Resource Prioritization and Task Allocation in Field Services using Fuzzy MCDM and MINLP

G. Jegan Jose[1], S. PrasannaVenkatesan[2], S. Kumanan[3]
[1](*Research Scholar, Department of Production Engineering, National Institute of Technology, Tiruchirappalli, India)*
[2](*Associate Professor, Department of Production Engineering, National Institute of Technology, Tiruchirappalli, India)*
[3](*Professor (HAG), Department of Production Engineering, National Institute of Technology, Tiruchirappalli, India)*

Abstract: Field service is a network of functionalities designed to fulfill demands at customer site. The focus of field service is to improve financial performance and customer service level through smart resource allocation. Researchers have attempted to build a flexible and approachable resource selection and allocation model. Developing hybrid modelsusing multi criteria decision making technique (MCDM) need attention. In this research, a hybrid fuzzy analytic hierarchy process (FAHP) and fuzzy preference ranking organization method for enrichment evaluation (FPROMETHEE) are proposed for resource prioritization. Mixed Integer non-linear programming (MINLP) model is used for resources allocation in field service. This work is to maximize the total value of resource allocation during the execution of power plant maintenance.

Keywords: Field service, Customer service, Resource allocation, Resource prioritization, MCDM, MINLP

1. INTRODUCTION

In a power plant, thermal generating units, such as gas turbines, steam turbines and combined-cycle plants generate a significant portion of the power for domestic and industrial usage. These power plants undergo periodic planned and unplanned maintenance. During this time the power plant units are shut down to perform maintenance tasks. Field resource are assigned to carry out these maintenance tasks. A field services company maintain and manage many field resources of different skills and talents across locations to fulfill upcoming maintenance tasks. To do this the field services company may have a resource manager to organise the assignment and mobilization of field resource across territories of power plants, each of which having a unique configuration. [1] In day to day operation, the resource manager manually assign field resources to maintenance tasks based on a variety of relevant criteria and constraints. This manual process is cumbersome and complex, often results in sub-optimal resource allocation [2]. Further, when it’s done in this way, costly errors are inevitable. Such errors may include scheduling assignments for a particular resource that overlap or having one of the maintenance tasks and few demands go unassigned. This sub-optimal allocation incur increased cost for the field service company including additional labor and travel costs [3]. As a result there is an ever growing demand to automate, optimize and improve resource allocation in the power generating industry. This application describes a manual way of generating a schedule to allocate the resources during a defined planning cycle [4]. This allocation schedule include a list of demands assigned to field resources in a planning cycle. The resource manager maintains the data related to field resources and tasks with constraints. An effective resource allocation system is proposed for automating and improving optimal allocation of field resources.

1.1 INDUSTRIAL FIELD SERVICES

Field services is evolving faster to meet customer requirements and to capture global market. Globalization provides new challenges for the delivery of industrial field services. Cost pressure, large travel distances, diverse cultures and languages, different market standards, currencies, customs, trade agreements, service level requirements and the global competitive situation are a few of the factors that add complexity to the successful delivery of field services [5]. Globalization is supported by the continuous development and application of new technologies. Technological changes and competitive advantage are playing critical role in growing connected field services. Field service studies are focused on improving the operational efficiency through cost reduction [6]. Today’s amplified voice of the customer is making it very clear that face-to-face interactions between customers and employees in the field have a massive impact on the overall customer experience. After a decade of slow spending, field service operations have started to move away from outdated platforms that were hard to use and expensive to customize, spending on field service technology has been rising [7].

1.2 UNCERTAINTY IN INDUSTRIAL FIELD SERVICES

Field Service delivery process has significant inherent uncertainties. The incident of field service demand is probabilistic and because of multiple equipment types to be served. The demand composition is heterogeneous in failure rates and repair times. The resource pool is also heterogeneous in its expertise levels and its pay rates. Since field resource must travel to the equipment site. The number of location of field offices will determine travel hours which is an element of total labor requirements [8]. All of these factors must be incorporated into the planning and scheduling cycle whose objectives are to minimize the costs while maximizing the value. Due to the lack of complete information, uncertainty, high level of vagueness and imprecision for technician ranking in any opportunity, a technique to perform selection calculations on imprecise representations of parameters is needed.

1.3 AUTOMATED PLANNING AND SCHEDULING

The adoption of new technology to improve service delivery has been held back in many companies due to the lack of supporting infrastructure and connectivity. For an increasing number of organizations, a real-time scheduling toolset is the only way to sustain service performance, to meet customer demands and to grow the business. This puts pressure on the 'back office' to automate scheduling process. Today's service environment demands quick response from a field service company to complete the task. This requires a more strategic planning approach to understand the demands on the service team and every aspect of their work [9]. This paper is organized as follows. The literature review is presented in section 2. The problem description and MINLP model formulation is reported in section 3 and 4. The proposed hybrid approach is presented in section 5. The case example and the results and discussion are presented in section 6. Section 7 concludes the work with future scope.

2. LITERATURE

In recent years, increasing competition and decreasing margins have emphasized the importance of continually reshaping and improving the organizational, controlling and manufacturing aspects of products and services [10]. As a result, there is an increasing awareness among maintenance providers that multi criteria decision-making processes associated with service delivery need to be improved. So companies focused on the allocation of service requests to field service workforce which is essential for the delivery of these services [11]. Research shows that providing good after-sales product support is an important competitive advantage and that improving field service planning processes, therefore, is an important source of profit and future growth for maintenance providers [12]. The concept of knowledge has been a significant focus of research for many years. Researchersintroduced a fuzzy model in decision competition making for selecting the best technician in any organization. Evaluating technician's suitability for a job is an important tool for Resources Managers to select the better candidates under various evaluation criteria. Many of these attributes are of high level of vagueness and imprecision especially in concern with the human behaviors and performance [13]. Multi criteria decision making support systems (MCDM) play an important role in organizational decision-making. It was define a MCDM as an ancillary or auxiliary information system that supports decision-making activities and enhances a person or group's ability to make decisions [14]. These computer-based systems improve decision-making by facilitating communication, structuring knowledge, analyzing situations, or recommending actions MCDM compensate weaknesses in human decision making by providing decisional guidance and increasing the effectiveness and efficiency of decision making [15]. According to researchs, they enable human decision makers to capitalize on their strengths while compensating for their weaknesses. A large body of research literature recognizes the use of computer-based MCDM as an important driver of organizational change alongside human change agents [16].

Many terminologies have been proposed for the categorization of MCDM problems. The dominant terms are the one of Multi-Criteria Decision Analysis (MCDA) or Multi-Attribute Decision Making (MADM), for problems in which the DM must choose from a finite number of explicitly available alternatives characterized by a set of multiple attributes (or criteria) and the one of Multi-Objective Mathematical Programming (MOMP) or Multi-Objective Decision Making (MODM)that deal with decision problems characterized by multiple and conflicting objective functions that are to be optimized over a feasible set of decisions [17]. FAHP is extensively applied, especially in large-scale problems where many criteria must be considered and where the evaluation of alternatives is mostly subjective [18]. Researchers concluded that FAHP is only based on fuzzy subjective attribute weights and has many computational steps and is the most complex one. On the other hand, showed by examples that the priority vectors determined by the extent analysis method do not represent the relative importance of decision criteria or alternatives and its implications in decision making [19]. PROMETHEE is reportedly more stable among the outranking methods. Implementing PROMETHEE requires the information on the criteria weights and the choice of preference functions with their parameters [20]. Researchers have proposed a hybrid AHP and PROMETHEE by combining the favorable characteristics of both approaches.

Recent studies hybrid flow shop scheduling problem with stage skipping and adjustable processing time in steelmaking- continuous casting production process. The SCC scheduling problem is solved to determine the machine allocations, starting times and ending times for all operations is addressed through Genetic algorithm [21]. Researcher suggest an improved particle swarm optimization algorithm is proposed to solve the distribution network reconfiguration model with distributed power supply [22]. Simulated annealing is presented for solving multiobjective programming problems. In which a new method for computing energy difference is proposed and the external file technology is used. And a set of approximate Pareto optimal solutions for multiobjective programming problem is obtained using the elite strategy [23]. Primavera is used as task management solution to mobilizing and managing people, materials, equipment and money to complete the assigned project work on time. It aims at achieving the specified objectives efficient by managing human energies [24]. This study presents an integrated collaborative model of framework agreements using cloud computing to improve the framework agreements which are not effective because of poor collaboration, communications, and information sharing [25]. In other work, a tendency to square measure formalizing the swarm algorithmic rule for hybrid criteria. Hybrid criteria use Rank, Merge, and selection for building the check cases from check suite for minimizing the redundancy [26].A number of papers in the literature consider multi-period scheduling. However,none of these papers incorporates stochastic elements of the problem using fuzzy hybrid approach integrating with MINLP models, and all of the papersstudy deterministic problems. In contrast, this paper considers dynamic ranking of resources for eachperiod of resource allocation by considering previous performance and change in resource skills, trainings and other key criteria and leads for continuous learning and improvement of total value of resource allocation.

3. PROBLEM DESCRIPTION

Resource managers keep a set of preferred field resources based on their performance against cost, quality, productivity, delivery, environmental health and safety is practiced to maximize total value of resource allocation (TVRA), these resources tend to be clustered in regions and handpicked for the tasks as per their choice. In recent changes in field services, Customers want more than mere product performance, they want swift, efficient recovery when things go wrong. They expect value from the products, equipment, support and other services they've purchased. So every day, your customers are measuring you against their best service experiences and your ability to maximize the value of their investments [27]. That means higher demand for ever faster responses and more effective service delivery with tighter service level agreements (SLAs) and less tolerance of failure have forced the firms to eventuality migrate from manual approach to new technological based platforms for prioritization and allocation of resources. The TVRA includes resource pool management cost, transportation cost, and an expected cost due to poor quality, penalty cost due to delay if a resource fails to attend a task on time. Allocation the right resource to right task maximizes TVRA as a firm tends to allocate as much tasks as possible to the preferred resources. This leads to high utilization of preferred resources and low utilization of un-preferred resources suffer a disruption, then the TVRA incurred by the manufacturer is low albeit the resource management cost is low. If the tasks are allocated to alternate resources as per required criteria, then the utilization will be balanced but this may also reduce the TVRA. The conflicting goals of minimizing the utilization and maximizing the TRVA thus require a multi-objective optimization approach. . To do so, organizations need to optimize their mobile workforce to react quickly to real-world events, deal with uncertainty and cope with constant change [28]. The models described in this paper can provide insights for transforming the technician prioritization and task allocation for the field service network.

4. MODEL FORMULATION

Assumptions:
Same type of thermal equipment i.e Turbine site repair is considered her
Pay is fixed for all type of technician
Service time of the task are greater than 0
All resources are capable and potential to deliver all scope with different level of competency
All resources will frequently undergo different trainings to upskill in new technology
All resources are capable of serving all the tasks and there skill is large enough to serve all tasks.
Service times of the tasks are greater than 0
Maximum and minimum duration of working days in a scheduling period is fixed
Overtime and shift preference is not considered. The length of the day is set to 8:00 hrs.
Consists of a set of tasks to service during a 5 day working week of a single service resource. Weekend are excluded while calculating the duration and allocation of resources.

These are only planned tasked. Unplanned tasked are not considered
The tasks are non-transferable

Indices:
i = no of tasks (i = 1, 2…I)
j = no of technicians (j = 1, 2….J)
t = no of planning period (t = 1, 2….T)

Parameters:
ait = arrival time of task 'i' in period 't'
dit = duration of task 'i' in period 't'
Ujt = upper limit for total tasks duration assigned to resource 'j' in period't' i.e 22 days
Ljt = lower limit for total tasks duration assigned to resource 'j' in period't' i.e 10 days
vit = net value of task 'i' in period 't'
hit = delay of task 'i' in period 't'
pit = penalty for the delay of task 'i' in period 't'
wj = weight associated with resource 'j'

Decision Variables:

$$X_{ijt} = \begin{cases} 1, & \text{if task 'i' is assigned to recource 'j' in period 't'} \\ 0, & \text{Otherwise} \end{cases}$$

$$Y_{it} = \begin{cases} 1, & \text{if task 'i' is delayed in period 't'} \\ 0, & \text{Otherwise} \end{cases}$$

Objective Function:
Max the Total Value of Resource Allocation (TVRA)

$$Max\ (TVRA) = \sum_{t=1}^{T}\sum_{j=1}^{J}\sum_{i=1}^{I} X_{ijt} W_j$$

Subjected to constraints:

1. Resource Utilization: Each resource in a planning period must be utilized [10, 22] days

$$L_{jt} \le d_{it} \le U_{jt} \qquad , for\ all\ j,t$$

2. Penalty constraint: $\left(\sum\sum h_{it} Y_{it} p_{it}\right) \le 0.10 \left(\sum v_{it}\right) \quad , for\ all\ j$

Here, A(j) □ i [A(j) is sub set of tasks assigned to resource j in period t i =1…A(j)]
Where, $a_{(A)t} - \{a_{(A-1)t} + d_{(A-1)t}\} = h_{it}$
[Arrival of task A to resource j – (Arrival of previous task (A-1) assigned to resource j + activity duration of task (A-1)] = delay of tasks A assigned to resource j
If, $h_{it} < 0$ then Y_{it} =1 otherwise 0.

5. PROPOSED METHODOLOGY

To solve the above defined problem description in this research we have proposed a hybrid approach defined in below figure1.

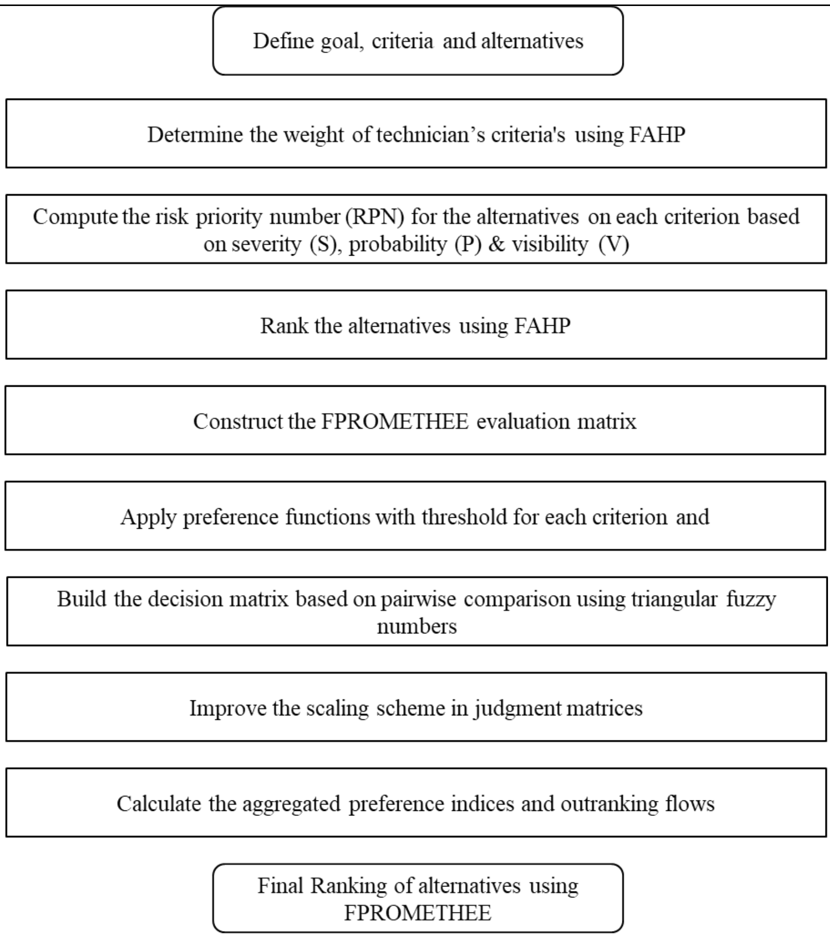

Figure 1Flow chart of proposed FAHP-FPROMETHEE hybrid approach

5.1 RESOURCE PRIORITIZATION USING FAHP

The field technician evaluation and ranking involves alternatives (resource 1 to resource 5) and criteria (competency to training). The alternatives denote a finite number of field technicians to be ranked. The criteria refer to the decision factors that are used to evaluate the engineers. The criteria weights denote the relative importance of each criterion.Identification of goal, criteria, and alternatives: Figure2 shows the decision hierarchy of technician evaluation and ranking. From the literature, three main criteria and thirteen sub-criteria are identified [17].Determine criteria and sub-criteria weights: The linguistic variables shown in Table 1 are used to carry out pair-wise comparisons between the criteria and sub-criteria [10]. The fuzzy pair-wise comparison matrices are converted into crisp matrices and the consistency of each matrix is verified. The criteria and sub-criteria weights are then determined using the improved extent analysis method [16]. Fuzzy AHP is used in this research to incorporate uncertainties in the decision maker's opinions. Fuzzy AHP approach uses a range of values and decision makers can select the value that reflects their preferences. Due to the fuzzy nature of the comparison procedure, decision makers find it more reliable to make interval judgments [29] [30].Triangular fuzzy numbers are the most commonly used fuzzy numbers in literature and practice because of their calculation conveniences. A triangular fuzzy number that is defined in R set can be described as R = (l, m, u) where l is the minimum, m is the most possible and u is the maximum value of a fuzzy case [31]. Its membership function is characterized below. Table 2 to table 4 shows the outcome of Fuzzy AHP.

$$\mu(x) = \begin{cases} (x-l)/(m-l), & l \le x \le m \\ (x-u)/(m-u), & m \le x \le u \\ 0, & x < l \text{ or } x > u \end{cases}$$

The Fuzzy AHP weights used for this work are calculated based on Chang's [32] extent analysis method.

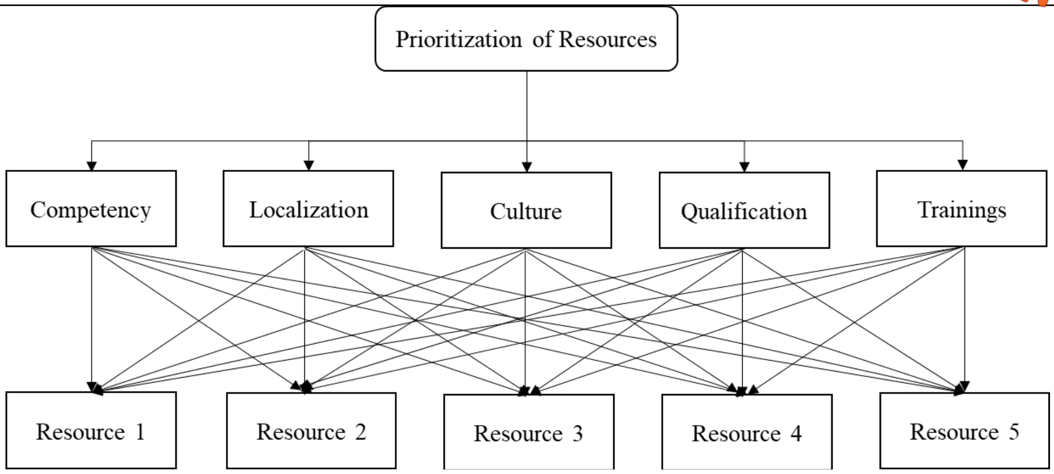

Figure 2 Decision hierarchy structure for resource prioritization

Table 1 Triangular Fuzzy conversion scale

Linguistic Values and Fuzzy Numbers			l	m	u
EI	Equally Important	(1,1,1)	1.0	1.0	1.0
WI	Weekly Important	(2/3,1,3/2)	1.0	1.5	2.0
SI	Strongly Important	(3/2,2,5/2)	1.5	2.0	2.5
VSI	Very Strongly Important	(5/2,3,7/2)	2.0	2.5	3.0
AI	Absolutely Important	(7/2,4,9/2)	2.5	3.0	3.5
WD	Weekly Difficult	(2/3,1,3/2)	0.5	0.7	1.0
SD	Strongly Difficult	(2/5,1/2,2/3)	0.4	0.5	0.7
VSD	Very Strongly Difficult	(2/7,1/3,2/5)	0.3	0.4	0.5
AD	Absolutely Difficult	(2/9,1/4,2/7)	0.3	0.3	0.4

Table 2Fuzzy Pairwise comparison matrix of alternatives

FAHP	Competency	Localization	Culture	Qualification	Training
Competency	EI	VSI	VSI	WI	WI
Localization	VSD	EI	WD	SD	WD
Culture	VSD	WI	EI	SD	WD
Qualification	WD	SI	SI	EI	WI
Trainings	WD	WI	WI	WD	EI

Table 3 Linguistic variable of Fuzzy Pairwise comparison for alternatives

Comparison	Competency			Localization			Culture			Qualification			Trainings		
Competency	1.00	1.00	1.00	2.00	2.50	3.00	2.00	2.50	3.00	1.00	1.50	2.00	1.00	1.50	2.00
Localization	0.33	0.40	0.50	1.00	1.00	1.00	0.50	0.67	1.00	0.40	0.50	0.67	0.50	0.67	1.00
Culture	0.33	0.40	0.50	1.00	1.50	2.00	1.00	1.00	1.00	0.40	0.50	0.67	0.50	0.67	1.00
Qualification	0.50	0.67	1.00	1.50	2.00	2.50	1.50	2.00	2.50	1.00	1.00	1.00	1.00	1.50	2.00
Training	0.50	0.67	1.00	1.00	1.50	2.00	1.00	1.50	2.00	0.50	0.67	1.00	1.00	1.00	1.00

Table 4 Result obtained from Fuzzy AHP

Alternatives	Weight	Rank
Resource 1	0.1657	2
Resource 2	0.1961	1
Resource 3	0.1086	5
Resource 4	0.1463	3
Resource 5	0.1431	4

5.2 RESOURCE PRIORITIZATION USING FPROMETHEE

In the F-PROMETHEE method the performance of each scenario to each criterion is introduced as a fuzzy number.The first step is to assign weights to the criteria so that a measure of relative importanceof a criterion over all the other criteria is established [31]. This is done by using a linguisticvariable called 'degree of importance'. It has nine linguistic values as shown in Table 1. Using this linguistic variable, pairwise comparison of the criteria is done to obtain aPairwise Comparison Matrix. Each entry in the pairwise comparison matrix is a fuzzynumber. A series of steps is then followed to obtain the Fuzzy Weights of the criteria [30].Thereafter, Degree of Possibility is calculated which gives the Normalized Crisp Weightsfor each criterion. The next step in the Fuzzy PROMETHEE algorithm is to evaluate the alternatives. Once the fuzzy numbers are assigned to each alternative for each criterion, the differencematrix is then constructed by pairwise comparison of all the alternatives over all thecriteria. The difference of the fuzzy numbers is calculated for each pair of alternatives for
each criterion. Standard fuzzy operations are used for the same. [32]
Positive outranking flow gives a measure of the strength of the alternative as compared toother alternatives over all the criteria. Negative outranking flow gives a measure ofweakness of the alternative as compared to other alternatives over all the criteria. The netoutranking flow is used to obtain complete ranking of the alternatives

Table 5 Outranking flows

Alternatives	Positive outranking flows	Negative outranking flows	Net outranking flows
Resource 1	0.0059133	0	0.0059133
Resource 2	0	0.12114	-0.12114
Resource 3	0.0033213	0.13296	-0.12964
Resource 4	0.2515	0	0.2515
Resource 5	0	0.0066425	-0.0066425

In this paper the ratings of qualitative criteria are considered as linguistic variables. These linguistic variables can be expressed in positive triangular fuzzy numbers as described in Table 1.The preference index is calculated as a fuzzy number. By the help of criteria weights, Fuzzy PROMETHEE steps are completed and the alternatives are ranked. Results of the application are submitted in Table6.

Table 6 Ranking obtained from Fuzzy AHP

Alternatives	Weight	Rank
Resource 1	0.0059	2
Resource 2	-0.1211	4
Resource 3	-0.1296	5
Resource 4	0.2515	1
Resource 5	-0.0066	3

5.3 DETERMINE THE FINAL RANK

An integrated Fuzzy AHP, Fuzzy PROMETHEE approach is conducted for evaluating the alternatives based on critical criteria of Power Generation Company. The contribution of FMCDM hybrid approach is adopted to fine-tune and improve the accuracy of ranking as in table 7

Table 7 Final ranking of FAHP and FPROMETHE

Alternatives	FAHP Weight	FAHP Rank	FPROMETHEE Weight	FPROMETHEE Rank
Resource 1	0.1657	2	0.0059	2
Resource 2	0.1961	1	-0.1211	4
Resource 3	0.1086	5	-0.1296	5
Resource 4	0.1463	3	0.2515	1
Resource 5	0.1431	4	-0.0066	3

5.4 RESOURCE ALLOCATION USING MINLP

The problem is to allocate a set of tasks to a set of resourcesin a given scheduling period. Here the resources remains constant and task can vary. The goal is to allocate the tasks among the resources in a way that maximizes the total value of overalltasks.In order to maximize the total value the resourcesneedto be assigned to right tasks based on the rank and utilization limits. The resources should neither be over-utilised or under-utilised to improve productivity, and reduce cost of failure due to fatigue, also they should not be kept idle.

6. ILLUSTRATIVE EXAMPLE

6.1 RESOURCE ALLOCATION FOR SINGLE PERIOD

A power generation company want to schedule there field resources for the upcoming tasks in the next scheduling period t = 30 days.The single period job involves the allocation of one technician to one task. The file service company has five technicians j=5 and there are 10 planned outage task i=10 lined up. Each technician must be utilized for at least 10 days L = 10 and maximum 22 days U=22. The details of the upcoming tasks with ranking based on estimated price, customer want date and duration are given in table 8.

Table 8 Details of tasks to be assigned in single planning period

Planning Period	Job Ranking	Customer Want Date	Duration in days	Estimated Cost in Rs	Estimated Price in Rs
1	5	1	8	24,346	40,576
	2	5	10	37,584	62,640
	4	5	10	31,056	51,760
	10	9	3	9,101	15,168
	7	9	5	20,664	34,440
	8	16	6	17,453	29,088
	9	17	5	14,904	24,840
	1	18	9	37,930	63,216
	3	20	11	36,854	61,424
	6	22	7	24,259	40,432

With the objective to maximize the total value of resource allocation with minimum fulfillment cost. The MINLP model is formulated and solved using excel solver. The optimal allocation of resources is based on the final rank obtained through FPROMETHEE is shown in table 9. It is found that higher rank resources are assigned many tasks and maxim utilized within the utilization limits. This means that if high ranked resources utilization has higher impact on the value of the projects.

Table 9 Allocation of resources to tasks using MINLP

Job No & Resource Allocation to Jobs	R4	R1	R5	R2	R3
5	0	1	0	0	0
2	0	0	0	1	0
4	0	0	1	0	0
10	1	0	0	0	0
7	1	0	0	0	0
8	1	0	0	0	0
9	1	0	0	0	0
1	0	0	0	1	0
3	0	0	0	0	1
6	0	1	0	0	0

The total delay in fulfilling all 10 tasks is 10 days and penalty cost is Rs 2213 which is given in table 10.This amount is less than 5% of overall of value against a permissible value of 10%.

Table10 Allocation of resources to tasks and its impacts in delta and penalty

Job Rank No	Resource Assigned	Expected Start Date	Actual Start Date	Delta in days	Penalty in Rs
5	R1	1	1	0	0
2	R2	5	5	0	0
4	R5	5	5	0	0
10	R4	9	9	0	0
7	R4	9	12	3	827
8	R4	16	17	1	194
9	R4	17	23	6	1192
1	R2	18	18	0	0
3	R3	20	20	0	0
6	R1	22	22	0	0

The total value, penalty, number of projects, days utilized, delay by resource is given in table 11.

Table11 Summary of resources allocation

Summary by resource	R1	R2	R3	R4	R5	Total
Final Resource Weight	0.0059	-0.1211	-0.1296	-0.0066	-0.1296	-
Project Value in Rs	81008	125856	61424	103536	51760	423584
Penalty in days	0	0	0	2212.8	0	2212.8
Number of Projects	2	2	1	4	1	10
Total delay in days	0	0	0	10	0	0
Days utilized	15	19	11	19	10	-

Total value of resource allocation is obtained as 0.63, with net revenue of Rs 421371. It is found that tasks 7,8,9 is delayed by 3,1,6 days respectively. For 7 tasks the resources started on time. The details of objective function is shown in table 12.

Table 12 Objective function and its implications

TVRA	Gross Revenue Rs	Penalty Days	Net Revenue Rs	Projects Completed	On-time Delivery
0.63	423,584	2,213	421,371	10	7

Table 13 gives the utilization of the resources in the range of 45% to 86%. The ideal utilization percentage should be R4 > R1 > R5 > R2 > R3. However, the actual utilization as per the allocation and final schedule in little different. This is because of the trade-off between the ranking and the availability of technicians with in the utilization limits. In some cases that the less preferred resource is being assigned to more demands if the high preferred resource is not available.

Table 13Resource utilization during single period tasks allocation

Job rank/Resource	R4	R1	R5	R2	R3
5	0	8	0	0	0
2	0	0	0	10	0
4	0	0	10	0	0
10	3	0	0	0	0
7	5	0	0	0	0
8	6	0	0	0	0
9	5	0	0	0	0
1	0	0	0	9	0
3	0	0	0	0	11
6	0	7	0	0	0
Days utilized	19	15	10	19	11
% Utilized	86%	68%	45%	86%	50%

7. CONCLUSION AND FUTURE SCOPE

This paper presents a hybrid approach combining FAHP, FPROMETHEE integrated with Mixed Integer Non-Linear Programing model to prioritize and spatially distributed task allocation. This solution is to assist the resource managers for optimal resource allocation in a Power Generation Company. The resources are first prioritized based on the preference value obtained using FAHP and FPROMETHEEthen using a Mixed Integer Non-Linear Programing is used to allocate resources to field service demands. From the results it is observed that that the highly preferred resources is assigned to more number of high value projects even there is a need for permissible delay. The proposed model has few limitations which can be considered as future scope. We have not included the uncertainty in processing time and priority based emergency breakdown tasks. Similarly, multi-resource with multi-duration for single project using non-traditional techniques such as GA, PSO can be used as solution algorithm to solve large scale filed problems.

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