An Interactive Method for Project Evaluation, Risk and Development Trend Assessment

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KEYWORDS

Project Evaluation, Multiattribute Utility Function, Risk and Trend Assessment

ABSTRACT

Description has been performed of the methodology of selecting alternatives in the regional planning and management of the Building Industry. A new stochastical approach has been developed not only to evaluate the project proposal, but also to determine the risk and the trend of possible development. An interactive computer program for the subjective evaluation and analysis of the designed system is presented. This program has been used for assessing recent industrial and urban developments on the territory of Czechoslovakia.
By using the multidimensional analysis it has been possible to solve successfully the most various projects, like the reconstruction of urban centres, the investment policy of an extensive territorial complex and route design, including also the consideration of alternative solutions for TEM (Transeuropean Motorway North-South) construction.
The goalseeking application of the multidimensional process connected with the evaluation of risks and development trends enables to introduce an advanced building technology into the practice, where a simple economic calculation is not adaquate to the solved technological problem.
In contrast to the usual multiattribute utility function (MUF) the authors use three dimensional multiattribute evaluation systems {MUF | 3 dim}.

La méthode interactive pour l´évaluation du projet, pour la fonction multiattributive d´utilité et pour l´évaluation de la tendance

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MOTS CLÉFS:

Evaluation du Projet, Multiattributive fonction d´utilité, Risque et Evaluation de la Tendance

SOMMAIRE:

L´étude décrit la méthodologie concernant la sélection des alternatives dans la planification du territoire et dans le management de l´industrie du bâtiment. Un nouvel accès stochastique a été développé non seulement pour l´évaluation du projet proposé, mais aussi pour la détermination des risques et des tendances du développement possible. L´étude comprend aussi le programme interactif du calculateur pour l´évaluation subjective et pour l´analyse du système déssiné. Ce programme a été appliqué pour l´évaluation du récent développement industriel et urbain sur le territoire de la Tchécoslovaquie.
En utilisant l´analyse multidimensionnelle, il a été possible de résoudre avec succès les projets les plus différents, y compris la reconstruction des centres urbains, la politique d´investissements des vastes complexes territoriaux et le dessin de la route, et aussi la considération des solutions alternatives pour la construction de TEM / Autoroute Transeuropéenne Nord - Sud /.
L´application consciente du procédé multidimensionnel évaluant en même temps les risques et les tendances de développement permet d´introduire une technologie avancée de construction dans la pratique dans les cas, où une calculation économique simple n´est pas adéquate du problème économique respectif.
A la différence de la fonction multiattributive de l´utilité / MUF / les auteurs ont appliqué les systèmes multiattributifs d´évaluation de trois dimensions {MUF | 3 dim}.

INTRODUCTION

A new technique, called "Multidimensional Analysis of Projects Proposals" has been developed and mainly used for the Urban Planning, but the experience with its applications in the Building Industry are also available. The main innovation consists in the evaluation of the risk and development of project proposals.

MULTIDIMENSIONAL MULTIATTRIBUTE EVALUATION SYSTEM

This paper offers the practical illustration of methods selecting alternative regional or general economic strategies in connection with conflicting multiple objectives in an enviroment, which is mainly given as fuzzy.

The construction of effective variants in the technical sphere has two phases:

1. evaluation and creation of criteria,
2. rational change of existing proposals oriented at improved results.

In contrast to usual multiattribute utility functions (MUF) the authors have selected and widely practically used three multiattribute evaluation systems (MUF | 3 dim) working with

1. dim - absolute evaluation,
2. dim - risk connected to dim 1,
3. dim - evolution tendencies connected with dim 2.

The structure of criteria is given by means of graphs (branch graphs). For example, the applications in the sphere of urban planning worked usually with the main goals formulated as given in Table I, (another application being in Fig. 1), the reconstruction of a historical city centre. Both examples are characterized by a deeper deviation of criteria on the practical level of solution, which has been described in detail and finally evaluated by means of technical indices of the (MUF | 3 dim).

The main problem of the multicriterion optimization is well known, and can be considered in the following form:

$$\underset{x \in X}{\text{maximize}} \left\{ f_1(x), f_2(x), \ldots, f_m(x) \right. \qquad \text{Eq. (1)}$$

where $f_i \in R^1$, $i = 1, \ldots, m$, is the criterion function of an n-dimensional decision variable x , and X is the constrained set of feasible decisions.

To deal with the problem, we consider an overall decision problem in the following form:

$$\text{maximize } U \left\{ f_1(x_1), f_2(x_2), \ldots, f_m(x_m) \right\} \qquad \text{Eq. (2)}$$

The function $U \in R^1$ is the overall preference function defined on the values of the multidimensional criteria function, and the multiattribute utility analysis assesses the problem in the form

$$\sup_{x_i \in X} U(x_1, x_2, \ldots, x_m) = \sup_{x_i \in X} U(u_1(x_1), u_2(x_2), \ldots, u_m(x_m)) \qquad \text{Eq. (3)}$$

In this notation x_i denotes the measure of effectiveness of all objectives i and is used in the place of the $f_i(x_i)$,which is subjectively assessed as $\{ x_i \mid 3 \text{ dim} \}$.

The practical solution has been elaborated in the MDAP (Multidimensional Analysis of Proposals) - computer program, and the single decision maker on the expert evaluation level works with a code-table shown in Table II.

To convert the values of technical, economic or other parameters into the required type, for example into the seven-degree evaluation, it is necessary to determine, first of all, the marginal values. The dependence between the marginal values can be either linear, or non-linear. For the evaluation purposes the MDAP computer program includes four different groups of utility transformation functions containing always three main functional modifications filled up with three elementary utility functions. The individual evaluator-engineer has altogether $4x(3 \times 3) = 36$ possibilities how to shape the utility functions, and each of them may be modified in such a way as to be inversed by the computer program, and with regard to this fact there are 72 possibilities how to control the right shape of the proposed utility transformation. The Evaluator-engineer, a specialist in a particular technical sphere, has to select the right transformation function and computer program MDAP transform the evaluated technical index, like m2 / inhabitant, costs / m2, etc., to the respective utility units.

There exists an insight into the Eq. (3) , and its utility functions, $u_i(x_i)$.

More insights into the multidimensional analysis of the project proposal evaluation are represented by Fig.2. The evaluator-engineer gives the probability density input as a function from the data base by means of Table II. This function has to reflect the past experience of the evaluated attribute (criterion) , and this result has to be transformed into the modified function by menas of the utility transformation functions, the graphic description of which is shown in the middle of Fig. 2. The interactive MDAP computer program arranges the assessment and calculation of single or group evaluations. Then it is necessary to perform the aggregation to single knots of the decision network. In this phase a new information concerning the designed variant is available.

Fig. 2, represents the process of solution. Zhe input probabili-distributions obtained from the data base distributions have been transformed into the distributions of modified utility functions - see the middle part of Fig. 2. The aggregation of these distributions is giving us the resulting evaluations in individual knots of the graph - see the dotted distributions in Fig. 2. On the basis of statistical charakteristics like mean value,dispersion, obliquity, etc.,it is possible to compare the achieved results to individual knots of the graph.

Fig. 3, shows the probability distribution function of two urban soultions of a territorial complex, and was constructed from the probability distribution to the decision tree end knot. At first sight it is evident from the solution that the result prefers the variant solution indicated as "A" against the solution indicated as "X" to the whole extent of the evaluation scale. The obtained result of this solution is unambiguous,and leads to an unambiguous selection of the variant solution. More com-olicated situations can, however, occur, whose solution is not unambiguous at first sight, and where even the current method of evaluation performed by the undimensional way can lead to incorrect results. This situation is shown in Fig. 4. The solu-tion indicated as "C" has been preferred on the probability level, P = 0.65, and from this level the solution "D" is more interestimg. It includes also more advantageous results in the whole zone of the so called "commercial reliability", i.e. P = 0.75 to P = 0.90.

The above mentioned process is of big practical importance particularly in those technical, urban or economic solutions, in which individual variants are loaded by various extents of risks and by various trends of developments.

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TABLE I.

Main structure of decision criteria

Code	Name of criterion	Priority
1	Assets from the view-point of the satisfaction of social needs and improvement of living conditions of the population	.50
2	Costs, requirements and negative consequences connected with the realization of evaluated variant	.50
1.1	Economic assets	.30
1.2	Social assets	.20
1.3	Assets to cultural values of the territory	.20
1.4	Assets in ecological sphere	.20
1.5	Other assets	.20
2.1	Costs, requirements and negative consequences in economic region	.20
2.2	Drawing of non-renewable resources	.10
2.3	Negative consequences in social sphere	.30
2.4	Negative consequences in ecological sphere	.30
2.5	Negative consequences in cultural sphere	.10

TABLE II.

Evaluation of the achieved results·

Mean Daily Solar Radiation (langleys)	Exposure Period, (years)			
	10	15	20	25
	Untreated[a]			
300	.016	.029	.043	.056
350	.021	.036	.051	.067
400	.025	.043	.060	.078
450	.029	.049	.069	.089
500	.034	.056	.078	.099
	Specially Treated[b]			
300	.008	.015	.021	.028
350	.010	.018	.026	.033
400	.013	.021	.030	.039
450	.015	.025	.034	.044
500	.017	.028	.039	.049

[a] After allowing for 0.010-inch swelling (thickness increase).

[b] After allowing for 0.005-inch swelling.

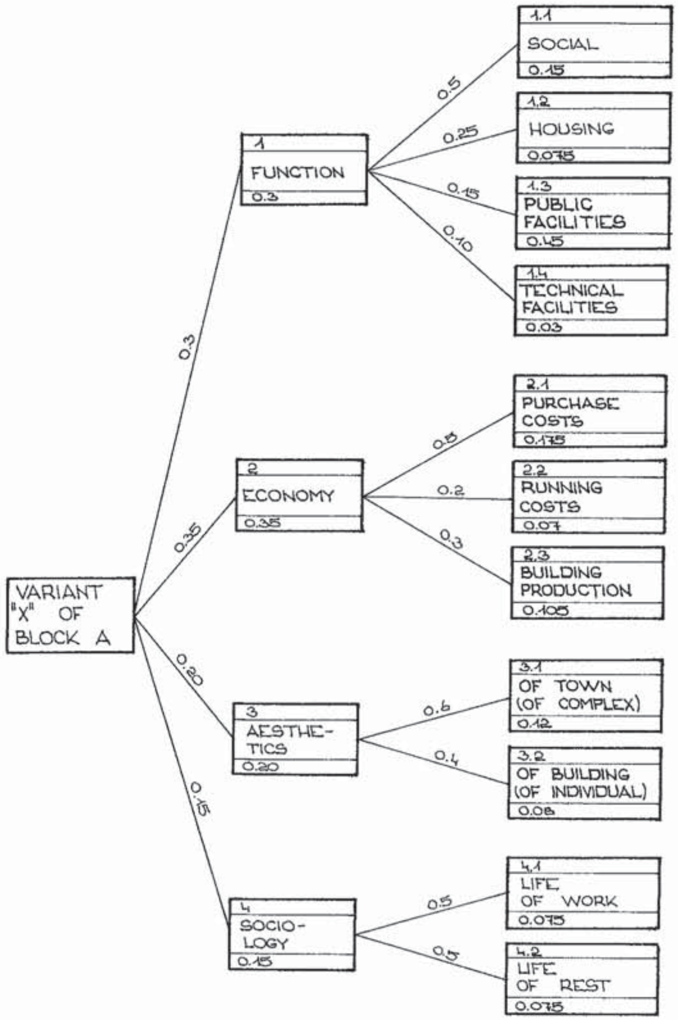

Fig. 1 Criterions for the reconstruction of a historical city core.

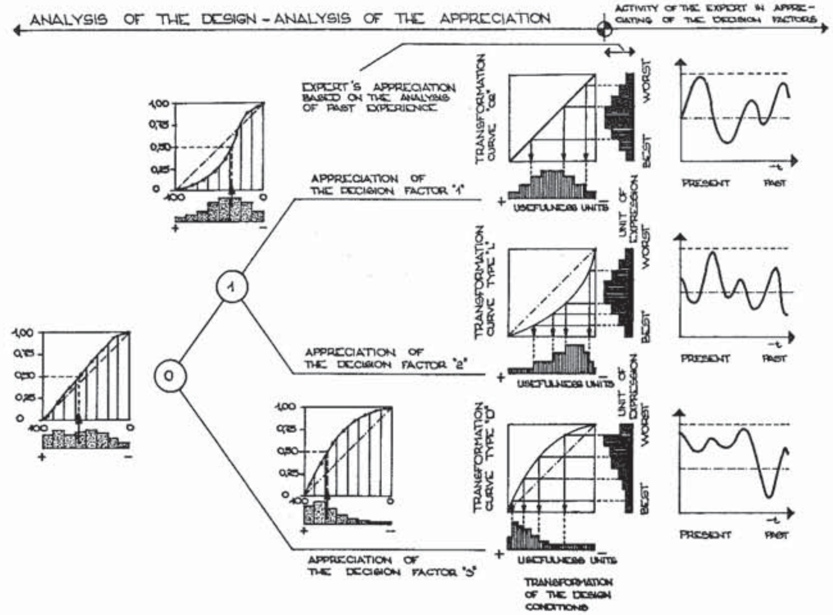

Fig. 2 Scheme of the algorithm solution.

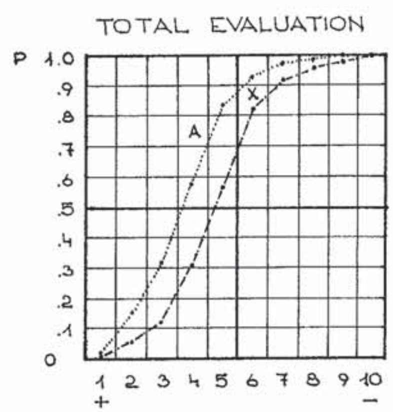

Fig. 3 Comparison of variants with the same risk and development.

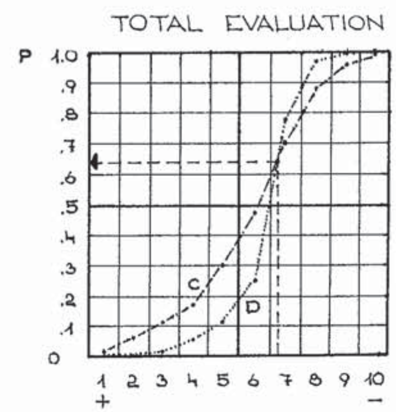

Fig. 4 Comparison of variants with various risks and developments.