

Applying the Data Envelopment Analysis to Discuss Performance Evaluation of Customer Relationship Management in Shipping Industry

Chienta Chen[†], Ziping Chiang^{*†}, Minliang Hsieh[†], and Xinggui Zeng[†]

[†]School of Management
Fujian University of Technology
Fuzhou 350118, China

[‡]College of Civil Engineering
Fuzhou University
Fuzhou 350116, China



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ABSTRACT

Chen, C.; Chiang, Z.; Hsieh, M., and Zeng, X., 2018. Applying the data envelopment analysis to discuss performance evaluation of customer relationship management in shipping industry. In: Liu, Z.L. and Mi, C. (eds.), *Advances in Sustainable Port and Ocean Engineering*. *Journal of Coastal Research*, Special Issue No. 83, pp. 833–838. Coconut Creek (Florida), ISSN 0749-0208.

Along with frequent global trading, trade between countries becomes popular. Import/export trade also relies on shipping that it is an important issue to maintain good customer relationship and interaction to enhance stable customer sources and promote company performance in shipping industry. To maintain highly competitive advantages, price differentiation, concentration strategies, and low shipping expenses could attract new customers, consolidate old customers, and satisfy customer needs with professional knowledge to reinforce customer relationship management, i.e. the possession of competitive advantages. Data Envelopment Analysis (DEA) is used as the efficiency evaluation tool in this study. The efficiency acquired with DEA and the information of variables show that 1 DMU presents strong efficiency on customer relationship management, 4 DMUs, with the efficiency between 0.9 and 1, reveal marginal inefficiency on customer relationship management, and 7 DMUs appear obvious inefficiency, with the efficiency lower than 0.9, on customer relationship management. The key factors in customer relationship management in shipping industry are further found out through sensitivity analysis. According to the results, suggestions are eventually proposed, expecting that shipping businesses, under limited resources, manpower, and budgets, could grasp market conditions, customer preference, complicated international trade trend, and the practice of governmental policies within limited time to promote the organizational performance.

ADDITIONAL INDEX WORDS: *Shipping industry, customer relationship management, performance evaluation.*

INTRODUCTION

Along with the advance of time, a lot of enterprises, in face of the trend of globalization and regional economic integration, need to apply the geographic advantages and develop the economic strength to enhance the international competitiveness and further find out the optimal position in the global economic stage. Liner shipping is the major operation style in global shipping market. Container liner service presents the service characteristics of fixed ports, fixed routes, fixed schedule, and fixed time. Since the needs for shipping are increasing annually, shipping companies, in order to satisfy customer needs, would positively expand the market share. In consideration of annually increasing oil prices and labor costs, container ships have turned to the trend of large scale, fast, oil-reduction, and engine room automation development to seek for economies of scale, reduce operating costs, and strengthen

the competitiveness (Wang *et al.*, 2012; Wu *et al.*, 2012). In other word, liner shipping companies have to maintain the cooperation with customers in order to survive in the fiercely competitive market. When establishing cooperation relationship, good interaction with customers could be acquired for the loyal support. Furthermore, liner shipping companies could establish long-term relationship with customers so as not to worry about the problem of over-tonnage in off-season (Basak and Gajbhiye, 2018; Fu and Liu, 2017; Jasinski, 2017; Khosravi *et al.*, 2018; Shen *et al.*, 2017).

Along with frequent global trading, trade between countries has become popular. Import/export also depends on shipping that customers would inspect the service quality of shipping businesses with high standards. Price competition and low costs might be the methods to retain customers, but not the sole one. It is the future trend to promote competitiveness in the professional field and create unique advantages to segment from the market and provide customers with customized services. Nonetheless, the growth cycle of shipping industry has getting mature due to market competition that shipping businesses no longer have the advantages. After all, product service offered does not appear

DOI: 10.2112/SI83-137.1 received 12 December 2017; accepted in revision 2 March 2018.

*Corresponding author: ziping@fzu.edu.cn

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large differences. Each shipping company offering about similar information service quality and freight, and the factors of too many homogeneous businesses, low customer loyalty, and low-cost orientation have shipping businesses consider how to maintain good relationship and interaction with customers for stabilizing customer sources and enhancing company performance. In this case, the advantages of price differentiation, concentration strategies, and low freight could attract new customers and consolidate old customers to maintain the highly competitive advantages. Besides, satisfying customer needs with professional knowledge could reinforce customer relationship management, i.e. the possession of competitive advantages. Accordingly, aiming at customer relationship management in shipping industry, the performance evaluation is preceded in this study, expecting that shipping businesses, under limited resources, manpower, and budgets, could actually grasp market conditions, customer preference, and complicated trade trend, and cope with the practice of governmental policies within limited time to enhance the organizational performance.

LITERATURE REVIEW

Customer Relationship Management

Hsu, Chih, and Liou (2016) proposed the one-to-one marketing idea (or relations marketing) and suggested that an enterprise had to establish long-term partnership with customers and provide customers with personalized marketing and services to create the relative core competitive advantage. Harrigan *et al.* (2015) mentioned that, owing to the advance of information technology, the diversified communication channels had relations marketing break through the past one-to-one restriction. Such an idea gradually became the basic concept of customer relationship management. Customer relationship management was not simply an academic research point but was highly emphasized and broadly applied in various large enterprises. Ashley and Tuten (2015) pointed out customer relationship management as an enterprise applying complete resources, comprehensively understanding each customer, and interacting with customers through various channels to enhance customer value. Orenga-Roglá and Chalmeta (2016) regarded it as effectively managing customer data, providing customers with satisfactory product orientation and service needs, and establishing long-term, stable, and mutually trustful relationship with customers. Carlson and Lee (2015) proposed that customer relationship management was the comprehensive strategy and procedure to acquire customers, retain customers, and become partners with selected customers to create higher value for companies and customers. Ascarza *et al.* (2017) proposed that customer relationship management did not simply establish relationship and use systems for collecting and analyzing data, but contained the cross-function integration of all activities, connected such activities with company and customer value, expanded integration activities to the entire value chain, develop the ability to integrate such activities, and generate customer value and shareholder value through the cooperation with company network (Luarn, Lin, and Chiu, 2015). Boerman Willemsen, and Van Der Aa (2017) proposed CRM as a tactic that an enterprise understood and affected customer behaviors through meaningful communications, aiming to increase new customers, prevent existing customers from losing, promote customer loyalty, and enhance customer profits.

Performance Evaluation

Social resources are limited. How to make optimal utilization of limited resources has been the focus of managers. Efficiency and effectiveness are often used for measuring the ability of an organization applying resources and the degree of achieving goals, which is also the point in performance evaluation. Wang and Phan (2014) considered that efficiency was to do things right, stressing on the use of correct means (Ahn and Min, 2014), mainly measuring the degree of resources being effectively applied in an organization in short term (Shao and Sun, 2016), acquiring the most outputs with the least inputs by discussing the relationship between inputs and outputs (Li, Masuda, and Masatake, 2014), or finding out the methods to reduce production costs in order to enhance the cost effectiveness of resource use (Chen, Lai, and Piboonrungraj, 2017) and regard the result as the improvement reference for evaluating organizational productivity (Förster, 2015). In terms of the definition of effectiveness, Duygun *et al.* (2016) regarded effectiveness as doing right things, referring to an organization, under the premise of customers obtaining the maximal value, utilized external operation to generate income. It stressed on the measurement of ends, mainly discussing whether an organization effectively achieved the set goals in a period of time (Lu and Xia, 2014).

Efficiency could be regarded as the performance on transferring inputs into outputs, which emphasized the effective utilization of existing production resources. In economics, the idea of Pareto Optimality (Chow, Fung, and Law, 2016) could be used for the explanation. From the aspect of input orientation, it referred to an organization, under the premise of maintaining the same outputs, could not increase outputs unless input resources were increased or other outputs were decreased. In this case, an organization was efficient. From the aspect of output orientation, it referred to an organization, under the premise of maintaining the same inputs, could not reduce inputs unless outputs were reduced or other inputs were increased. The organization therefore was efficient (Périco, Santana, and Rebelatto, 2017).

Data Envelopment Analysis

Data Envelopment Analysis, first appeared in the article of Charnes, Cooper, and Rhodes in 1978 (Fuentes and Adelaida, 2015), is a non-parametric method, i.e. calculating the points on production frontier, with linear planned mathematical model, of multiple inputs and outputs of decision making units without default production functions. Points on production frontier economically referred to the most beneficial inputs/outputs of decision making units, i.e. relatively efficient units. Efficiency frontier composed of such efficient units is the envelope. Furthermore, comparing the observed value of input/output ratio of decision making units with efficiency frontier, the relative efficiency of decision making units and the improvement direction for achieving the efficiency could be measured.

Chang *et al.* (2016) concluded the systematic Data Envelopment Analysis application with four major steps.

(1) Definition and selection of decision making units: Decision making units are the objects evaluated with Data Envelopment Analysis. The homogeneity of each decision making unit should be confirmed in order to have decision making units be evaluated at the same standpoint, i.e. presenting same goals, executing similar work, and operating under the same market conditions. According to the empirical law proposed by Ramón and Adelaida (2015), the number of decision making units should be at least twice of the number of inputs and outputs.

(2) Selection of input/output: The evaluation of relative efficiency between inputs/outputs and decision making units is closely correlated that the selection should rely on the business characteristics of decision making units and confirm the business goals of the organization. The selected inputs/outputs should be tested the correlations, i.e. the isotonicity between inputs and outputs, revealing that the number of outputs could not be reduced when increasing the number of inputs.

(3) Selection of evaluation model: The selection of evaluation model should depend on the research goal and information for decision making.

(4) Result analysis and interpretation: The Data Envelopment Analysis results should be able to explain the performance of decision making units and provide improvement suggestions for decision makers. The analysis results therefore should contain efficiency analysis, slack variable analysis, and management suggestions.

RESEARCH DESIGN

Selection of Input/Output

To combine the selection of inputs/outputs with expert opinions, reduce input costs, and avoid fuzziness in the survey process, Modified Delphi Method is used for selecting inputs and outputs in this study. Based on special considerations and omitting brainstorming open-ended questions, the structured questionnaire is directly developed after referring to large amount of relevant literatures for the first run questionnaire survey. With Modified Delphi Method, the structured questionnaire is directly used for the first run survey to save lots of time. Besides, the structured questionnaire could have the experts immediately concentrate on the research subject without guessing the open-ended questions. Total 50 copies of questionnaire are distributed, and 42 valid copies are retrieved, with the retrieval rate 84%. The variable data used in this study are acquired from open statistical data.

Definition of variable:

Input variable:

(1) Cost input: All costs for introducing customer relationship management.

(2) Manpower cost: All manpower (number of people) for introducing customer relationship management.

Output variable:

(1) Response performance: Response time to customer needs or complaints.

(2) Financial performance: Operation performance of a company.

Efficiency Evaluation Analysis

From the viewpoint of economics, the fewer inputs but more outputs of a business unit reveals the better "performance" of the unit. "Efficiency" could be used as the evaluation standard for such performance measurement. By comparing inputs and outputs, efficiency is defined as $\text{efficiency} = \frac{\text{sum of weighted outputs}}{\text{sum of weighted inputs}}$, and the maximum output function of different input combination is called "product function". The maximum outputs with general inputs are lower than the yield of product function that product function is the maximum frontier of various yields, also called "product frontier". In the geometric meaning, efficiency maps the inputs and outputs of all decision making units to the space with envelope for evaluating the relative efficiency of the organization and finding out the envelope surface which could envelope the efficiency of all observed data to form efficiency frontier. The observation value of individual decision

making unit and the distance of efficiency envelope surface are further calculated the relative efficiency.

Data Envelopment Analysis (DEA) is used for evaluating efficiency in this study. Unlike traditional regression analysis which merely seeks for the mean routes with the points in a series of data, DEA envelopes the data of various samples and attempts to find out the relationship that it presents the advantages of a good efficiency evaluation model. The method applies linear planning techniques, considers the factors in the measurement of performance among decision making units, and compares performance of units with similar features.

EMPIRICAL ANALYSIS OF CUSTOMER RELATIONSHIP MANAGEMENT IN SHIPPING INDUSTRY

Performance Analysis of Customer Relationship Management in Shipping Industry

By substituting various inputs/outputs into CCR and BCC models, the overall production efficiency and pure technical efficiency of customer relationship management in shipping industry could be calculated. The returns to scale of customer relationship management in shipping industry could be further acquired by dividing the two. The overall production efficiency, pure technical efficiency, scale efficiency, and returns to scale are organized in Table 1.

From Table 1, a shipping enterprise with the overall efficiency=1 shows the best efficiency, while the rest shipping businesses appear low overall production efficiency on customer relationship management; especially, Fuzhou Kuohong Shipping, as the most inefficient company, shows the lowest overall efficiency. In other words, except the DMU with the relative overall production efficiency=1, the rest 11 DMUs are relatively inefficient shipping enterprises. It might be the reason that they could not effectively apply inputs or do not achieve the optimal production scale. It requires further analyses.

Table 1. *Relative efficiency of customer relationship management in shipping.*

Shipping Enterprise	Overall Efficiency	Technical Efficiency	Scale Efficiency
Fujian Shipping Company	0.98	0.97	0.98
Fujian Xiamen Shipping Co., Ltd.	0.97	0.97	0.97
Fujian Minfeng Shipping Co.	0.84	0.83	0.84
Fujian Shihua Shipping	0.76	0.77	0.75
Fujian Lianfa Shipping	0.82	0.83	0.82
Fujian Foreign Trade Centre Shipping Co.	0.85	0.86	0.84
Fujian Guohang Ocean Shipping(Group) Co., Ltd.	1.00	1.00	1.00
Fuzhou Kuohong Shipping	0.71	0.70	0.71
Fujian Jian Shipping	0.80	0.82	0.78
Fujian Sinan Shipping	0.81	0.81	0.81
Fujian Orient Shipping Co., Ltd.	0.93	0.92	0.94
Fujian Gangxiang Shipping	0.90	0.90	0.91

Sensitivity Analysis

This study aims to analyze and find out key factors in customer relationship management in shipping industry with sensitivity analysis. By eliminating inputs and outputs step by step and proceed DEA, the sensitivity to efficiency is understood. In the research results, rate of change is regarded as the evaluation basis for the sensitivity factors of cost input, manpower cost, response performance, and financial performance. From Table 2.

(1) The efficiency of all DMUs reduces, after removing “cost input”. In other words, cost input appears higher importance to all DMUs.

(2) The efficiency of all DMUs reduces, after removing “manpower cost”, revealing higher importance of manpower cost to all DMUs.

(3) The efficiency of all DMUs reduces, after removing “response performance”, showing the higher importance of response performance to all DMUs.

(4) The efficiency of all DMUs reduces, after removing “financial performance” that financial performance presents higher importance on all DMUs.

Table 2. *Sensitivity analysis of eliminating inputs and outputs step by step.*

DMU	Original Relative Efficiency	Removing Cost Input	Removing Manpower Cost	Removing Response Performance	Removing Financial Performance
Fujian Shipping Company	0.98	0.93	0.92	0.95	0.95
Fujian Xiamen Shipping Co., Ltd.	0.97	0.91	0.90	0.92	0.93
Fujian Minfeng Shipping Co.	0.84	0.82	0.80	0.80	0.81
Fujian Shihua Shipping	0.76	0.73	0.70	0.71	0.74
Fujian Lianfa Shipping	0.82	0.80	0.78	0.80	0.76
Fujian Foreign Trade Centre Shipping Co.	0.85	0.81	0.80	0.81	0.83
Fujian Guohang Ocean Shipping(Group) Co., Ltd.	1.00	0.98	0.96	0.95	0.99
Fuzhou Kuohong Shipping	0.71	0.66	0.65	0.68	0.62
Fujian Jian Shipping	0.80	0.78	0.76	0.75	0.77
Fujian Sinan Shipping	0.81	0.80	0.78	0.76	0.74
Fujian Orient Shipping Co., Ltd.	0.93	0.90	0.88	0.89	0.90
Fujian Gangxiang Shipping	0.90	0.86	0.84	0.86	0.88
No. of efficient DMU	1	0	0	0	0

Data source: *organized in this study.*

CONCLUSIONS

According to the efficiency acquired with DEA and the information of variables, 1 DMU, about 8% of all DMUs, shows strong efficiency on customer relationship management, with the efficiency=1, revealing the better efficiency of customer relationship management. Four DMUs, about 33% of all DMU, show the efficiency in 0.9-1, as marginal inefficiency, revealing the efficiency of customer relationship management could be easily enhanced. Seven DMUs, about 58% of all DMUs, appear the efficiency of customer relationship management lower than 0.9, obvious inefficient, where Fuzhou Kuohong Shipping shows the lowest efficiency of customer relationship management in shipping industry.

DISCUSSION

In the DEA result, Fujian Guohang Ocean Shipping (Group) Co., Ltd. presents better efficiency on customer relationship management in shipping industry. The businesses of Fujian Guohang Ocean Shipping (Group) Co., Ltd. focus on coal transportation of coastal and river-side power plants and other bulk

cargo transportation. Fujian Guohang Ocean Shipping (Group) Co., Ltd. always insists on large customers in the customer relationship management to establish good cooperation relationship and long-term transportation service with domestic large customers. After the stable development for more than a decade, the company presents stable customers with large goods, appropriated berth, and strong resource integration ability to complete domestic and international logistic systems, ship management ability, and professional talents step by step. It also positively undertakes social responsibilities and presents rich experiences and higher brand awareness in bulk cargo transportation. With good brand image and operation for several years, the transportation power, market awareness, and economic effectiveness achieve certain standards.

SUGGESTIONS

Aiming at customer relationship management in shipping industry, the following suggestions are proposed in this study.

(1) In addition to retaining old customers, shipping businesses are suggested to take businesses which cannot be handled by

competitors. By flowing the service word-of-mouth and advantages in the market through competitors, it could have customers actively request for businesses and could enhance organizational performance by competitors introducing customers.

(2) When implementing customer relationship management, shipping businesses should actively provide tailored customized services and shipping programs to enhance customers' loyalty and satisfaction. Moreover, it should maintain good relationship and interaction with customers by moving towards innovative service goals with effective application of various software/hardware resources as well as internal system integration. The employees should constantly promote themselves to enhance the desire for professional skills. In this case, it could create high added value for the enterprise and present market share with the work advantages which could not be copied. The implementation of such successful customer relationship management strategy could largely enhance organizational performance.

(3) When abnormal situations happen in shipping industry, the relevant accountability should be clarified to find out the optimal solution for reducing customer losses. After solving the abnormal conditions, relevant operation improvements could be proposed to win the trust and satisfaction of customers. Such an improvement model could enhance shipping operators' abilities to deal with abnormal conditions as well as deepen customer trust and satisfaction that it is regarded as a strategy to enhance customer relationship management and organizational performance.

ACKNOWLEDGEMENTS

The work is supported by the Scientific Research Foundation of Fujian University of Technology (Grant No. GY-Z160140) and Fujian Education Science 13th Five-Year plan (Grant No.FJJKCG17-059), and Supporting funding ID: 2016J01229.

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