

MULTI-OBJECTIVE OPTIMIZATION FOR FACILITIES MANAGEMENT

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Abstract. The main point of this article is to present in a short text all aspects of Multi – Objective Optimization for Facilities Management, so to say from the cradle until the grave. Additionally, the combination of Multi – Objective Optimization with Nominal Methods and Scenario Writing represents an innovation. It is also stated that all stakeholders interested in the issue, instead of one decision maker, have to be involved. First, desk research will discover all the surrounding conditions of the issue under consideration. Therefore, during a period of creative thinking in a nominal exercise all the main influencing events are recorded and finally ranked. From this information, scenarios for the future of the facilities sector are deduced. On basis of all these data, objectives and alternatives are simulated. A Multi – Objective Optimization for the facilities sector is made possible by two methods: an additive method with ratios and the application of Reference Point Theory. Automatically, using these methods, all objectives are normalized to dimensionless numbers between zero and one. Nevertheless, a problem of importance for each objective may remain. Therefore, two methods are proposed. First, weights are granted in a nonlinear way. Secondly, an objective becomes more important by introducing different attributes for the same objective. The latter method seems to be more refined. In this way, a final ranking of the alternatives for the fulfillment of the objectives is obtained.

Keywords: stakeholders, attributes, Delphi method, scorecard method, nominal group technique, scenario writing, simulation, Brauers additive method with ratios, reference point theory, weights.

1. Introduction

On which level the decision making with multiple objectives is taken? The acceptance of a single Decision Maker represents a first option. Recently, Prof. Evangelos Triantaphyllou stated: „in this book we concentrate our attention to single decision maker deterministic MCDM methods“ [1]. Leaving aside that with multiple objectives it is realistic or not to distinguish between deterministic and stochastic methods, a single decision maker is no more of our time. Instead of a decision maker-dictator, we have rather to speak of an arbiter, referee, negotiator, reconciler, or for the practical organization a panel leader.

Several Decision Makers could be chosen haphazardly or voluntarily, which is still different from the notion of „stakeholder“. Stakeholders mean everybody interested in a certain issue. They are represented, either personally or by representative experts. Additionally, they can delegate their viewpoint to trade unions, employer and consumer organizations, to groups of ecologists or to politicians in an indirect

democracy. Stakeholder philosophy is a part of what is called „Group Decision Making“ [2].

Stakeholders in multiobjective optimization are involved in: the necessary desk research, the choice of the objectives with their attributes (the quantitative approach of the objectives), the alternative solutions, projects or simply alternatives, the methods of optimization, with final acceptance of the results. Anyway, negotiations will be needed.

2. Negotiations

Unanimity among stakeholders without any discussion is seldom. Different ways of decision making with stakeholders are possible:

- For day-to-day decisions, some form of delegation may be necessary;
- For very important and broad issues, such as the choice of a Strategy, all stakeholders have to be involved.

Several ways are therefore possible: open discussion methods and nominal methods.

2. 1. Open Discussion Methods

Open Discussion means a dialogue face-to-face presenting on-the-spot opinions. Panels, Committees or Round Table Discussions may show conflicting situations with shy people contra rhetoric and even demagogic orators. The consequence could be that the audience nearly blindly follows this leader like a flock of sheep. Otherwise, passionate debating is possible with failure to make assumptions and reasoning clear with unwillingness to abandon publicly expressed opinions. Brainstorming on these points, which is already better, shows a lack of convergence.

2. 2. Nominal Methods

In nominal methods, the contacts are indirect by intermediate instruments such as computers or by third persons, which means no direct confrontation. Delphi and Nominal Group Technique are examples of the nominal method.

2. 3. The Delphi Method

The Delphi Method is a method for obtaining and processing judgmental data in a nominal way. It consists of a sequenced program of interrogation in session or by mail, the last time also by teleconferencing, interspersed with feedback of persons interested in the issue while everything is conducted through a steering group.

The essential features of Delphi are:

1. It concerns a group of especially knowledgeable people (Expert Knowledge);
2. In case of a meeting: communication between the panel members is impossible (Nominal Method);
3. Inputs have a singular meaning and are quantitative as much as possible;
4. The sources of each input are treated anonymously (characteristic of Anonymity);
5. The opinions about inputs are evaluated with statistical indexes (mostly Median and Quartiles);
6. Different feedbacks of the statistical indexes with requests for re-estimation, also after consideration of reasons for extreme situations, are organized until Convergence is practically reached. In this way, voting is excluded (for more details on Delphi, see [3], p. 39 – 44).

However, what would happen if no convergence is reached and the stakeholders stick to their original position? The Scorecard method may offer an outcome by offering a new project acceptable by everybody.

2. 4. The Scorecard Method

The „Ooster – Schelde“ problem forms an example of a remaining antagonistic opinion between stakeholders. In 1953 the islands of the province of Zeeland in the Netherlands were flooded causing the death of thousands of persons and billions of dollars damage. Closing the islands with one huge dam, making the islands a part of the continent and changing the „Ooster – Schelde“ estuary in a huge sweet water reservoir presented a good solution for the security people but was found very harmful by the ecologists. Higher dikes on the islands were accepted by the ecologists but not by the safety people. In this way, the „Ooster – Schelde“ problem was a good example of antagonistic opinions defended by several groups.

The breakthrough would come by finding a solution acceptable for the parties and more or less satisfying the objectives. It means an effort of creative thinking. The Scorecard Method was invented by Rand Corporation in the case of the Ooster-Schelde [4, 5]. All the advantages and disadvantages of all the propositions were enumerated in a systematic way by tables, graphs etc. On basis of this information, new solutions were looked after bringing a kind of greatest possible divisor for all objectives. The solution found consisted of storm dams in front of the islands which would weaken the floods, but keep the Ooster – Schelde as an open estuary with salt water. This solution was satisfactory to both security officers and ecologists, and the proposition finally passed in Dutch Parliament. Perhaps one objective was overlooked at that time viz. the increase in costs of such gigantic hydraulic public works. Moreover, it is clear that it will not always be possible to find a compromise solution, despite desk research and creative thinking.

2. 5. Nominal Group Technique

To reach convergence with Delphi and Scorecard methods is time and money consuming. Therefore, the Nominal Group Technique maintains Expert Knowledge, the Nominal Method and Anonymity, but convergence is replaced by nominal voting. Individual rates are added up (R).

Originally, Delbecq and Van De Ven designed the Nominal Group Technique [6, 7]. As still much wishful thinking remained, additionally Brauers asked after the possibility of realization. Therefore, the median of the individual probabilities of occurrence of an influencing event was calculated (P). Finally, Effectiveness Rates (E) were ranked [8]:

$$E = R \times P . \quad (1)$$

3. Application: Nominal Group Technique for the Facilities Sector in Lithuania: Which events will the most influence the business outlook of the Facilities Sector in Lithuania in the period 2003-2012) [9]?

3. 1. Definition of the Facilities Sector in Lithuania

- Acquisition, leasing and renting of existing buildings.
- Management of buildings, which is a multi-functional service. This means that all supervision, maintenance and repairing is included in the sector.
- In Lithuania, composed of a small number of small firms, which even performs other tasks, such as waste management.
- In theory the facilities sector could include the entire management of Corporate Real Estate. This means the effective management of which is called in the US *the Fifth Resource*, after the resources of people, technology, information and capital [10].

3. 2. Composition of the group of Stakeholders (2002)

15 delegates from:

- *The Facilities Sector,
- *The Ministerial Departments,
- *The Academic World,
- Steering Group Prof. Dr. W.K. Brauers and Dr N.Lepkova,
- Panel leader, Prof. Dr. W.K.Brauers.

3. 3. Preliminary Desk Research

The panel leader gave some preliminary information in order to assist the participants in their judgments, such as:

- Information about Technological Forecasting,
- Information about SWOT analysis,
- Comparison of indicators concerning the at that moment still candidate members of the European Union,
- The result of a Nominal Group Technique exercise held with students in the previous year about the application of the Nominal Group Technique to the Economic Outlook of Lithuania over the period 2002–2011 [11].

3. 4. The Period of Creative Thinking

The group of participants is asked to generate and write down influencing events about the problem

under examination. These ideas should have a singular meaning and a quantitative form as much as possible. Participants do not discuss their ideas with each other. This stage lasts between five and twenty minutes.

Each person in round–robin fashion produces one idea from his own list and eventually gives further details. Other rounds are organized until all events are recorded.

The panel leader discusses with the participants the overlapping and final wording of the influencing events.

3. 5. The Voting

Each participant has to choose the most important five influencing events from his point of view, with the most important event receiving five points and the less important event one point. The members of the steering group do not participate in the voting. The median of the estimations of the possibility of realization is also calculated. The outcome is presented in table 1.

3. 6. The Outcome

The introduction of probabilities of realization, presenting a sense of reality and a guaranty against wishful thinking, produces quite some changes in the ranking.

The results of the Nominal Group Technique by a group of especially knowledgeable persons around the Facilities Sector are extremely interesting. Nineteen % of all the voting points go to the Membership of the European Union, which indeed will not only influence the Business Outlook of the Facilities Sector, but the Economic Outlook of Lithuania itself. Additionally, this membership will go together with a large increase in foreign capital (rank 2), more relations with foreign companies (rank 8, bis) and exchange of students (rank 19). A positive consequence could be a large increase in Gross Domestic Product (rank 4), together with a negative one: an increase in the cost of living (rank 13). This last consequence could look strange. It is interesting to develop this point a bit further.

When countries with a lower productivity join an economic union, the productivity of the international tradable goods sectors, mostly the industrial sectors, will raise over time to approach as much as possible the higher productivity of the other countries. However, the „Balassa–Samuelson Effect“ maintains that this increase is less the case for the nontradables [12 – 15]. The international tradable goods sectors will

have the opportunity to increase their wages. By osmosis of the labor market, the nontradable sectors have to raise their wages too, although their productivity does not increase in equal importance. Inflation is the result with an increase in the cost of living. In particular, the facilities sector, belonging to the nontradables, will have to pay higher wages without a proportional increase in production. Will this explain more competition between facilities management companies (rank 3) ?

Stability in international security (rank 6) was specified in the students exercise as membership of

Nato (see [10], p. 22), which is realized in the mean time.

Furthermore, the facilities sector is aware of the fact that with the higher demand for new construction (rank 17) and the introduction of new materials and technologies (rank 5) the quality of the construction has not to suffer of the increase in quantity (ranks 7, 8, 11, 17 bis and 21).

More interest of the government in the organization of the economic sectors, such as the facilities sector, is expected (ranks 10, 12, 14, 16 and 22).

Table 1. The events, which were written down during the Nominal Group Technique for the Facilities sector of Lithuania (October 15, 2002)

	Events 2003-2012	Given Points R	Rank	Median Probabilities P	$E = R \times P$	Final rank
1	Member of European Union	37	1	0.75	27.75	1
2	Large increase in foreign capital	20	2	0.75	15	2
3	More competition between facilities management companies	16	3	0.88	14.08	3
4	Large increase in GDP	16	3	0.75	12	4
5	New materials and technologies	12	6	0.75	9	5
6	Stability in international security	14	5	0.50	7	6
7	Higher quality in building construction	8	11	0.75	6	7
8	Application of new information technologies to facilities management	9	9	0.63	5.67	8
8	More relations with foreign companies having more experience in facilities management	9	9	0.63	5.67	8
10	Better legislation in supervision sector	11	7	0.50	5.5	10
11	Optimal quality-price relation for services	7	13	0.75	5.25	11
12	Better public estimation for facilities management	8	11	0.63	5.04	12
13	Increase of the cost of living	10	8	0.50	5	13
14	Positive influence of the laws in favor of facilities management	6	16	0.75	4.5	14
15	Higher qualification of the staff in facilities management	5	20	0.75	3.75	15
16	Change taxation for buying and selling property	7	13	0.50	3.5	16
17	Higher demand for construction	6	16	0.50	3	17
17	Higher level of education	6	16	0.50	3	17
19	International exchanges between students in facilities management	7	13	0.25	1.75	19
20	Increase of industrial sector and decrease of agricultural sector	6	16	0.25	1.5	20
21	Improvement of sanitary services	4	21	0.25	1	21
22	Increase of individual property of housing	1	22	0.25	0.25	22
	Total Points	225			145.21	

Finally, a decrease of the importance of the agricultural sector (7 % of GDP, see [8] p. 4) in favor of the industrial sector is beneficial for the facilities sector (rank 20).

4. Scenario Writing for the future of the Facilities Sector

The Nominal Group Technique for the Facilities Sector stimulates to go a step further by writing down scenarios for the medium and the long term.

4. 1. The Fifth Resource Scenario

Foreign direct investments will come to Lithuania. They may find industrial zones with ready premises. However, they want more and they like to decide themselves on location. This is the moment that the fifth resource beside the resources of people, technology, information and capital, comes fully alive, namely the management of the Corporate Real Estate Assets. New companies will respond to this demand. These new companies of real estate assets management will look after space (location), design of the buildings, construction, reparations, maintenance, waste management and eventually demolition. They will look after the direct investments so to say „from the cradle until the grave“.

4. 2. The Status Quo Scenario

In this scenario, the situation in the facilities sector does not change. A set of small firms will remain operative. By competition, aging, disagreement, etc. some small firms will disappear, but new ones will take their place.

4. 3. The Cut Throat Competitive Scenario

In the Cut Throat Competitive Scenario the consequences of the „Balassa–Samuelson Effect“ will fully play. The productivity in the new member countries of the European Union will increase in the internationally traded sectors. The result is an increase in wages. The more national services have to raise their wages too, without an increase in productivity of the same size. This increase in wages will have an inflation effect in the country.

The Facilities Sector in Lithuania will fully undergo that influence. If it increases its prices, together with the other not internationally traded services, inflation will go up in Lithuania and ipso facto the cost of living will rise.

Instead of increase in prices, diminution of quality of its services forms another alternative for the facilities sector. At that moment cut throat competition between the facilities management companies will occur. In this struggle for life, only the fittest will survive. It is also the moment that mala fide companies will appear, which will exploit the customers as much as possible.

5. Simulation of a Choice of Objectives and Alternatives for Facilities Management

The stakeholders choose, given Consumer Sovereignty, the following Objectives in Macro–Economics: Employment, Terms of Trade evolution, Gross Value Added and Balance of Payments beside objectives from Micro–Economics (NPV, IRR, Pay Back Period, Turn Over).

Given the Scenarios the Sector Managers decide to go in the offensive themselves by the following growth alternatives:

- Expansion in the own Country → Project *C*
- Expansion mostly in the European Union → Project *B*
- Expansion mostly in Eastern Europe → Project *A*

6. Methods of Optimization as applied for Facilities Management

Given Consumer Sovereignty, it is necessary to use Nonlinear Methods, namely Ratio Analysis with Brauers Additive Method and Reference Point Theory with Maximal Criterion Values.

6. 1. Ratio Analysis with Brauers Additive Method

As agreement is reached on objectives and alternatives, the starting point is the matrix:

$$(x_{ij}), \tag{2}$$

with: x_{ij} as the response of alternative j on objective i
 $i = 1, 2, \dots, n$ as the objectives
 $j = 1, 2, \dots, m$ as the alternatives

For optimization these responses, but normalized, are added in case of maximization and subtracted in case of minimization:

$$N^V_j = \sum_{i=1}^{i=g} N^x_{ij} - \sum_{i=g+1}^{i=n} N^x_{ij}, \tag{3}$$

with: $i = 1, 2, \dots, g$ as the objectives to be maximized,

$i = g+1, \dots, n$ as the objectives to be minimized
 $N^v_j =$ the normalized situation of alternative j responding to all objectives

$$N^v_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^m x_{ij}^2}}, \quad (4)$$

$N^v_{ij} =$ the normalized response of alternative j on objective i ; normalized as a dimensionless number is obtained between zero and one.

6. 2. Reference Point Theory with Maximal Criterion Values

In Reference Point Theory with Maximal Criterion Values, a Maximal Criterion Reference Point is chosen, possessing as co-ordinates the dominating co-ordinate per objective of the candidate alternatives, the lowest co-ordinate in the minimum case.

In order to be sure of a nonconvex outcome, necessary for Consumer Sovereignty, the Min–Max metric with absolute values is chosen (see: [3] p. 159 – 163):

$$\text{Min}_{(j)} \{ \max_{(i)} \{ |r_i - N^v_{ij}| \} \}, \quad (5)$$

with: $r_i =$ the i^{th} co-ordinate of the maximal criterion reference point or of the minimum value in case of a minimization of an objective. For the latter, absolute values have to be introduced in the formula.

For objectives and alternatives, an example of a matrix is simulated in the following table 2. The three projects A, B and C are considered to face the following objectives with their attributes:

- 1) Maximization of Net Present Value (in m. \$),
- 2) Maximization of Internal Rate of Return in interest percentage,
- 3) Minimization of Payback Period in years before end of the year,
- 4) Minimization of Taxes minus Subsidies (in % of Profits),
- 5) Maximization of Domestic Turn Over in billion \$,
- 6) Maximization of Turn Over in Eastern Europe in billion \$,
- 7) Maximization of Turn Over in European Union in billion \$,
- 8) Maximization of Turn Over in the Rest of the World in billion \$,
- 9) Minimization of the Deterioration in the Terms of Trade as a % of Net Present Value,

- 10) Maximization of Employment in number of jobs,
- 11) Maximization of Gross Value Added in billion \$,
- 12) Maximization of Surplus in Balance of Payments in million \$.

6. 3. The Final Ranking for Facilities Management

After a cardinal exercise like performed in table 2, is it allowed to draw an ordinal conclusion? Arrow is right when he states: „Obviously, a cardinal utility implies an ordinal preference but not *vice versa*“ [16].

Accordingly, the following ranking gives Project B as the optimal solution:

- 1) Project $B \rightarrow$ Expansion mostly in the European Union.
- 2) Project $A \rightarrow$ Expansion mostly in Eastern Europe.
- 3) Project $C \rightarrow$ Expansion in the own Country.

The Ranking Result is the same for the two methods:

- Brauers Additive Method with Ratios
- The Reference Point Theory

7. How to give More Importance to an Objective?

Table 2 subtable 2c shows per objective dimensionless measures between zero and one. In this way normalization occurred. Nevertheless, it is possible that an objective needs to have more importance than the other ones. Two ways are open for that purpose: the introduction of weights or of more attributes around an objective.

7. 1. The Method of Weights

In order to give more importance to an Objective its dimensionless numbers, obtained in the additive method with ratios, are multiplied with a coefficient. Assume, for instance, that more importance needs to be given to employment then the dimensionless numbers for employment of table 2c are, for instance, multiplied by 2. After the definition of Schlaifer [17], it means attributing weights in an indirect way. This introduction of weights has nothing to do with the Linear Method with Weights or Piecewise Linearity with Weights, which were rejected on the ground of very fundamental objections (for more details: [3] p. 135, 155–160, 166). Indeed Ratio Analysis, on basis of the calculation of ratios, can rather be classified as a nonlinear method. Moreover, in a second stage, the

Table 2. Simulation for Facilities Management (10 year period)
Table 2a. Matrix of responses of alternatives on objectives

1. NPV (in m.\$)	2. IRR (in %)	3. Payback Period (before end of y.)	4. Taxes min. Subsidies (in % of Profits)	5.1 Domestic Penetration. (bln \$)	5.2 Pen. Eastern Europe (bln \$)	5.3 Pen. European Union (bln \$)	5.4 Pen. Rest of World (bln \$)	6. Deteriorat. Terms of Trade (% NPV)	7. Employm (jobs)	8. Gross V.A. (bln \$)	9. + Bal of Paym. (in m. \$)
Project A	25.5	5	10	1	20	4	2	20	1000	11	4
Project B	21	5	12.5	8	1	30	1	5	2,200	22	3
Project C	19.5	4	15	36	0	0	0	0	4,000	25	1
Sum	66	14	37.5	45	21	34	3	25	7,200	58	8

Table 2b. Sum of squares and their square roots

Projects											
Project A	16000000	650.25	25	100	400	16	4	400	1,000,000	121	16
Project B	3240000	441	25	156.25	64	900	1	25	4840000	484	9
Project C	2560000	380.25	16	225	1296	0	0	0	16000000	625	1
Sum of squares	21800000	1471.5	66	481.25	1361	916	5	425	21,840,000	1230	26
Square roots	4669.047	38.360136	8.124038	21.937411	36.891733	30.265492	2.236068	20.615528	4673.32858	35.07136	5.09902

Table 2c. Attributes divided by their square roots and Brauers additive method with ratios

	sum	rank
Project A	0.856706	2
Project B	0.385518	1
Project C	0.342682	3

Table 2d. Co-ordinates of the reference point equal to the maximal criterion values

r_i	0.856706	0.6647526	0.492	0.4558423	0.9758284	0.99875234	0.9912279	0.89443	0	0.855921	0.712832	0.78446
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Table 2e. Deviations from the reference point

	max.	rank
Project A	0	2
Project B	0.471188	1
Project C	0.514024	3

addition of ratios, concerns an addition of dimensionless numbers with no link with linearity.

7. 2. The Introduction of More Attributes around an Objective

Secondly, to give more importance to an Objective, the Stakeholders agree to add one or more Attributes around that Objective, reminding that attributes concern the quantitative approach of the objectives. For instance, in the Simulation Exercise, more importance can be given to the Employment Objective by introducing, beside an attribute concerning Direct Employment, another one concerning Indirect Employment. In this way the 12 attributes of table 2 are increased to 13 attributes in table 3.

The Attribute Method is more refined than the Weights Method as the attribute method succeeds in characterizing an objective better. For instance in table 3c for Project A, 2×0.21398 of table 2c, is changed in: $0.21398 + 0.1589908$, characterizing the direct and the indirect side of employment. Therefore, the introduction of more Attributes around an Objective is preferred above the Method of Weights. The corresponding results are found in table 3.

8. A changed Final Ranking for Facilities Management in Lithuania

The Final Ranking is changed for Brauers additive method with ratios:

- 1) Project C → Expansion in the own Country,
- 2) Project B → Expansion mostly in the European Union,
- 3) Project A → Expansion mostly in Eastern Europe,

The First Rank of Project C is here understandable as C is very labor-intensive in Lithuania itself.

The Ranking Result is not the same for the Reference Point Theory, where the ranking did not change from the first simulation, namely:

B P A P C (P means preferred to)

Does it mean that Reference Point Theory is not refined enough ?

9. General Conclusions

The purpose of this article was to examine multi-objectives, eventually with a possible optimization and as a strategy and not for day–o–ay decisions. Strategy

would mean a policy for the long run, but also for the middle term and even for immediate use in case of a sudden trend break. At this occasion, not a single decision maker is taken into account, but all the stakeholders interested in the issue under consideration.

Under these circumstances, all aspects leading to multiple objectives and their optimization are considered, so to say from the cradle until the grave.

With „desk research“ one has to be aware of all the conditions surrounding the issue. Moreover, many influencing events may bring unexpected changes. With a Nominal Group Technique one tries to grasp the most important influencing events. At that moment, preparedness for initiating scenarios is assumed. Scenarios are, in plain terms explained, simple descriptions of the future. However, a set of effective scenarios has to cover all future possibilities in a certain domain. After that stage, one has to be clear about the desired objectives and to be ready to give alternatives their chance to fulfill these objectives. What will be the best or rather the optimum alternative for this fulfillment? Therefore, two methods were chosen: an additive ratio system and the reference point method. On basis of simulations, the reference point method seems not to be enough refined. Therefore, the reference point method is only maintained as an extra control instrument on the ratio method.

Is it possible to give more importance to an objective? First, it has to be noted that with the proposed additive ratio system all objectives are already normalized until values between zero and one. If nevertheless, the importance of an objective has to be more accentuated, the attribution of weights is a possibility, at least on nonlinear grounds. More importance to an objective will rather be given by increasing its attributes, which additionally increases the information on this objective. As an example, more importance was given to employment by means of distinguishing two attributes, namely maximization of the number of jobs in direct and in indirect employment, represented each with a utility between zero and one.

These different stages of Multi – Objective Optimization from the cradle until the grave were illustrated by the application on the Facilities Sector of Lithuania.

We tried to cover all aspects of multiobjective decision making in a nutshell. Perhaps too ambitious,, nevertheless, we hope it will be useful for the reader.

Table 3. Simulation for Facilities Management with subobjective „Indirect Employment“ (10 year period discounted)
Table 3a. Matrix of responses of alternatives on objectives

Projects	1. NPV (in m. \$)	2. IRR (in %)	3. Payback Period (before end of y.)	4. Taxes minus Subsidies (in % of Profits)	5.1 Domestic Penetration. (bln \$)	5.2 Pen. Eastern Europe (bln \$)	5.3 Pen. European Union (bln \$)	5.4 Pen. Rest of World (bln \$)	6. Deteriorat Terms of Trade (% NPV)	7. Direct Employem (jobs)	8. Indirect Employem (jobs)	9. Gross V.A. (bln \$)	10. + Bal of Paym. (in m.\$)
Project A	4,000	25.5	5	10	1	20	4	2	20	1000	250	11	4
Project B	1,800	21	5	12.5	8	1	30	1	5	2,200	400	22	3
Project C	1,600	19.5	4	15	36	0	0	0	0	4,000	1,500	25	1
Sum	7,400	66	14	37.5	45	21	34	3	25	7,200	2,150	58	8

Table 3b. Sum of squares and their square roots

Projects													
Project A	16000000	650.25	25	100	1	400	16	4	400	1,000,000	62500	121	16
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Table 3e. Deviations from the reference point

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