

A HEURISTICS EVOLUTIONARY APPROACH TO THE RESOURCE ALLOCATION TO MULTIPLE PROJECTS

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ABSTRACT

The authors present a two-level approach to solving a multi-projects resource allocation problem using a heuristic evolutionary approach derived from a sound theoretical background. It is focused on the commensurable human resources. The approach is based on heuristic rules on the upper level and the direct search method with evolutionary improving characteristic on the lower level. The basic concept of approach is explained by an illustrative example.

INTRODUCTION

The resource allocation to multiple projects is often required solving in every organizations. Though the problem of human resource allocation has several angles with a long range or a short range viewpoint, the work presented here is focused on the short range viewpoint to maximize the overall project performance. The problem of human resource allocation to a specific project consists of the assignment of key personnel and that of compatible personnel. This means the human resource allocation is a multiple objective decision making problem which includes the commensurable and incommensurable objectives. In real situations, the key personnel for a specific project can be identified among those persons being available to the specific project or not, and the resolution of this incommensurable resource allocation problem is to find the compromise solutions based on the availability among the candidates taking the fitness or adaptability to the project into consideration and this can be done intuitively by the managerial judgment of decision makers. The resource allocation of compatible personnel to the project is based on their skill level and the availability to the project. The problems of resource allocations have been well investigated. Among these research results, the approaches by mathematical programming have the long history and a typical one is to solve the varieties of allocation problems by linear programming.

Due to rapid change of business environment, it is desired to have a simple rule that has a sound theoretical background to adapt quickly to align the present state of resource utilization to more efficient and effective ways of usage. The resource allocation problem in the present study is focused on the commensurable resources and the work is concerned with utilizing the principle of allocation without directly solving the problems. The principle is presented by a set of heuristic rules that give us the solutions directly applicable to the real practice. A heuristics evolutionary approach is to take appropriate actions to have better states from the evolutionary viewpoint using some heuristic rules. The applications of heuristic rules to a specific situation will give us the insight on the reason or interpretation on the justifying remedial actions to realize better situation. It is always necessary for the upper level of managers to control simultaneous running projects and to align the current situation to better or more efficient one. Such dynamic alignment of resource allocations leads to evolutionary change from the current state to better one.

The authors present firstly a two level of hierarchical structure of decision making and secondly the

methods of decision making for resource allocations in each level. The approaches in each level have the evolutionary characteristic.

A TWO LEVEL APPROACH TO DECISION MAKING

Multi-level approaches to decision making in organizations have been well investigated in the past four decades. One of the authors reported papers on the optimal design methodologies of processing systems by two level approach[1,2] and has recognized its applicability to various areas because of generic systems characteristics. Regarding the coordinating activities in the hierarchical structures, a typical one is a two level approach where the upper level has a role of coordination among the lower level activities subject to some constraints given by the upper level decision making. The resources are allocated from the upper level management to each organization such as a project team positioned on the lower level. The activities of projects teams (lower level activities) should be carried out within the given resources. It is, however, not expected to make the optimal allocation from the beginning of project execution due to the existence of uncertainties in the project life cycle. Therefore the alignment of resource allocation should be occasionally done by the coordination on the upper level decision making. Assuming that the lower level activities are carried out optimally during a certain period before alignment being done subject to the given constraints of resource allocated to each organization, the coordination on the upper level should be made the best efforts toward the optimal allocation. The optimal decision making on this allocation should be based upon the upper level organizational preference from the standpoint of profit, business strategy, technological advantage etc. The present work is concerned with the heuristic approach aiming at the optimal decision making on the commensurable resource allocation to the lower level organizations.

The portfolio management with multiple criteria decision making [3] involves commensurable and incommensurable resources allocation and corresponds to one of the activities on the upper level and alignment follows. The structure of two level decision making is schematically depicted in Fig. 1.

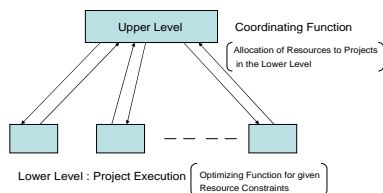


Fig. 1 A Two Level Approach to Resource Allocation with Coordination

The value creating activities of each project on the lower level is based upon the given resources from the upper level, respectively. The activities are characterized by an evolutionary with adopting multiple criteria decision making in the development projects due to the existence of uncertainties. It is necessary to align a series of decision making until the final decision being determined. The activities of each project are reported occasionally to the upper level, so that the upper level decision are revised by evaluation the activities and taking the environmental conditions into consideration. The results of the upper level decision on the resource allocation are informed to the projects on the lower level, where the survived projects are doing the revised activities. These actions between the two levels are repeated until the final decision as the business activities are made. The detailed description on the evolutionary approach is given elsewhere [4].

HEURISTIC RULES ON RESOURCE ALLOCATION

The resources are classified by the characteristics of flexibility or compatibility. Fig. 2 [5] shows the framework of resources classification.

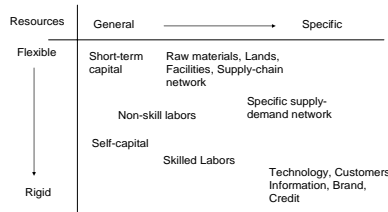


Fig. 2 Classification of corporate resources

The optimal assignment of human resources to ranked jobs is an example of General and Flexible type resource assignment problems, where the human resource is mutually compatible within a skill-ranked constraint, so that the allocation for minimizing total cost depends on the skill level reflecting unit cost of resources. The following heuristic rule can be derived by investigating the solutions.

Heuristic Rule1: The specific resources limit the allocation to specific jobs as an extreme case due to the incompatibility.

Heuristic Rule 2: The skillful resources should be proportionally allocated to difficult jobs.

The Heuristic rule 1 is no degrees of freedom and cannot formulate the optimization problem and only the feasible solution is obtained. The Heuristic rule 2 is directly derived from the analysis of linear programming solutions.

Using these two rules to allocate the resources, it is possible to find the result without any computations. The coordination of the projects' activities is carried out through the resource allocation on the upper level.

METHOD OF RESOURCE ALLOCATION

The projects on the lower level report make the best efforts to have optimal performance subject to the given resources and the results of activities are reported to the upper level. Since it is assumed for the projects to carry out optimal actions respectively, the evaluation of results on the upper level relies upon whether the allocations are appropriate or not. As the result of evaluation, the upper level decision making is revised for the projects to have a better state within the acceptable conditions reflecting the business strategy. This process is repeated periodically or occasionally in the respective business units.

Regarding the method of resource allocation and projects activities on the basis of the repeating process described above, the combination of the heuristic approach (the upper level) and evolutionary approach (the lower level) gives us the optimal solutions of resource allocation. Since the evolutionary approach to have a series of better solutions is presented elsewhere [5], no explanation is given here.

The procedure of heuristic and evolutionary approach is depicted in Fig. 3.

S.0 START (n =1)
 S.1 Allocate the 1st resources to each project (Upper level)
 S.2 Execute project for given Resources (Lower level)
 S.3 Report the result of project execution to the upper level
 S.4 Check the result whether it is acceptable or not.
 IF NOT, GO TO S.5, IF YES, GO TO S.6
 S.5 Revise the nth allocation and give the n+1th resources
 (Upper level)
 RETURN to S.2
 S.6 FINISH

Fig. 3 The Procedure of Heuristic and Evolutionary

The S.1 and S.5 is done by the heuristic approach and the criterion whether the revised allocation is appropriate or not using at S.4 reflects the various environmental conditions and business strategy. The course of the repetitions shows the evolutionary change of states. Due to the limited availability of resources, some projects might not allow to continue the activities as the results of poor performance or unsuitable environment for continuation.

AN EXAMPLE FOR ILLUSTRATION [6]

A problem of commensurable resource allocation to several projects is taken up for illustrative purpose. Assuming that the information of projects under consideration is given as the result of setting up the project portfolios with required resources for executing projects, the problem relates to the decision making at the upper level and it is to allocate resources to projects within the allowable limit, by using the heuristic rules. The following matrix (Fig. 4) shows the result of allocation. At first, the ranking order of project' importance is determined by the preference on the upper level, usually by the preference of executives in charge. The order corresponds to the horizontal low of the matrix and the vertical line shows the order of human skill from top (high) to bottom (low). Secondly, the human is ranked by the level of skill and arranged the ranking result so as to positioning the higher to lower from top to bottom. The optimal solution is shown by giving 1 for assignment on the diagonal position and other position given by 0 for no alignment. The assignment of specific resources to specific projects is carried out before solving this resource allocation problem.

Importance of Project	High			
	Low			
Skills of Human Resource	High	1	0	0
	Low	0	0	1

Fig.4 The optimal resource allocation by heuristic approach

The important items of projects are mainly concerned with QCD: Quality, Cost, and Delivery. Though every project has quality, cost, and time constraints, there exists one or more constraints being dominant to respective projects and appropriate resource should be allocated according to those required situations. The human skills are also classified by the same category as that of project. There are 7 cases of dominant items: Q,C,D, Q&C,Q&D,C&D, and Q&C&D ,and it is possible to present a single matrix including these 7 cases. The framework is schematically shown in Fig.5.

Project Management	High → ← Low		High → ← Low		High → ← Low	
	High ↓ Low	Low	High ↓ Low	Low	High ↓ Low	Low
High ↓ Low	Q					
		C				
			D			
High ↓ Low				Q&C		
					O&D	
						C&D
High ↓ Low						Q&C&D

Fig.5 The presentation of optimal resource allocation for seven cases

CONCLUDING REMARKS

The problem of commensurable human resource allocation to a specific project is taken up. The two level structure of decision making with heuristic and evolutionary approach is presented. The approach on the upper is based upon using the heuristic rules used is effective and easy to quick decision making. Since the rules are derived by the mathematical programming, they give us sound basis. The resource allocation of compatible personnel to the project is based on their skill level and the availability to the project. The approach used on the lower level is based upon the direct search method and evolutionary in nature of seeking better results. Detailed description is given elsewhere.

Since there are plural projects running or to be running at the same period, it is necessary to allocate resource among those projects and to align the results of allocation based on the evaluation of status of projects after some period of running the projects.

The work is characterized by the deductive approach with a set of heuristic rules which are derived from a scientifically sound basis.

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