Proceedings of the
International Conference on Mechanical Engineering 2007
(ICME2007) 29- 31 December 2007, Dhaka, Bangladesh

ICME07-AM-67

MULTI CRITERIA DECISION MAKING FOR PERFORMANCE EVALUATION IN RMG SECTOR

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ABSTRACT

It is a common trend to use time study, line balancing and capacity utilization for improving the productivity in many labor oriented manufacturing systems especially in the field of RMG. Performance of the worker is the main key to enhance the quality production. From observation it has been found that there is no established performance grading system in RMG industries. The primary intent of this thesis is to find how the worker's performance and efficiency affect the productivity. This necessitates categorizing the workers according to their performance. This study has evaluated that workers' performance is a function of some variables, which are expressed in qualitative form. To measure the performance these qualitative variables are required to convert into numerical value. Then a questionnaire has been prepared and survey has conducted at different garment industries. From this survey several criterion that affect performance of workers has been identified. Then simulation AHP model has been developed using MCDM. This paper may help to find out the dependent functions of worker performance and also the independent variables behind each dependent function. This study will establish a reliable system to measure worker's performance. The proposed model can be used to make decision about the performance of different workers doing similar operations. At the same time it may help to take decision about salary and incentive system to the workers.

Keywords: Performance, AHP Model, MCDM.

1. INTRODUCTION

The recently emerged economic sector in the country is the garment sector. But the industry has been facing stiff competition both in terms of quality and price. To sustain in the world in terms of the above two factors, a garment factory should ensure the optimum use of its resources i.e. machines, workers, space etc. In these mass production oriented labor intensive garment factories it is required to have a skilled and efficient work force to obtain higher production rate. In the current situation international competition in RMG sector has been increased a lot. Therefore garments companies in Bangladesh need to become more competitive and efficient to survive, to retain market position and increase market base. The foreign competitors have upper hand basically in three areas: Stronger backward linkage, more skilled manpower and better methodology of manufacturing. Thus there is obvious need for upgrading production methodology as well as increasing skill of manpower through application of modern tools and techniques. Analytical Hierarchy Process (AHP) is such a tool that can be used to evaluate workers' performance.

Firms' decisions on how to organize workers and the consequences of these decisions on employee and employer outcomes are an important topic in labor-oriented industries. It has been found that diversity in knowledge, experience, skill and physical and mental conditions possessed by workers who work together in different production floors of the firm can cause fluctuation in output quantity and quality from floor to floor. So performance grading is important for a stable production rate from all floors. Performance grading can create productive competition by motivating workers: observing the high performers may motivate the low performers to work hard in hopes of gaining respect and approval from their supervisors and co-workers for promotions and higher wages, while observing the low performers may inspire the high performers to preserve their superior relative status. On the other hand, performance heterogeneity may create unproductive competition among workers in the form of disharmony, uncooperative behavior and sabotage.

2. BACKGROUND INFORMATION

The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making approach and was introduced by Saaty [1]. The AHP has attracted the interest of many researchers mainly due to the nice mathematical properties of the method and the fact that the required input data are rather easy to obtain. The AHP is a decision support tool which can be used to solve complex, unstructured decision problems [2]. It uses a multi-level hierarchical structure of objectives, criteria, sub criteria, and alternatives.

Some of the industrial engineering applications of the AHP include its use in integrated manufacturing [3] , in the evaluation of technology investment decisions [4], in flexible manufacturing systems [5], layout design [6], location planning of airport facilities and international consolidation terminals [7,8], large and complex project such as the “Silverlake Project” [9], software development [10], supplier selection [11], selection of alternative communication media [12] and also in other engineering problems [13].

Some more examples of AHP applications are selection of assembly systems [14], technology choice [15], site selection [16], project risk assessment [17], inventory problems [18], forecasting foreign exchange rates [19] and facility layout [20].

Nerija [22] has evaluated the life cycle of a building by using multi variant and multiple criteria approach. AHP has also been used for efficient allocation of bandwidth [23], human resource allocation [24], earth quack risk mitigation in bridges and tunnels [21], treatment and land-filling technologies for waste incineration residues [25], analyze the information technology outsourcing decision [26] , and choice in the chemical industry [27] . AHP has also found its applications in hospitality industry [28 and even in petroleum pipeline industry [29].

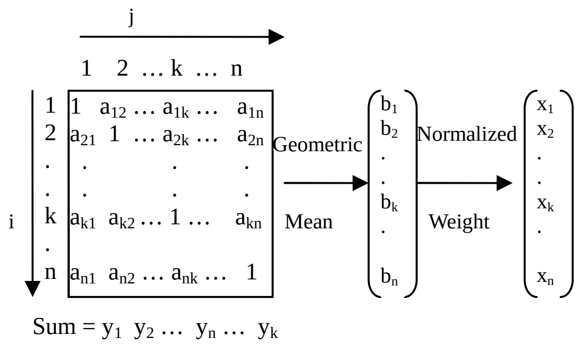
The probable alternatives of any selected item may be evaluated through different multi-criteria models. Because, the alternative items, generally, have multiple characteristics which demand consideration for selection. There are several such models to evaluate different alternatives. The two most favorite techniques are (i) Analytic Hierarchy Process (AHP) and (ii) ELECTRE Method.

The above two methods/ techniques actually rank different alternatives as a decision support system for the management to decide what alternative system/model they can select from several available alternatives.

The Analytical Hierarchy Process (AHP) is a multi criteria decision making process that is especially suitable for complex decisions which involve the comparison of decision elements which are difficult to quantify. It is based on the assumption that when faced with a complex decision the natural human reaction is to cluster the decision elements according to their common characteristics.It is a technique for decision making where there are a limited number of choices, but where each has a number of different attributes, some or all of which may be difficult to formalize. It is especially applicable when decisions are being made by a team. It involves building a hierarchy (Ranking) of decision elements and then making comparisons between each possible pair in each cluster (as a matrix). This gives a weighting for each element within a cluster (or level of the hierarchy) and also a consistency ratio (useful for checking the consistency of the data).

The crux of AHP is the determination of the relative weights to rank the decision alternatives. Assuming that there are *n* criteria at a given hierarchy, the procedure establishes an *n x n* pair-wise comparison matrix, A, that reflects the decision maker’s judgment of the relative importance of the different criteria. The pair-wise comparison is made such that the criterion in row *i* (*i = 1,2,3,....,n*) is ranked relative to each of the criteria represented by the *n* columns. Letting a_{ij} define the element *(i,j)* of A, AHP uses a discrete scale from 1 to 9 in which $a_{ij} = 1$ signifies that *i* and j are equally important, $a_{ij} = 5$ indicates that *i* is strongly more important than *j* and $a_{ij} = 9$ indicates that *i* is extremely more important than *j*. Other intermediate values between 1 and 9 are interpreted correspondingly. For consistency, $a_{ij} = k$ automatically implies that $a_{ji} = \frac{1}{k}$. Also all the diagonal elements a_{ii} of A must equal 1 because they rank a criterion against itself. The relative weights of criterion can be determined from A by dividing the elements of each column by the sum of the elements of the same column. The resulting matrix is called normalized matrix, N.

The numerical results of attributes are presented to the decision maker to assign relative importance according to a predefined scale. Now a judgment matrix prepared. It is an (n x n) matrix; normalized weights are calculated as follows.



where, i and j are the alternatives to be compared. a_{ij} is a value that represent comparison between alternatives or attributes i and j.

The above judgment matrix may be consistent if

$$a_{ij}.a_{jk} = a_{ik} \quad \text{...} \quad (1)$$

For all values of i, j, k

In the above judgment matrix, sum of the element in a column

$$y_k = \sum a_{ij} \quad \text{...} \quad (2)$$

Where, i = 1,2, ….. n and j = 1,2, …… n

Geometric mean is calculated of row as follows:

$$b_k = [(a_{k1}).(a_{k2}).........(a_{kn})]^{1/n} \quad (3)$$

where, k = 1, 2, …… n

Normalized weights are calculated as follows:

$$X_k = \frac{b_k}{\sum b_k} \quad (4)$$

Acceptability of alternative or attribute is measured in terms of Consistency Ratio (C.R.)

$$Consistency\ ratio = \frac{consistency\ index}{randomly\ generated\ consistency\ index}$$

Atty's measure of consistency is done in terms of Consistency Index (C.I.)

$$C.I. = \frac{\lambda_{\max} - n}{n-1} \quad (2)$$

where,

$$\lambda_{\max} = y_1x_1 + y_2x_2 + ... + y_kx_k + ... + y_nx_n = \sum y_kx_k$$

= largesst eigen value of matrix of order n

Now, some Randomly Generated Consistency Index (R.I.) values are as follows:

n	1	2	3	4	5	6	7	8	9	10
R.I.	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

If C.R. < 10%, then the level of inconsistency is acceptable. Otherwise, the alternative or attribute is rejected. The over-all consistency may also be measured to justify the validity of selection.

Using this tool AHP it has been tried to find out a systematic approach of workers performance evaluation.

3. RESULTS AND DISCUSSION

Performance is a measure of results achieved. It is an abstract concept and it must be represented by concrete, measurable phenomena or events in order to be measured. Performance efficiency is the ratio between effort expended and results achieved.

It is not easy to measure productivity and performance. To begin with, one has to distinguish productivity, an end-point measure, from performance, an intermediate measure of what a worker produces in the course of doing his or her job.

This study reveals that workers performance is a function of some dependent variables. From survey these variables have been identified which are quality, quantity, adaptability, durability, regularity, education, behavior and skill in multiple operations. These variables are again function of some independent variables. This study has focused the independent functions behind workers' efficiency i.e., quality and quantity.

The efficiency of the worker depends on workers physical condition, mental condition, working environment, company's policy on salary and performance appraisal. This study has found from survey data that working condition has major impact on workers efficiency.

3.1 Impact of Health on Performance

The impact of health on labor productivity is a topic of considerable interest in the labor intensive industries like RMG sectors. A healthy workforce is one of our most important economic assets as a nation. This analysis examines three major sources of lost economic productivity related to health: adults who do not work because of poor health or disability; workers who miss time from their jobs as a result of health problems; and workers who, while working, are less productive than they could be as a result of their own health problems or worries about sick family members.

3.2 Impact of Mental Condition on Performance

Mental health is a state of successful performance of mental function, resulting in productive activities, fulfilling relationships with other people, and the ability to adapt to change and to cope with adversity. Mental health is indispensable to personal well-being, family and interpersonal relationships, and contribution to community or society. Mental illness is the term that refers collectively to all diagnosable mental disorders. Mental disorders are health conditions that are characterized by alterations in thinking, mood, or behavior (or some combination thereof).

Mental illness a burden on productivity. This study has found that more than half of an organisation's absenteeism was caused by the mental health issues of a large and diverse workers.

3.3 Impact of Company's Compensation Policy on Performance

Employee compensation programs are designed:

(1) To attract capable employees
(2) To motivate them towards better performance
(3) To retain their services over extended period

Research in the same organization revealed that though employees on incentive plans were more highly motivated than those on hourly pay, the latter were more satisfied with the pay actually received. Productivity was highest under the individual price rate system and lowest hourly. In separate measures of satisfaction, hourly paid personnel reported the highest satisfaction with pay received, individual incentive employees next highest and those on group[plans reported the greatest dissatisfaction. Thus it is suggested that one may have to choose between developing motivated employees and satisfied employees.

3.4 Impact of Performance Skill on Performance

In today's garment industries, the only constant is change. Everyday products of new style run throughout each lines. Thus jobs require relatively high performance work processes and enhanced skills. If workers are properly trained than less time is required for new design and new process. They can easily handle problems with machines and thus machine downtime is reduced. So for enhancing skill of workers training is very necessary.

3.5 Impact of Working Environment on Performance

The relation of performance with different Ventilating and Air Conditioning System is given below.

(1) Performance decreases when too cold or too hot
(2) Performance decreases in polluted air
(3) Performance decreases when too noisy
(4) Performance decreases when person/equipment vibrates
(5) Performance decreases with no control (perceived or real)

Lighting system is another important issue on which efficiency varies. Due to lack of proper lighting that is either too much or dim lighting hamper performance. It disrupts visual inspection and interpersonal interaction. Task demands and user age change light requirement.

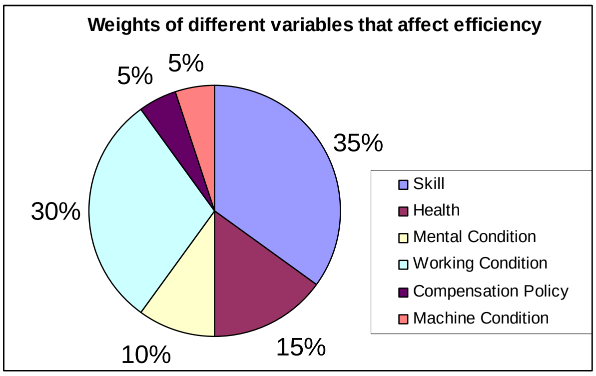


Fig 1:Weight of different variables that affect efficiency

Noise is often defined as "unwanted" sound. In the workplace, noise can have varying effects based on the sound level, frequency, and amplitude, and the task being performed. In general, noise acts as a stressor in the work environment. It has been found that performance decreases with loud/annoying noise, poor privacy and noise stress. From survey data the relative weights of these variables are found and these are shown in Fig.1.

As a part of this study a survey was conducted in different garments industry. The working condition and pay system is totally different in these visited garments. The organizational efficiency is also varies as a function of working condition.

In a well reputed garments industry Square Knit & Garments the efficiency is about 53.75%. The facilities they provide to worker are better than the other two industries that have been taken under consideration. They provide launch facilities, the working environment is centrally air conditioned, day care center, medical facilities are available. Again their pay scale is good and they have provision for gratuity and pension. As a result of sound environment and job security the worker as well as organization efficiency is higher than other two industries.

The next garment is Fakir Knit wear Ltd. Here organization efficiency is 48%. The working condition is not so good like previous industry. There is no air conditioning system. Launch is not provided. So there is a decrease in efficiency. The other one is Babylon group Ltd. Its efficiency is 39.4 %. The data collected for measuring efficiency are given in Table-1.

Table 1: Data for comparison of efficiency

Operation Name	M/C	Babylon	FKL	Square
Shoulder joint	O/L	0.23	0.23	0.2
Shoulder top stitch	S/N	0.12	0.12	0.14
Lebel swing	S/N	0.12	0.14	0.15
Rib sewing	S/N	0.13	0.13	0.11
Neck joint	O/L	0.16	0.18	0.16
Back rib piping	F/L	0.15	0.15	0.15
Kantack	S/N	0.09	0.09	0.07
Neck top stitch	S/N	0.14	0.16	0.14
Back rib top stitch	S/N	0.17	0.17	0.14
Sleeve joint	O/L	0.33	0.35	0.3
Sleeve top stitch	S/N	0.22	0.25	0.21
Side seam	O/L	0.46	0.46	0.48
Sleeve Hem	F/L	0.26	0.26	0.23
Body Hem	F/L	0.3	0.3	0.22
Total SMV		2.88	2.99	2.7
Per hour Production		180	180	215
Line performance (%)		**48**	**49.83**	**53.75**

3.6 Proposed Calculation

The comparison matrix for the criterion is,

	Ql	Qt	Rg	Ad	Bh	Ed	Te	X_k
Ql	1	5	6	5	9	8	7	0.51
Qt	0.2	1	1.2	1.5	1.8	1.6	1.4	0.11
Rg	0.17	0.83	1	0.5	1.5	1.33	1.17	0.08
A	0.2	0.67	2	1	1.8	1.6	1.4	0.11
Bh	0.11	0.56	0.67	0.56	1	0.5	0.78	0.05
Ed	0.13	0.61	0.75	0.63	2	1	0.88	0.07
Tec	0.14	0.71	0.86	0.71	1.29	1.14	1	0.07

$\lambda_{max} = 7.09$, C.I = 0.015, C.R = 0.01

The comparison matrices regarding the relative importance of the eight alternatives are given below.

A(quality)

	A	B	C	D	E	F	G	X_k
A	1	2	3	9	9	0.6	8	0.30
B	0.5	1	1.5	4	4	0.5	3.5	0.15
C	0.33	0.67	1	2.5	3.5	0.20	3	0.10
D	0.11	0.25	0.4	1	1	05	1.2	0.05
E	0.11	0.25	0.29	1	1	0.07	0.89	0.03
F	1.67	2	5.0	2	15	1	8	0.32
G	0.13	.29	0.33	0.83	1.13	0.13	1	0.04

$\lambda_{max} = 7.41$, C.I = 0.068, C.R = 0.05

A(quantity)

	A	B	C	D	E	F	G	X_k
A	1	5	0.65	0.31	2	0.25	0.52	0.08
B	0.2	1	0.15	0.5	0.4	0.05	0.1	0.03
C	1.54	6.67	1	0.48	3.08	0.38	0.8	0.12
D	3.23	2	2.10	1	6.45	0.81	1.68	0.23
E	0.5	2.5	0.33	0.16	1	0.13	1.26	0.04
F	4	20	2.6	1.24	8	1	2.08	0.33
G	1.92	9.62	1.25	0.6	3.85	0.48	1	0.16

λ_{max} = 7.58, C.I = 0.096, C.R = 0.073

A(Regularity)

	A	B	C	D	E	F	G	X_k
A	1	3	0.5	5	0.21	0.1	4	0.06
B	0.33	1	0.17	1.67	0.07	0.03	1.3	0.02
C	2	6	1	10	0.42	0.2	8	0.13
D	0.2	0.6	0.1	1	0.04	0.02	0.8	0.01
E	4.76	14.3	2.38	23.8	1	0.48	9	0.26
F	10	30	5	50	2.1	1	9	0.50
G	0.25	0.75	0.13	1.25	0.11	0.11	1	0.02

λ_{max} = 7.46, C.I = 0.076, C.R = 0.058

A(adaptability)

	A	B	C	D	E	F	G	X_k
A	1	4	0.48	0.1	2	0.32	1	0.06
B	0.25	1	0.12	0.03	0.5	0.08	0.25	0.01
C	2.08	8.3	1	0.21	4.17	0.67	2.08	0.12
D	10	40	4.8	1	9	3.2	9	0.52
E	0.5	2	0.24	0.11	1	0.16	0.5	0.03
F	3.13	12.5	1.5	0.31	6.25	1	3.15	0.19
G	1	4	0.48	0.11	2	0.29	1	0.06

λ_{max} = 7.12, C.I = 0.020, C.R = 0.015

A(Education)

	A	B	C	D	E	F	G	X_k
A	1	2	0.35	0.1	0.5	0.32	0.5	0.04
B	0.5	1	0.18	0.05	0.25	0.16	0.25	0.02
C	2.86	5.71	1	0.29	1.43	0.91	1.43	0.13
D	10	20	3.5	1	5	3.2	5	0.44
E	2	4	0.7	0.2	1	0.64	1	0.09
F	3.13	6.25	1.09	0.31	1.56	1	9	0.20
G	2	4	0.7	0.2	1	0.11	1	0.08

λ_{max} = 7.42, C.I = 0.07, C.R = 0.053

A(Behavior)

	A	B	C	D	E	F	G	X_k
A	1	5	1	0.5	2	0.21	5	0.11
B	02	1	0.2	0.1	0.4	0.04	1	0.02
C	1	5	1	0.5	2	0.21	5	0.11
D	2	10	2	1	4	0.42	9	0.22
E	0.5	2.5	0.5	0.25	1	0.11	2.5	0.06
F	4.76	23.8	4.76	2.38	9.52	1	9	0.46
G	0.2	1	0.2	0.11	0.4	0.11	1	0.03

λ_{max} = 7.15, C.I = 0.025, C.R = 0.018

A(Technical skill)

	A	B	C	D	E	F	G	X_k
A	1	4	0.21	0.25	4	0.36	2	0.08
B	0.25	1	0.05	0.06	1	0.09	0.5	0.02
C	4.76	19.04	1	1.19	9	1.70	8	0.33
D	4	16	0.84	1	9	1.40	8	0.29
E	0.25	1	0.11	0.11	1	0.09	0.5	0.02
F	2.78	11.1	0.59	0.71	11.1	1	5	0.22
G	0.5	2	0.13	0.13	2	0.2	1	0.04

λ_{max} = 7.10, C.I = 0.016, C.R = 0.013

criterion	Ql	Qt	Rg	Ad	Bh	Ed	Te	Final
Alt.	(0.51	0.11	0.08	0.11	0.05	0.07	0.07)	priority
A	0.29	0.15	0.10	0.06	0.03	0.34	0.04	0.184
B	0.08	0.03	0.12	0.23	0.04	0.33	0.16	0.086
C	0.06	0.02	0.13	0.01	0.26	0.50	0.02	0.125
D	0.06	0.01	0.12	0.52	0.03	0.19	0.06	0.173
E	0.11	0.02	0.11	0.22	0.06	0.46	0.03	0.056
F	0.04	0.02	0.13	0.44	0.09	0.20	0.08	0.321
G	0.08	0.02	0.33	0.29	0.02	0.22	0.04	0.054

Therefore the best worker is A. The order of ranking is A>F>D>C>B>E>G as shown in Fig.2.

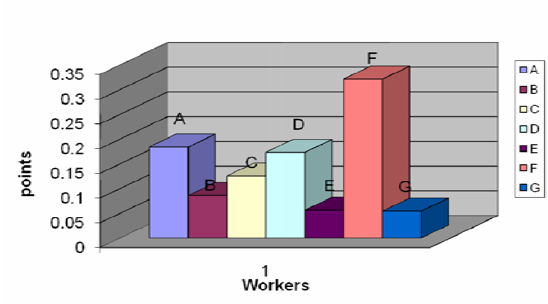


Fig 2: Decision analysis graph

4. CONCLUSION

The above study can be concluded that AHP can be a new tool for Performance evaluation. Performance improvement is possible by finding out the independent variables behind this dependent function. Here only functions behind the quality and quantity are taken into consideration but further study can be done with the other variables.

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