IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684, p-ISSN: 2320-334X
PP 27-32
www.iosrjournals.org

Ranking Of Workforce Factors Using Multi-Criteria Decision Making

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ABSTRACT : *To improve the production rate, the work environment, labour efficiency, reduce the delivery time, lower the production cost and even increase the product range to fulfill the customer's needs. When a choice is to be made from among several alternatives for a given industrial application, it is essential to measure up to their performance characteristics in a decisive way. Multi-criteria decision-making (MCDM) method can be effectively used to solve such type of problem. It is observed that many methods give almost the same rankings of MCDM method, although the performance of MCDM method is slightly better than the others. In this project, most popular MCDM method is considered and the relative performances are compared with respect to the rankings of the factors as engaged in industrial pick-n-place operation. It can be concluded that for a given industrial problem, more attention is to be paid on the proper selection of the relevant criteria and alternatives.*

Keywords: *Workforce Factors; MCDM; PROMETHEE; Ranking*

I. INTRODUCTION

Performance of the worker is the main key to enhance the quality production is the primary intent of this project. This project will establish a reliable system to measure worker's performance at the same time it may help to take decision about salary and incentive system to the workers. This requires employee's involvement from every person in the organization. This is achieved by introducing the reward and compensation system. Reward systems are based more on group incentive scheme because an individual incentive scheme can destroy good teamwork and synchronized production. Hence find how the worker's performance and efficiency are affecting the productivity [1].

Many executives are under the mistaken impression that the level of employee performance on the job is proportional to the size of the employee's compensation package. Although compensation package is one of the extrinsic motivation tools, it has a limited short term effect on workers performance. A broadly accepted statement is that better workplace environment motivates employees and produces better results.

It is important to distinguish between ranking and performance review criteria. Only competencies or other criteria of a performance review system can systematically judge the contributions of an individual to an organization [2]. Ranking alone only designates that one person has been rated better at something than another person. In order to be effective, ranking must be based on criteria that are proven to contribute to the industry [3].

1.1 Multi Criteria Decision Making

Multi-criteria decision making (MCDM) is a branch of operation research models and a well known field of decision-making. These methods can handle both quantitative as well as qualitative criteria and analyze conflict in criteria and decision makers.

The Multi criterion Decision-Making (MCDM) are gaining importance as potential tools for analyzing complex real problems due to their inherent ability to judge different alternatives (Choice, strategy, policy, scenario can also be used synonymously) on various criteria for possible selection of the best/suitable alternative. These alternatives may be further explored in-depth for their final implementation [4].

Multiple Criteria Decision Making (MCDM) problems involve five key steps.

a) Identification of the problem/issue: Decision-makers need to identify the nature of the research problem. They must determine specifically which criteria should be considered, and which decision-making strategies should be adopted.

b) Problem structuring: Practitioners/decision-makers need to identify the goals, values, constraints, external environment, key issues, uncertainties, and stakeholders of this enterprise. In this step, we need to collect the appropriate data or information so that the preferences of decision-makers can be correctly identified and considered.
c) Model building: Decision-makers then specify the alternatives, define all criteria, and elicit values for model building. This process allows them to compile a set of possible alternatives or strategies in order to guarantee that the goal will be achieved.
d) Using the model to inform and challenge established thinking: Especially decision-makers collect and synthesize information, challenge people's intuition, suggest other new alternatives, and analyze the robustness and sensitivity of the model.
e) Developing an action plan: in the final step, an action plan is constructed as a solution. In other words, we can select the appropriate method to help us to evaluate and rank the possible alternatives or strategies (i.e., determine the best alternative).

II. PROBLEM DESCRIPTION

In the current state the company manufactures 9,000 shafts per month with a 26 day working nature. This yields a rate of 300 shafts per day with a work force of 12 labours. But, the stiff competition and growth nature of the market must increase the company's production.

There are possibilities of solutions like work force expansion; effective vendor development and automation of the plant, but each of these factors have their own limitation, work force expansion is possible but factors like, time for their training, enough salary with increment at a good rate and continuous switch over of the new generation workers nature are major hurdles in the work force expansion and it seems to be a long term goal rather than immediate action.

Plant automation is very effective but on a clear note it is costlier, the company is not in a position to afford automation of the plant and the final case of vendor development is a better idea, but as a present scenario and growing power demand it is difficult to meet the requirement of the company by vendor development and quality also a concern in getting the required product in right time.

Considering the above situation, the company needs a good technique or system of approach to improve their productivity with increasing labour efficiency, without increasing work force and without compromise the quality of products.

III. METHODOLOGY

There are many industrial engineering techniques for providing better solution for most of the demands that industries put forward to the research society. MCDM is one of a renewed technique used for increasing productivity worldwide, this is an easy and intuitive technique used effectively to provide expected results for many problems like the present one[5].

There are basically three major steps in utilizing any decision-making technique involving numerical analysis of alternatives:

a) Determining the relevant criteria and alternatives.
b) Attach numerical measures to the relative importance to the criteria and the impact of the alternatives on these criteria.
c) Process the numerical values to determine a ranking of each alternative.

This technique provides closer correlation of time intervals that needs to be work with a selected man power system; this is effectively arrived by conducting time study of the required process and finding the tolerance and allowance required for the work with different human range and finally providing the optimum time for the work will minimizes the lead time of the product development. As by overall study in the company, there are several workforce factors noted and are listed below.

a) Deviation from benchmark time in manufacturing
b) Frequent changes of labours
c) Usage of modern machines
d) Training facilities of employees
e) Poor quality of raw materials and accessories
f) Working conditions of unit

g) Operator to helper ratio in shop floor
h) Technological changes in field
i) Absenteeism
j) Accident

In this present project work, time study will be used to extract the present time of the shafts manufacturing and are thoroughly integrated to find optimum time for the process. Also workforce factors are included and the same will be provided for trails in the process, the result of the trail time will be evaluated to fine tune further and recommended for implementation.

A. PROMETHEE Method

The PROMETHEE method is based on mutual comparison of each alternative pair with respect to each of the selected criteria. For performing alternative ranking by PROMETHEE method, it is essential to define preference function $P(a,b)$ for alternatives a and b after defining the criteria. Alternatives a and b are calculated according to the criteria functions. It is measured that alternative a is better than alternative b according to criterion f, if $f(a) > f(b)$. The decision maker has possibility to assign the preference to one of the alternatives on the basis of such comparison. The preference can take values on the scale from 0 to 1, and related combinations are likely to represent using following relations:
$P(a, b) = 0$ no preferences, indifference,
$P(a, b) \approx 0$ weak preference $k(a) > k(b)$,
$P(a, b) \approx 1$ strong preference $k(a) >> k(b)$,
$P(a, b) = 1$ strict preference $k(a) >>> k(b)$.
Relations have following limitations:
$0 < P(a,b) > 1$,
$P(a,b) \neq P(b, a)$

Higher preference is defined by higher value from the given interval. It is explained that, for each criterion the decision maker considers certain preference function [6]. In Fig. 1, six generalized criteria are given and six preference functions $P(d)$. All six generalized criteria are possible to illustrate via linear functions, that is, they are obtained by choosing the highest four points inside criteria space of the given criterion. In Fig. 1, besides criteria functions, the parameters for chosen points are within the criteria space, which is given in x axis, and the level of preference which is given in y-axis (P). In the four-level criterion, instead of value $P(d) = 1/2$, we can give any value $0 < P(d) < 1$.

In Fig. 1, the following denotation is used: m – indifference limit, n – strong preference limit, q – approximate value between m and n for Gaus criterion.

After defining the type of general criteria, it is essential to determine the value of function preference of action a in relation to action b for each criterion, and calculate the index of preferences (IP) of action a in relation to action b. Every pair of actions is in set A. Index preference is calculated in the following way:

$$IP(a,b) = \sum_{j}^{n} W_j P_j(a,b), b \sum W_j = 1 \quad (1)$$

where Wj is the weight of criterion "j".

If all the criteria have the same weight, that is if $Wj = 1/n$, so the index preference is:

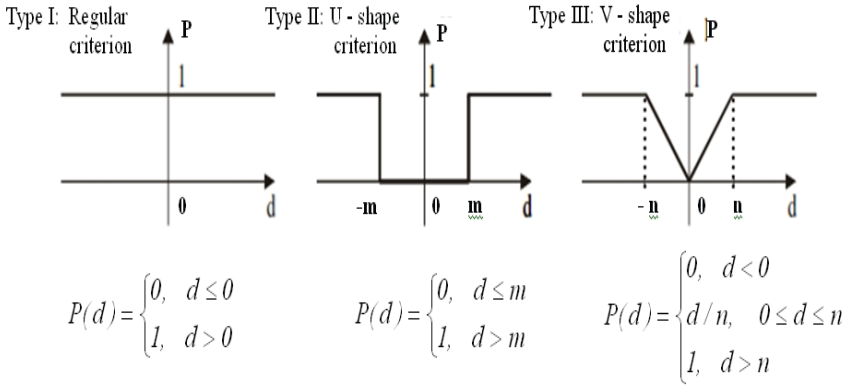
$$IP(a,b) = (1/n). \sum_{j}^{n} P_j(a,b), \quad (2)$$

and are determined by the subsequent relation:
$0 \leq P_j(a,b) \leq 1$

After determining index preference $IP(a,b)$, it is finally possible to calculate alternative flaw index $T(a)$, whose value represents the significance of the alternative. According to this index, the final decision about adequacy of one alternative from the set of alternatives is arranged. Then this is determined as:

$$T(a) = \frac{\sum_{x \in A} IP(a,x)}{i-1} \quad (3)$$

The selection of criteria to be used in the decision process needs to be done carefully so that the majority of the chosen criteria define the problem at hand adequately and in accordance with the decision maker's given requests [7]. In this way, the influence of experience and subjective evaluation of the decision maker during selection of generalized criteria is maximally reduced.



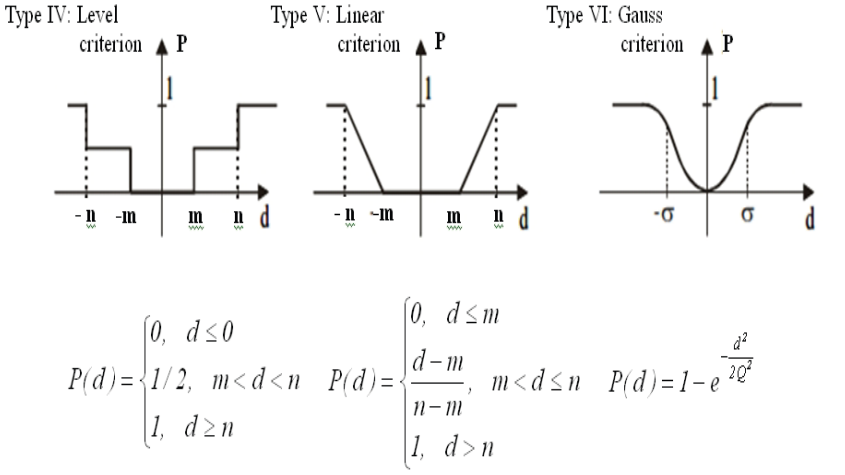


Fig.1 Types of preference functions *P* (*d*) with parameters that illustrate them

IV. MATHEMATICAL MODEL IMPLEMENTATION

The essence of the problem is, using mathematical support, to find indexes *T*(*a*) of the company. *T*(*a*) index evaluate logistic performances of a system. According to these indexes, we can determine the level of logistic strength and stability for the company. *T*(*a*) index solutions are obtained by means of the PROMETHEE method. For the alternatives, the following 10 factors are considered *(Ai = 10):* Deviation from benchmark time in manufacturing (A1), frequent changes of labours (A2), usage of modern machines(A3), training facilities of employees (A4), poor quality of raw materials and accessories (A5), working conditions of unit (A6), operator to helper ratio in shop floor (A7), technological changes in field (A8), absenteeism (A9), accident (A10), on the basis of which the given alternatives are evaluated, are considered by *5* respondents regarded as very competent experts in logistics.

The study was performed in company. With help of company experts, evaluating the criterias, and by using mathematical method, final *T(a)* index was obtained. During evaluation of alternative (*Ai*), *Cj=20* criteria have been used. The criteria are marked with indexes *Cj* and they include: safety (*C1*), skeletal disorders (*C2*),

geographical position (*C3*), inflation (*C4*), pre planning (*C5*), knowledge (*C6*), customer retention (*C7*), changes in setup (*C8*), manual handling (*C9*), the quality of overall infrastructure (C*10*), the complexity of customs control (*C11*), unity between labours (*C12*), labours and company relationship development (*C13*), number of local suppliers (*C14*), fees and taxes (*C15*), salary and productivity (*C16*), effectiveness (*C17*), anti-monopoly politics (*C18*), local competition (*C19*), and the development of supply chains (*C20*).

The results of ranking and criteria assessment are illustrated in Table 1 and used scale Table 2 for qualifying qualitative values of criteria *Cj* [8]. After evaluating criteria *Cj*, the experts also defined weights *Wj* for the criteria. The sum of all criteria weights equal to 1. This can be concluded that the safety criterion is the most influential, because its influence is *15%* of the total influence of all criteria, while the rest of the criteria are weaker.

Table 1 Evaluation of criteria Cj for each alternative-factors Ai on the level of importance

Criteria	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	Weights Wi
C1	4	3.5	4	4	4	5	4.5	4	4.5	5	0.15
C2	2	2	3	2	2	3.5	3	2	2	3	0.14
C3	5	3	2	2	4	3	3	3	4	2	0.11
C4	1	4	5	3	4	3	4	5	4	5	0.08
C5	4.5	4	4.5	5	5	5	5	4	5	5	0.11
C6	2.5	2	3	2	4	3	3.5	1.5	5	4.5	0.08
C7	2.5	3	2	2.5	2.5	3.5	2.5	2	2.5	3	0.06
C8	3.5	3.5	4.5	4.5	3.5	4	4	3.5	4	5	0.06
C9	2.8	3.8	3.7	3	4	3.4	3.5	1.6	4	5.3	0.04
C10	3	3	4	2.5	4.5	3	3.5	2	5	5	0.03
C11	3.5	3.5	4.5	4	4	4.5	4	3.5	4	5	0.03
C12	2	3	2.5	2.5	3	3	1.5	2	3.5	3	0.03
C13	3	4	3	4	5	4.1	5	2.5	4.5	5	0.02
C14	4.5	4.5	5	4.5	4.5	4.5	4	4	4.5	5	0.02
C15	3	3	5	2	2	3	2	3	3	3	0.02
C16	3.5	4	4	4.5	3	4	5	3	3.5	4	0.01
C17	2.5	3	3	2.9	3	4	4	2	3	4	0.01
C18	3	3.5	4	4	4	4	3.5	3	4	5	0.01
C19	4	4.5	4.5	5	5	4	4	3.5	4	5	0.01
C20	3	3	3.5	3	3.5	4	3	3	3	4.5	0.01

Table 2 Linear quantification of qualitative attributes

1	2	3	4	5
Very low	Low	Medium	Strong	Very strong

Besides weight factors *Wj*, the decision maker has to be able to assign to each *Cj* criterion a corresponding preference function *P*(*d*).Besides the preference function, it is essential to determine that which function is minimized and which is maximized. In this paper, the criteria belonging to the category of finances and the criteria having a negative influence on the system's logistic performances are minimized, while the criteria improving business conditions are maximized.

By final implementation of the PROMETHEE II method in the process of solving problems of multi-criteria decision-making for evaluating indexes of preferences *IP* (*a*,*b*) (3), the results of final index of alternative flaw *T*(*a*) (6) are calculated, and their values are shown in the Table 3. on the basis of given criteria, took the first place on the rank list, while technological changes in the field is the lowest ranked with *T(a)* = *-0.359.*

Table 3 Final workforce factors ranking on basis of T(a) index

Alternative	A_9	A_6	A_{10}	A_5	A_2	A_1	A_7	A_4	A_3	A_8
Rank	1	2	3	4	5	6	7	8	9	10
T(a)	0.217	0.159	0.090	0.050	0.045	0.040	0.008	-0.026	-0.225	-0.359

V. RESULTS ANALYSIS

Sequentially to determine the results, special software for data processing D-Sight [9], has been used. D-Sight software has been developing, is closely connected to the PROMETHEE method. This D-Sight software facilitates development of the model according to the PROMETHEE method through the following steps: setting alternatives, setting criteria, setting the weight coefficients for criteria separately, setting alternatives weights and their determination of function of criteria, normalization and their minimization/maximization and analyze the results.

VI. CONCLUSION

The details of workforce efficiency with respect to time study, ranking factors, existing allowance schemes and modification required are taken and noted. Multi-criteria decision-making (MCDM) method has been effectively used to rank the factors of workforce and improve workforce efficiency. To obtain *T(a)* indexes of the company by using multi-criteria analysis method, the PROMETHEE method is ranked as one of the most famous and most frequently used methods of multi-criteria decisions as well as a mathematical tool in order to obtain *T*(*a*) indexes. Thus by using the PROMETHEE method, *T*(*a*) indexes are obtained for ten factors on the basis of twenty criteria and by applying, improving these factors we can achieve more productivity than at present. According to *T*(*a*) index, we can also determine the level of logistic competition in percentage in relation to other alternatives. Using D-Sight software, analytic solutions are qualitatively analyzed and verified.

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