Optimization Model in Human Resource Management for Job Allocation in ICT Project

Sanghamitra Mohanty[1] Malaya Kumar Nayak[2]

[1]Professor and Head [2]Research Scholar
Department of Computer Science and Applications
Utkal University
Bhubaneswar – 751 004, India
E-mail Id: sangham1@rediffmail.com, malaya.au@gmail.com

Abstract

This research article highlights a novel approach of scheduling risk which assures decrease in cost and increase in performance for the human resource management in Information and Communication Technology projects. The cost management can be considered as all the processes required to ensure that a project team completes their assignment within an approved budget. This research paper will focus on much bigger dimension of problem considering various distributed factors in project management where all the entities involved in the project will be considered for risk scheduling. The proposed article will provide support to dynamically changing environments in ICT and also support its complex heterogeneous environment which will enhance the cost effectiveness factor in bigger scale project involved in ICT.

Keywords: Risk planning, ICT, Cost estimation, Project planning, Human resource management.

I. Introduction

Risk consequences based on risk management actions are embedded in institutional and organizational structure. Organizational structure engages with risk management through human resource management and its associated security issues. One of the key reasons point out by Matta and Ashkenas [1] is that managers use project plans, timelines and budgets to reduce what we call “execution risk”- the risk that the designated activities won’t be carried out properly – but inevitably neglect these two other critical risks – the “White Space Risk” that some required activities won’t be identified in advance, leaving gaps in the project plan, and the “Integration Risk” that the disparate activities won’t come together at the end. Often project managers do not have any risk cost estimation Staw and Ross [2] and when the project cost grows way beyond budget, they do another mistake which is stated by Davis [3]. And one of the toughest parts of project management is managing human resource effectively. Hughes [4] further claims that managing ICT risks must focus on a combination of process, people, technology and information. It also identifies the human resources required to implement the plan. Levine [5] also supports the view that ICT risk management must take into account people, process and systems, including organisational factors such as corporate culture and employees.

2. Risk Scheduling in ICT

Risk assessment in ICT project is very crucial with respect to human resource management. Certain issues in employee risk scheduling are loss of productivity for skill gaps in them for which reason the assignment allotted could not be accomplished efficiently. Inadequate requirement analysis of project is another issue which makes even the project manager difficult to understand the real requirements of client, for which reason the project manager fails to identify his best team and thereby improper project load allocation proceeds ahead giving rise to other tertiary issues. Sudden attrition rate is another issue for which the project manager has to manage the project development with his existing team. Normally ICT risk scheduling is rooted in corporate planning and audit system which are majorly deployed as a section of the risk management in any organization [6]. However, it is observed that such types of risk scheduling methodology are much concentrated on various parameters which have the potential to leverage business requirements.

3. Proposed Model

The proposed model will be based on the current issues in support of risk scheduling in ICT projects where the concern is more about human resources. Majority of the current researches are focused in general risk management schemes which mainly implements ISO31000 standards which normally facilitates only generic guidelines for the design, implementation and maintenance of risk management processes throughout an organization [7].

The ICT structure, as a top-down strategy, is represented in the COBIT framework which is extensively used to describe the business functions, processes and tasks to support top management in developing and implementing ICT governance [8]. By adopting COBIT, the organization is concerned more with a business view than with technical solutions to ICT risk management. This risk scheduling process seeks to find an optimal allocation of a limited amount of resource to objectives subject to the given resource constraint. The best or optimal solution may mean maximizing profits, minimizing costs, or achieving the best possible quality. The algorithm used in proposed system is well explained in the section 4 and the mathematical empirical model is explained in section 5.

4. Algorithm Description

The proposed algorithm is based on the mathematical optimization model with a motive to assist the project manager selects his best team from different skills with higher profit and cost-effective measures. Applying the mathematical optimization, an objective function is considered for project manager which basically represents the requirements of selection of optimized plans for risk scheduling and cost-effective job-allocation to his existing resources efficiently. This objective functions of real nature need to be optimized simultaneously in multi-objective optimization problem for manager towards planning of risk as cost estimation. It is not required that there has to be existence of solution which is best to all objective due to incommensurability and confliction among objectives. So, the outcome of any such computation may vary from best in one objective but may be worst in another objective. Therefore, there usually exist a set of solutions for the multiple-objective case which cannot simply be compared with each other. For such Pareto optimal solutions, no improvement is possible in any objective function without sacrificing at least one of the other objective functions.

Usually, our risk scheduling problem can be represented as:

$$\min y = f(x) = (f_1(x), f_2(x),..., f_n(x)), \quad (1\text{-}1)$$

$$\text{s.t. } g_i\,(x) \le 0.$$

Where administrative vector $x \in R_m$ where R is real value, and targeted vector $y \in R_n$, $f_1(x)(i = 1,2,..., n)$ is the objective function, $g_i(x) \leq 0$ is a bound condition. This representation highlights the project manager has a various alternative variables (x) as problems which needs to be solved under certain bound condition.

Theorem-1: If $x^* \in R_m$ is represented as a position in the search space; if and only if there is no i (in the search space) making $f_i(x)<f(x^*)$ establishment, then x^* is the non-dominated solution.

Theorem-2: Assumes u, $v \in R_m$, if and only if vectors meet with,

$$f_i(u) \leq f_i(v) \quad \forall i \in \{1,2,....,n\}; \qquad (1\text{-}2)$$

$$f_j(u) \leq f_j(v) \ \forall j \in \{1,2,....,n\}; \qquad (1\text{-}3)$$

The function f will depend on the skill issue of the employees. Then vector u dominates vector v, denoted as $u \prec v$.

Theorem-3: For a given individual $x \in P$, if there is no individual making $y \prec x$ establishment, then x is called the non-dominated individual. All the P's non-dominated individual consist the set which is called the dominated set of P.

5. The Mathematics Model

The empirical model for the diversified skill criteria human resource allocation problem to assign M staffs to n different posts for maximizing the benefit and minimizing the cost subject to one human resource constraint is designed as follows:

$$\max z_1(y) = \sum_{i=1}^{n} f_1(y_i) \qquad (2\text{-}1)$$

$$\min z_2(y) = \sum_{i=1}^{n} f_2(y_i) \qquad (2\text{-}2)$$

$$\text{s.t. } G_o(y) = \sum_{i-1}^{n} g_i(y_i) \leq M \qquad (2\text{-}3)$$

$$y_i = 0,1,.....M \quad \forall i \qquad (2\text{-}4)$$

According to the above mentioned mathematical representation (2-1), (2-2), (2-3), (2-4), the research work can be designed for risk scheduling considering multiple human resources with different available skills optimization model. This model is a map of criteria for resource allocation and costing problems of the managers, which will now enable the M set of employees to n varieties of jobs for incrementing the benefits as well as reducing the cost imposed to one set of human resource constraint. Therefore, an integer programming model for multiple specifications can be modeled as below:

$$\max z_i(x) = \sum_{i=1}^{n}\sum_{j=0}^{M} p_{ij}x_{ij} \qquad (2\text{-}5)$$

$$\min z_2(x) = \sum_{i=1}^{n}\sum_{j=0}^{M} c_{ij}x_{ij} \qquad (2\text{-}6)$$

$$P_{ij} = V_i \text{ x } \sum_{i}^{n} \frac{\alpha_{il}(d_{ijl} - d_{il}^{0})}{d_{il}^{0}} x \frac{D_{ij}}{D_{j\max}} \qquad (2\text{-}7)$$

$$c_{ij} = W_i \text{ x } \sum_{i}^{n} \frac{\alpha_{il}(d_{ijl} - d_{il}^{0})}{d_{il}^{0}} \qquad (2\text{-}8)$$

$$\text{s.t. } G_0(x) = \sum_{i=1}^{n}\sum_{j=0}^{M} jx_{ij} \leq M \qquad (2\text{-}9)$$

$$G_i(x) = \sum_{i=1}^{n} x_{ij} = 1, \ \forall i \qquad (2\text{-}10)$$

$$\sum_{i}^{n} \frac{\alpha_{il}(d_{ijl} - d_{il}^{0})}{d_{il}^{0}} \geq 0, \qquad (2\text{-}11)$$

$$x_{ij} = 0 \text{or} 1, \ \forall i, j \qquad (2\text{-}12)$$

Notation Used:

V_i = value of the i^{th} post, $(j=1, 2, . . . , n)$;

α_{il} is the weight of the i^{th} post's (i: index for department with parameter N total number) l^{th} skill competency; $(j=1, 2, . . ,n; l=1,2,. . .)$;

d_{ijl} is the level of the j^{th} post's (j: index for employees with parameter M total number) l^{th} skill competency;

($l=1,2,..M; l \leq d_{ijl} \leq 9, d_{ijl} \leq 9, d_{ijl} \in N$);

d_{il}^{0} is the reference level of the i^{th} post l^{th} skill competency;($l=1,2,...M; l \leq d_{ijl} \leq 9, d_{ijl} \in N$);

D_{ij} is the Manager's expectation level of the j^{th} staff to i^{th} post. ($l \leq d_{ijl} \leq 9, d_{ijl} \in N$);

$D_{j\,max}$ is the highest level of the j^{th} staff to all posts;

W_i is the remuneration / wage of the i^{th} post.

C_{ij} is cost of department i when j employees are assigned

P_{ij} is profit of department i when j employees are assigned.

5.1 Human Resource Optimization

We divide an evolution groups into several sub-groups with several different evolutionary direction, and then defined the dominated relationship of individuals using the concept of non-dominated solution. Then we can formulate a non-dominated set with the non-dominated optimal particles which is found in each subgroups. The global optimum region which is constituted by non-dominant individuals guides the evolution of whole particle group. The algorithm can obtain Pareto solution set of distributed uniformly through less times iteration. In order to use the human resource optimization with respect to cost evaluation in order to design with risk scheduling, we need to formulate certain special operations to guide the evolution of search process, or adopt the strategy of fitness taxis to achieve it. This paper presents the following definition:

Say x is an individual of group S, $f_i(x(t))$ is x's value of the i^{th} objective function value when is on the i^{th} times iterations.

Theorem-4: In the iterative process, if the value of x to all objective functions varies to be optimal, then x may be termed as entire optimal employee for this times iterative process. S_+ denotes the group which is made up of all entire optimal employees, and that is:

$$f_i(x(t+1)) < f_i(x(t)),\ \forall\, i \in \{1,2,...,n\}. \quad (3\text{-}1)$$

Theorem-5: Sometimes in iterative process, if the value of x to only one objective function varies to be optimal, then x is called the half optimal employee for this iterative process in this direction of the objective function. S_k denotes the group which is made up of all half optimal individuals, and that is:

$$f_k(x(t+1)) \leq f_k(x(t)), \exists\, k \in \{1,2,...,n\}. \quad (3\text{-}2)$$

Theorem-6: Sometimes in particular iterative process, if the value of x to all objective functions varies to be inferior, then x is called the entire inferior employee for this iterative process. S_- denotes the group which is made up of all entire inferior employees, and that is:

$$f_i(x(t+1)) > f_i(x(t)), \forall\, i \in \{1,2,..., n\}. \quad (3\text{-}3)$$

Theorem-7: Assume x and y is any two employees of group, x dominates y when they meet with the following conditions.

1) x is not inferior than y to all objective functions, that is

$$f_i(x) \leq f_i(y), i \in \{1,2,...,n\}. \quad (3\text{-}4)$$

2) There is one objective function at least making that x is better than y, namely:

$$f_k(x) < f_k(y),\ \exists\, k \in \{1,2,...,n\} \quad (3\text{-}5)$$

The research put forward the method that using multiple sub-groups ensured the multiple evolution direction of the entire group. Then we can determine the dominant relationship between the employee in the sub-groups.

5.2 Cost Estimation

In order to use the algorithm, the application must code for the solution of the problem firstly. It can simply use the order of natural number *1 ~ n* to present a potential solution. Assume the position vector of the i^{th} department is $X_i = \{x_{i1}, x_{i2},...x_{in}\}$ which presents the result of the human resource allocation. Of which x_{ij} is the number of employee for the j^{th} post within the scope of organization. The approach took the human resource allocation problem in ICT projects of 4 posts for example. The outcome of one position vector is = (4.2, 3, 2.3, 6.1). After the integral norms treatment the outcome is (4, 3, 2, 6). The optimal solution of the human resources allocation is that the 4th staff is allocated on the first positions; the 3rd staff is allocated on the second positions; the 2nd staff is allocated on the third positions; the 6th staff is allocated on the fourth positions. Such allocation design will help the manager to plan the cost estimation of the available skilled employees for risk scheduling in the organization.

5.3 Risk Scheduling Methodology

The skills required in Information Society involve the capability to deploy ICT resources to implement various dynamic e-government strategies of an organization in accordance with its overall risk scheduling. Such types of skills will involve analyzing various innovative technologies and their limits along with the corporate's risk planning with respect to human resource management. Referencing for the multi-objective optimization method, this research paper designs the process of the multi-objective optimization of human resource allocation with efficient performance, described as follows:

Step1: Initialize optimization, including population size *N*, the location of various entities like departments x_i with speed v_i;

Step2: Estimate the fitness value of each objective function;

Step3: Backup fitness value;

Step4: Retrieve the initial *pBest* and *gBest* using weight;

Step5: Update departments in accordance with standard optimization algorithm;

Step6: Divide the group into four sub-groups according to Theorem 4 - 6;

Step7: According to Theorem-7 find the global optimum region, and get a new individual extreme value and the global extreme value, and then update the entire inferior sub-groups;

Step8: Update the speed v_i and position x_i of every particle with the *gBest* and *pBest* in Step7;

Step9: If meet the suspension conditions, the circle stop; otherwise return to Step6.

6. Calculation

A company will expand its business extension. For example, the company has set up 4 new positions. The company decides to choose 4 staffs from four sectors; each sector selects a suitable staff. Each unit has 12 employees, totally 48 people. Supposing that we do not consider other special factors, we should allocate these staffs to 4 new positions with the target of maximum benefit and minimum cost.

After dealing with the data with formula (2-7)-and (2-8), we can obtain the cost and profit data of each employee in various positions which is presented in Table 1.

We can get a satisfactory result with the algorithm which has been validated by many times experiment.

Table I. The Profit and Cost of Staffs in Past 4 Years

Unit-1			Unit-1I			Unit-1II			Unit-1V		
X1	**cost**	**profit**	X2	Cost	Profit	X3	Cost	Profit	X4	cost	profit
X11	93	131	**X21**	91	140	**X31**	79	138	**X41**	77	147
X12	87	127	**X22**	82	134	**X32**	80	129	**X42**	71	141
X13	81	123	**X23**	84	129	**X33**	72	121	**X43**	63	134
X14	73	112	**X24**	70	118	**X34**	68	106	**X44**	66	127
X15	60	101	**X25**	63	103	**X35**	61	114	**X45**	55	121
X16	59	99	**X26**	51	106	**X36**	53	97	**X46**	51	113
X17	48	96	**X27**	46	91	**X37**	47	91	**X47**	47	101
X18	51	91	**X28**	42	87	**X38**	35	83	**X48**	41	97
X19	36	82	**X29**	31	77	**X39**	28	65	**X49**	35	91
X110	31	79	**X210**	21	71	**X310**	31	66	**X410**	31	85
X111	23	73	**X211**	23	63	**X311**	19	58	**X411**	26	77
X112	21	70	**X212**	22	62	**X312**	20	57	**X412**	24	73
X10	17	0	**X20**	14	0	**X30**	16	0	**X40**	21	0

Table II. The Optimal Pareto Solutions

Solutions k	**Designation-1**	**Designation 2**	**Designation 3**	**Designation 4**	**Cost**	**Profit**	**d>0**
1	10	2	1	4	258	478	205.39
2	12	2	5	2	235	459	193.13
3	11	4	1	5	227	450	191.09
4	*12*	7	1	2	217	440	188.83
5	10	12	1	3	195	413	191.25
6	12	6	8	2	178	400	190.88
7	10	9	8	3	160	373	204.82
8	11	6	12	5	149	357	214.85

After performing the above evaluation, calculate the generational distance value from noninferior solutions to the optimal Pareto solutions through generational distance method. According to calculation of the generational distance value, we can obtain the optimal solution of this problem. The optimal solution is: $X_i = \{12,7,1,2\}$. So the manager should select the 12th employee to designation 1 in unit 1; select the 7th employee to designation 2 in unit 2; select the 1st employee to designation 3 in unit 3; select the 2nd employee to designation 4 in unit 4.

7. Conclusion

This research article applied the competency model and position assessment and employee's expectation to determine synthetically the profit of some employee on some post when we developed the mathematical model of multi-objective criteria human resources allocation while risk scheduling in ICT project. This method embodies the double principles of staffs' competency matching with position request and staffs' expectations matching with position, which accord with the actual situation of human resource management.

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