

Efficiency Evaluation of Employees in Shipping Firm by Using Data Envelopment Analysis

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ABSTRACT

The paper Evaluating and ranking the employees working in organization are very valuable but it might be challenging tasks. Each employee has several performance levels in various factors. This paper evaluates employee performance using Data Envelopment Analysis (DEA) and the causes for decreasing employee efficiency and the way that overcome it. And also this paper presented here is designed to develop elements and standards that measure employee and work accomplishments rather than to develop other measures that are often used in appraising performance, such as measuring behaviors or competencies. Human resource is one of the leading determinants in maritime transport industry and both the industry and the individual shipping companies consider human resources strategies as an important area of research. This study concern with employees' efficiency in shipping industry and at the end of the study find out the less efficient employees and the problems they faced when they reached their goals.

KEYWORDS: Data Envelopment Analysis

INTRODUCTION

The development is upgrading an employee from one level to a higher level. This is a long term process and it includes both education and training. Employee development is a joint, on-going effort on the part of an employee and the organization for which he or she works to upgrade the employee's knowledge, skills, and abilities. Successful employee development requires a balance between an individual's career needs and goals and the organization's need to get work done.

As an agent of shipping line, the employees should have to complete their work

charges imposed by Port Authority. As a result of late submission and inaccurate documents, they have to face some effects from port authority and also principal company. Therefore some employees have to work hard and sometimes they have to work more and more to end up their jobs. According to their jobs sometime they pay less attention for their core activities and pay more attention for other work that they have to do.

During this study it tried to find out employee efficiency states and the reasons for less efficiency states.

LITERATURE REVIEW

Human resource management (HRM) is the strategic and coherent approach to the most valued asset of management in an organization. Workers in the company contribute individually and co-operatively to achieve the objectives of the business. The terms "human resource management" and "human resources" (HR) have widely replaced for the term "personnel management" as a description of the processes involved in managing the people in an organization. Simply HRM

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on time with accuracy. Otherwise they have to be responsible for paying additional

means employing the people, developing their skills, utilizing, maintaining and compensating their services in tune with the job and organizational requirement.

HRM features include:

- Organizational management
- Personnel administration
- Manpower management
- Industrial Management

Performance management is the systematic process of

- Planning work and setting expectation
- Monitoring performance
- Developing the capacity to perform
- Periodically rating performance in a summary fashion
- Rewarding good performance

Data Envelopment Analysis

Data envelopment analysis (DEA), as developed by Charnes et al. (1978) does not require any priori weights for inputs and outputs. In DEA, the relative efficiency of a decision making unit (DMU), is determined by assigning same weights to the inputs and outputs of all DMU. The ratio of the weighted sum of outputs to the weighted sum of inputs for DMU which is under consideration is maximized. Toward the end, factor weights are allowed to vary freely (within the general constraints) in each run of the model. Therefore, as the methods of DEA run for each DMU separately, the set of weights will typically be different from the various DMUs, and in some cases, it may be considered unacceptable as the same factor is accorded widely differing values. A possible answer to difficulty lies in the specification of a common set of weights that was first introduced by Roll et al.

For dealing with the difficulty and assessment of all the DMUs on the same scale, normally use a multiple objective linear programming (MOLP) approach for

generating common set of weights under the DEA framework.

DEA study provides the following four properties relatively to efficiency measures,

- A piecewise linear empirical envelopment surface to represent the best practice frontier, consisting of units which exhibit the highest attainable outputs in relation to all other DMU's in the population, for their given level of inputs.
- An efficiency metric to represent the maximal performance measure for each DMU measured by its distance to the frontier
- Specific targets or efficient projections onto the frontier for each inefficient DMU
- An efficient reference set or peer group for each DMU defined by the efficient units closest to the DMU

Some of the benefits of DEA are:

- No need to specify explicitly a mathematical form for the production function
- proving would be useful in uncovering relationships that remain hidden for other methodologies
- capability of handling multiple inputs and outputs
- capability of being used with any input-output measurement
- the sources of inefficiency can be analysed and quantified for every evaluated unit

There are three basic DEA models. These frameworks are: (a) CCR (Charnes, Cooper & Rhodes 1978), (b) BCC (Banker, Charnes & Cooper 1984), and (c) CCGSS (Charnes, Cooper, Golany, Seiford & Stutz 1985). These models have different mathematical formulations, but all share the principle of envelopment (Golany & Roll 1989). In DEA either output maximisation or input minimisation is possible. The present study focuses on the output maximisation BCC model to improve the

efficiency of existing inefficient employees. The BCC model has two main elements.

- Variation of outputs is not in same scale of inputs (Variable Return to Scale (VRS))
- Increasing Return Scale (IRS) or Decreasing Return Scale (DRS) can be found out with this model on each DMU (i.e., employee). (Either an increase or decrease in input, which may result in output increase or decrease respectively to identify IRS or DRS.)

The BCC Model

Indices: J – DMUs, $j = 1, 2, 3, \dots, n$

r – outputs, $r = 1, 2, 3, \dots, n$

i – inputs, $i = 1, \dots, m$

Data: y_{rj} – the value of the r^{th} output of the j^{th} DMU

x_{ij} – the value of the i^{th} input for the j^{th} DMU

ϵ – a small positive number (non-Archimedean constant, order 10^{-5} or 10^{-6})

Variables: s_i, σ_r – slacks corresponding to input i , output r respectively (≥ 0)

λ_j – weight of DMU in the facet for the evaluated DMU (≥ 0)

μ_r, v_j – virtual multipliers for output r , input i respectively ($\geq \epsilon$)

h_k – relative efficiency of DMU $_k$

u_k – returns to scale, is an indicator interpreted by BCC

The linear programming problem (LPP) formulation for each individual DMU to solve is

$$\begin{aligned} \text{Max } h_k = \sum_r \mu_r y_{rk} - u_k & \quad \text{subject to} \quad \sum_j v_j x_{ij} = 1 \\ & \quad \sum_r \mu_r y_{rj} - \sum_j v_j x_{ij} - u_k \leq 0 \quad (1) \end{aligned}$$

The objective here is to find the largest sum of weighted outputs of individual while keeping the sum of its ratio of the sum of weighted outputs to the sum of weighted inputs for any individual which is to be less than one. This ratio corresponds to the classical engineering ratio definition of efficiency. Consequently, the dual formulation for DMU is written and solved as follows.

$$\begin{aligned} \text{Min } h_k = \theta_k - \epsilon(\sum_r \sigma_r - \sum_i s_i) & \quad \text{subject to} \quad \sum_j x_{ij} \lambda_j - \theta_k x_{ik} + s_i = 0 \\ & \quad \sum_j y_{rj} \lambda_j - \sigma_r = y_{rk} \\ & \quad \sum_j \lambda_j = 1 \end{aligned}$$

The objective function of this model attempts to find a minimal value for an intensity factor (θ_k) which indicates the potential of an individual. In addition, the objective function seeks the largest slack values in all input output dimensions. In other words, it finds the reference point on the empirical production function that portrays individual in the worst efficiency characterisation.

METHODOLOGY

The Shipping Industry in Sri Lanka is rapidly growing. Annual import, export and transshipment containers are increasing. Sustaining this sector of the Sri Lankan economy provides the imperative to focus on the strategies. It would preserve company growth and profitability. Consequently, a major managerial challenge is needed to address employee performance.

The study site acts as a shipping agent company located in Colombo Sri Lanka, which is responsible for all the activities done in Sri Lankan agent. The company was established three years ago and is involved in import, export and transshipment services.

The main focus of the study is to improve the working efficiencies of the employees and to determine their training needs. Employee rankings can be used to decide the types of incentives and promotions during the future expansion of the company. The dataset considered for the evaluation process is classified into input and output factors. One of the major advantages of the DEA is the inputs and outputs which can be measured and used in their own units. No universally applicable rational template is available for the selection of factors. However, in general, the inputs must reflect the resources used and the outputs must reflect the service levels of the utility and the degree to which the utility is meeting with its objective.

The dataset is decided upon, by having discussions and brainstorming sessions with the managers, supervisors and representatives of employees. While considering input and output factors the harmonic relations are assumed for DEA (i.e., an increase in any input should not result in a decrease in any output). Consequently, the values of some factors had to be inverted before they are entered into the analysis.

Another group of factors considered in the research is qualitative factors which help to assign numerical values in order to participate in the mathematical evaluation of efficiency. Any number of input or output factors which are relevant and have an impact on the efficiency of employees could be considered for DEA.

But the number of employees in the analysis should be at least twice as the number of inputs and outputs considered. To evaluate efficiency scores of employees the following factors were used. Job knowledge, customer relations, interpersonal relations, and work habits as input factors; and quality, and quantity of products produced as output factors. Among the input factors customer relations and interpersonal relations are more qualitative. Qualitative factors are important in a wide

range of problem settings to which DEA can be applied. Marketing's interest in consumer perception and expectation, and human resources' desire to explore and describe employees' skills are two areas that routinely involve the quantification of qualitative concepts. As only quantitative measures are used in DEA, qualitative factors need to be converted into quantitative scores. Such factors may be legitimately quantifiable, but very often such quantification is superficially forced, as a modeling convenience. Typically, a qualitative factor is captured either on a Likert scale, or is represented by some quantitative surrogate such as plant downtime or percentage sick days by employees. In here assign weights for each input factors which explain include above according there specification.

Data Analysis

Minitab version 14 was used to analyse the data. A series of regression analyses (Min, Min & Standard Deviation) was conducted for classifying the factors as input or output factors. The statistical details of the dataset used in this study are shown in Table 4. Any factor with a weak relation to inputs and strong relation to outputs indicates a preference towards classifying the factor as an input. A weak relation to all the factors may indicate a need to reexamine the factor. Alternatively, a strong relation may indicate that the information contained in that factor is already represented by other factors and again its participation should be reexamined. The regression analysis is helpful in eliminating redundancies and reducing the number of factors for investigation.

Once the consensus decision on dataset is taken by managers, supervisors and representatives of employees, only the required data need to be fed into the DEA software. Most of the data are quantitative and available from databases. There is an

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obvious need for such software tools to improve the performance appraisal process.

Frontier Analyst software version 3 used to analyse the data. Any factor with a weak relation to inputs and strong relation to outputs indicates a preference towards classifying the factor as an input. A weak relation to all the factors may indicate a need to reexamine the factor. Alternatively, a strong relation may indicate that the information contained in that factor is already represented by other factors and again its participation should be reexamined.

17	100.00
18	98.96
19	100.00
20	99.44
21	100.00
22	100.00
23	100.00
24	100.00
25	99.18
26	100.00
27	100.00
28	99.91
29	100.00
30	99.76

Table 1: Summary of statistical details of dataset

Parameter	Summary of statistical details of dataset				Correlation Between Factors					
	Mean	Std	Max	Min	X1	X2	X3	X4	Y1	Y2
Job knowledge (X1)	4.030	1.638	6.00	1.5	0.94	0.28	0.29	0.64	0.74	
Customer relations (X2)	0.830	0.127	1.00	0.6	0.44	0.35	0.67	0.80		
Work habits (X3)	0.895	0.095	0.90	0.6		0.19	0.42	0.24		
Interpersonal relations (X4)	0.853	0.070	0.95	0.7				0.38	0.69	
Quality (Y1)	0.949	0.816	0.97	0.9						0.69
Quantity (Y2)	737.560	11.759	755.00	722.0						

The statistical details of the dataset used in this study and the correlation between the factors of the DEA dataset is also presented in following table.

RESULTS

Table 2: Employee Efficiency Table

EMPLOYEE	EFFICIENCY - %
1	99.44
2	99.18
3	100.00
4	100.00
5	100.00
6	100.00
7	100.00
8	100.00
9	99.91
10	100.00
11	99.76
12	100.00
13	99.69
14	100.00
15	100.00
16	97.3

DISCUSSION AND CONCLUSION

This research study use to identify employee efficiency in shipping firm by using Data Envelopment Analysis. When using DEA techniques, weights given for each inputs and outputs of employee. Given weighs are decided by researches according to value of those variables. It depends on the researcher therefore employee efficiency may be different value for different researchers.

There are a few basic roles for a supervisor in developing employees' skills. They include:

- Providing both positive and corrective feedback
- Offering organizational insight, information, and advice
- Guiding the planning through goal setting and following up
- Allocating time and money for development experiences
- New learning opportunities to workers should be ensured

It is very helpful for an employee to get an honest assessment of their work, as well as access to others who may be able to provide information or coach the employee. The successful supervisor will also respect every employee's learning curve. It takes time for anyone to learn new skills and be able to apply them well; this does not

happen overnight. Building this development time into the application of a new skill set will make the employee more successful.

Some things that the employee should consider in their own development include seeking a variety of assignments, tackling tough problems and asking for feedback. Coaching is another helpful activity, both in looking for opportunities to coach others and finding good coaches for him. It can help to ask for feedback when working with a variety of people and in a variety of situations. Employees should be looking for developmental relationships that can provide a variety of learning. They can also identify goals for new skills and abilities and then look for ways to meet those goals. It can also be helpful to attend classes and workshops to fill in conceptual needs.

REFERENCES

1. Alexouda, G. (2005). *Decision Support System A user-friendly marketing decision support system for the product line design using evolutionary algorithms*. 38(4), 495-509.
2. Banker, R. D., Charnes, A., & Cooper, W. W. (1984). *Management Science*, Some models for estimating technical and scale inefficiencies in data envelopment analysis. 30(9), 1078-1092.
3. Becker, B. E., Huselid, M. A., & Ulrich, D. (2001). *The HR scorecard, linking people, strategy, and performance*. Harvard Business School Press: Boston.
4. Biehl, M., Cook, W., & Jonston, D. A. (2006). *The efficiency of joint decision making in buyer-supplier relationships*. *Annals of Operations Research*, 145(2), 15-34.