

Chapter 7

Vector Distribution of Limited Resources in Complex Systems

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ABSTRACT

The problem of distribution of the given global resource of the system under the constraints imposed on individual resources is considered. It is shown that the problem lies in constructing an adequate objective function for optimization of the resources distribution under their limitations. For solving the considered problem, the multicriteria optimization approach is undertaken with the nonlinear trade-off scheme. The proposed nonlinear compromise scheme has the property to adapt to the situation of multicriteria decision-making. The adaptation to the situation of a nonlinear scheme is carried out continuously, while the traditional selection of compromise schemes is done discretely that adds to subjective errors the errors, associated with the quantization compromise schemes. Model examples are given.

INTRODUCTION

In various areas of management and economics the problem of such resource distribution of the controlled system between the individual elements (objects), which provides the most effective functioning of the system under the given conditions, is urgent (Voronin, 2017). The problem of allocating of limited resources is a main problem of economics. It is believed that the proper distribution and redistribution of resources – this is just the economics. Similar problems arise in other subject areas, in particular, in techno-social systems for modern economical and governmental

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infrastructures. The art is to allocate properly limited resources, depending on the circumstances.

Often the problem is solved subjectively, on the basis of the experience and professional qualifications of a decision maker (DM). In simple cases, such approach may be justified. However, when there is a large number of objects and for important cases, the price of the error of management decisions sharply increases. The development of the formalized methods of decision making support, for competent resource distribution between objects, taking into account all the given circumstances, becomes urgent.

One of such circumstances is usually resources limitation. The most prevalent is the case of upper limitation of a total (global) system resource to be distributed among the individual objects. The problem of redistribution of resources, while decreasing the previously planned level of projects funding, is considered, in particular, in Voronin (2004).

In practical cases, constraints are imposed not only on the global resource, but also on the individual resources, given to individual objects. The constraints may be imposed both from below and from above. Such constraints either are known in advance, or are determined by technical and economic calculations or by peer review methods. One should distinguish the conditional limitations (when the violation of limits is not desirable) and limitations unconditional (when their violation is physically impossible).

Example 1

To run several flights to different cities the airport has a certain fuel resource to be distributed between the aircrafts. For every flight there is a lower limit below which the fuel providing is pointless, because the plane just will not fly to its destination. This is the essence of the lower limit for every individual resource. If the given flight obtains the fuel above the certain lower limit, it has, on the one hand, an opportunity to maneuver freely by echelons, bypass a thunderstorm, going away to an alternate airfield, etc. On the other hand, the partial resource cannot be increased unlimitedly too, since there is an upper bound of the resource. This is understandable, since every aircraft has a certain capacity of tanks and physically it cannot take on board more fuel.

But usually the upper limit is introduced as conditional and assigned by the flight plan. Taking into account this set of constraints, it is required to allocate the global resource of fuel between flights to ensure the most effective operation of the airport as a whole.

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