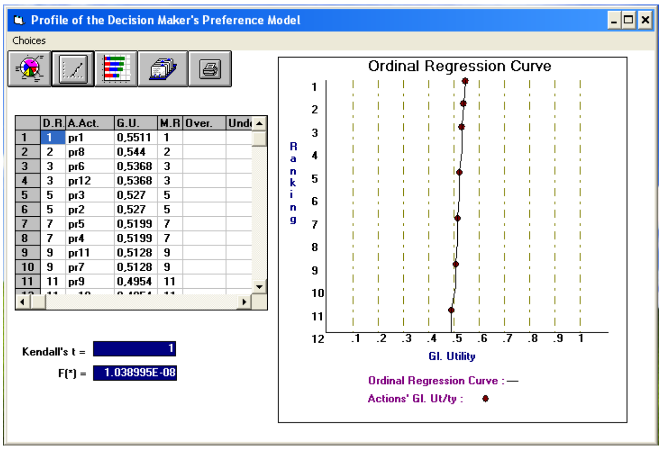
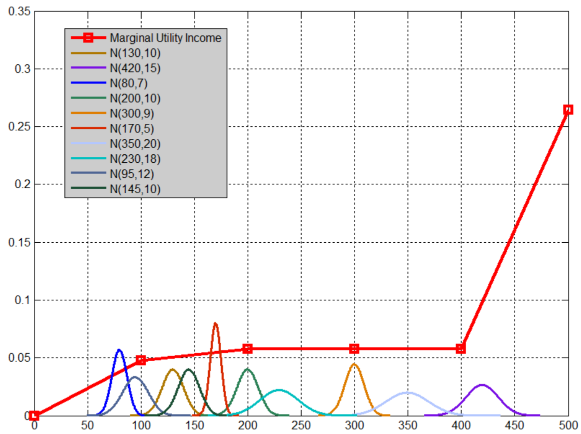


Figure 8: The estimated weights of the criteria





Figures 9 & 10: Ordinal Regression Curve and Gaussian distributions for each alternative project

No	A. Actions	G.U.
1	p7	0,572505
2	p2	0,548397
3	p6	0,539224
4	p4	0,536797
5	p9	0,536037
6	p5	0,530075
7	p10	0,514275
8	p1	0,512775
9	p3	0,509359
10	p8	0,503402

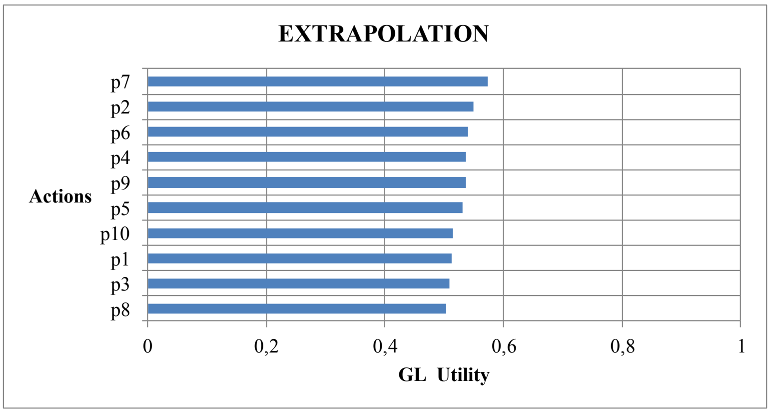


Figure11: Extrapolation to the whole set of jobs

In the second phase according to the proposed methodology, the selection of projects portfolio is accomplished by taking into account the global utilities (Figure 11), the parameters related to the external environment (table 1, Business Risk and Competition) and the resources availability (table 1). Therefore, the following Multi-Objective Linear Programming Problem was created:

Let x= (x_1, x_2, ..., x_{10}) the vector of the unknown values, $x_j \in \{0,1\}$:

Maximize Global Utilities: $g1\ (x) = U_1x_1 + U_2x_2 + \ldots + U_{10}x_{10}$
Minimize Business Risk: $g2\ (x) = R_1x_1 + R_2x_2 + \ldots + R_{10}x_{10}$
Minimize Competition: $g3\ (x) = C_1x_1 + C2x_2 + \ldots + C_{10}x_{10}$

Subjected to conditions concerning (the values of a_j,b_{ij}, c_j are presented in table 1):

- **Resources Restrictions:**
  Resource A ($40 \le A \le 50$): $a_1x_1 + a_2x_2 + \ldots + a_{10}x_{10} \ge 40$
  $a_1x_1 + a_2x_2 + \ldots + a_{10}x_{10} \le 50$
  Resource B ($3 \le B1 \le 5$): $b_{11}x_1 + b_{12}x_2 + \ldots + b_{110}x_{10} \ge 3$
  $b_{11}x_1 + b_{12}x_2 + \ldots + b_{110}x_{10} \le 5$
  ($2 \le B2 \le 4$): $b_{21}x_1 + b_{22}x_2 + \ldots + b_{210}x_{10} \ge 2$
  $b_{21}x_1 + b_{22}x_2 + \ldots + b_{210}x_{10} \le 4$
  ($2 \le B3 \le 4$): $b_{31}x_1 + b_{32}x_2 + \ldots + b_{310}x_{10} \ge 1$
  $b_{31}x_1 + b_{32}x_2 + \ldots + b_{310}x_{10} \le 3$
  Resource C ($C \le 220$ K€): $c_1x_1 + c_2x_2 + \ldots + c_{10}x_{10} \le 220$

- **Business Policy Restrictions**
  1) Expected Total Net Income (mean value) ≥ 750 K€: $m_1x_1 + m_2x_2 + \ldots + m_{10}x_{10} \ge 750$
  2) The average SD of the undertaken projects ≤ Total average SD of all alternative projects: $\frac{1}{k}(\sigma_1x_1 + \sigma_2x_2 + \ldots + \sigma_{10}x_{10}) \le \frac{1}{10}\sum_{j=1}^{10}\sigma_j = 11{,}6$

  k: the number of selected projects
  $x_j \ge 0$, j = 1, 2, ..., 10

The pay-off table (Figure 12) has been calculated by solving the three linear programming problems (Maximize Global Utilities Minimize Business Risk and Minimize Competition subjected respectively to conditions). Then, a pareto optimal solution closer to decision maker's desired level is estimated, by using the desired goals method. The desired level is the following point (Global Utilities, Business Risk, Competition) = (2.35, 11, 12). The decision maker accepted the indicated projects' selection due to high political and economical uncertainty. Higher utility values can be achieved only by significant increase of business risk and competition. The last policy condition has been checked manually after the estimation of the selected portfolio. The average standard deviation of the selected projects is less than the average standard deviation of all alternative projects and equal to 9.25.

Projects	project 1	project 2	project 3	project 4	project 5	project 6	project 7	project 8	project 9	project 10	Utility	Business Risk	Competition
Max_U	0	1	1	1	0	0	0	1	1	0	2,634	13	16
Min_Risk	0	0	1	1	0	0	1	0	0	1	2,133	7	14
Min_Competition	0	1	1	0	1	0	0	1	0	0	2,091	14	8
Desired Level 1	0	1	1	1	0	1	0	0	0	0	2,134	11	12

Figure12: Pay – off Table – Selection of Projects Portfolio with Desired Goal Method

4. Conclusions

The contribution of the proposed methodological frame is focused on specific issues for an effective projects' selection supporting portfolio managers in this area. A structured process is provided to evaluate the alternative projects by taking into consideration the strategic planning, the risks of the external environment, the availability of business resources and the uncertainty of the future outcomes. The synergetic utilization of multicriteria disaggregation - aggregation methods with the multi-objective linear programming techniques allows the complexity management of projects selection problem with the active participation of the DM.
Also, the utilisation of the proposed approach cannot be bordered only to construction firms. The last decades, firms are organized into a project based form because this kind of structure provides flexibility in the internal operation and supports the effective utilisation of the available resources, the operational cost reduction and the achievement of higher quality results. Appropriate adaptations of the proposed methodological frame can be applied in firms and organizations following projects oriented operational structures.
This research work constitutes one step forward in the research of an efficient portfolio selection method aiming to link the desired strategic goals with the expected project achievements. One direction of future research is the exploitation of the proposed approach to support strategic decision making teams (Montibeller and Franco, 2010) by checking the feasibility of alternative strategic plans through the direct interaction between the organizational governance and the executive managers. The enriched of the proposed process with the robustness analysis techniques is another future perspective.

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