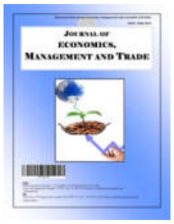

Journal of Economics, Management and Trade

27(1): 42-52, 2021; Article no.JEMT.67369
ISSN: 2456-9216
(Past name: British Journal of Economics, Management & Trade, Past ISSN: 2278-098X)

Relationship between Logistics Cost and Relative Firm Efficiency in Indian Food Processing Sector

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Authors' contributions

This work was carried out in collaboration among all authors. Author RKS designed the study and wrote the protocol and the first draft of the manuscript. Author KD performed the statistical analysis. Authors AS and PV managed the analyses of the study and managed literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEMT/2021/v27i130324
Editor(s):
(1) Dr. Kamarulzaman Ab. Aziz, Multimedia University, Malaysia.
Reviewers:
(1) Dursun Eğriboyun, National Defence University, Turkey.
(2) Waleed Khalid Abduljabbar, University of Fallujah, Iraq.
Complete Peer review History: http://www.sdiarticle4.com/review-history/67369

Original Research Article

Received 19 February 2021
Accepted 23 April 2021
Published 05 May 2021

ABSTRACT

Logistics plays an important role in determining the profits for a business enterprise through a dual influence on revenues and costs. Logistics are considered critical in the growth and performance of the food processing sector. The present study was undertaken to examine the relative performance of food processing units in India on the basis of logistics cost. Data Envelopment Analysis (DEA) was used to study the relative performance and the set considered for analysis consisted of 32 food processing units with the period of analysis covering 5 years from 2007-2011. Results indicate that no food processing unit was efficient throughout the period of analysis. Logistic regression results indicate that with a unit increase in logistics cost likelihood of the firm being efficient decreased 0.642 times. The results of the study underline the criticality of logistics management in the context of the food processing sector in India. For improving firm efficiency, it is imperative for Indian food processing companies to ensure efficiency in logistics operations.

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Keywords: Relative efficiency; food processing units; logistics regression; benchmarking.

ABBREVIATIONS

SCM : Supply Chain Management
FPI : Food Processing İndustry
AAGR : Average Annual Growth Rater
GVA : Gross Value Addition
SCI : Supply Chain İntegration
IS : Informations
SC : Supply Chain
AHP : Analytic Hierarchy Process
BSE : Bombay Stock Exchange
NSE : National Stock Exchange
DEA : Data Envelop Analysis
DMU : Decision Making Unit
CAGR : Compound Annual Growth Rate
IRS : Increasing Returns to Scale
DRS : Decreasing Returns to Scale
CRS : Constant Returns to Scale

1. INTRODUCTION

Supply Chain Management is a network of facilities that produce raw materials, transform them into intermediate goods and then final products, and deliver the products to customers through a distribution system. It spans procurement, manufacturing and distribution [1]. Supply Chain Management is concerned with the reduction or even elimination of uncertainties to improve the performance of the chain. The basic objective of supply chain management is to “optimize performance of the chain to add as much value as possible for the least cost possible. Supply chain management (SCM) is a major issue in many industries as organizations begin to appreciate the criticality of creating an integrated relationship with their suppliers and customers, as well as all other stakeholders [2]. Much ink has been devoted to defining and developing the concept and analysing its use or non-use [3]. Supply Chain Management basically looks into the interrelationship and inter- linkages between various functions, processes and chain members and analyses the impact of their interaction on value additions and profit maximization [4].

Due to lack of efficient infrastructure and food processing industry about 30-35 per cent of all foods produced in India are wasted [5]. The challenge of supplying healthy diets to 9 billion people in 2050 will in part be met through increase in food production. However, reducing food losses throughout the supply chain from production to consumption and sustainable enhancements in preservation, nutrient content, safety and shelf life of foods, enabled by food processing will also be essential [6].

Supply chain management is a rapidly evolving area of interest to academics and business management practitioners alike and aspects of marketing, economics, logistics and organizational behaviours are all important for developing insights into how and why different supply chain management arrangements emerge and for understanding the consequences of these arrangements for industry efficiency and competitiveness. As is the case in many industries around the world, supply chain management (SCM) initiatives are growing in popularity throughout the food industry as organizations seek to reduce costs and improve profitability in an increasingly competitive environment. Firms seeking competitive advantages are participating in cooperative supply chain arrangements, such as strategic alliances, which combine their individual strengths and unique resources [7].

Food processing is defined as transforming agricultural products into food that are in consumable form or transforming one food item into another by adding value to it [8]. Food processing industry provides the vital linkage between industry and agriculture and is of enormous significance for India's development. With India moving from a position of scarcity to surplus in food production the prospects for increasing processing levels are enormous [9]. Food processing industry (FPI) is one area which has the potential to add value to farm output, create alternate employment opportunities, improve exports and strengthen the domestic supply chain [10]. During the last 6 years ending 2017-18, Food Processing Industries sector grew at an Average Annual Growth Rate (AAGR) of around 5.06 per cent. The sector constitutes as much as 8.83 per cent and 10.66 per cent of Gross value addition (GVA) in Manufacturing and Agriculture sector respectively in 2017-18 at 2011-12 prices. In the case of India, overall per capita sales of packaged and processed foods nearly doubled from USD 31.3 in 2012 to USD 57.7 in 2018 [11]. Indian food processing sector is undoubtedly on a fast growth track. The global food processing industry looks at India as a recharged economy with immense opportunities and perhaps as a sourcing destination [12]. Over the years, India has been able to attract investment from food and beverages companies like Nestle, Cargill, McCain, Mondelez, Pepsi, Coco cola etc., and also from retail trade companies like Amazon, Walmart, etc. [13].

India has a huge opportunity to become a leading global food supplier if only it has the right marketing strategies and agile, adaptive and efficient supply chain. The food supply chain is complex with perishable goods and numerous small stake holders. In India, the infrastructure connecting these partners is very weak. So, there is a high scope of studying the food processing sector from supply chain management point of view. Present study is focused at finding out the relative efficiency of selected food processing and also examines the relationship between Logistics Cost and Firm performance [14] Demand management is identified as key interface between a company's manufacturing, planning and control systems and the marketplace. Its scope included activities, which range from forecasting, through converting customer orders to promised delivery dates and as the mechanism for balancing supply and demand. The empirical evidence of the effectiveness of various supply chain integration (SCI) practices were provided under different competitive strategies in terms of cost leadership and differentiation [15]. It has already been examined the relationship between supply chain (SC) strategy and supply chain information systems (IS) strategy, and its impact on supply chain performance and firm performance. They developed hypotheses proposing a positive moderating effect of two supply chain IS strategies – IS for Efficiency and IS for Flexibility – on the respective relationships between two SC strategies – Lean and Agile, and supply chain performance [16]. The study on exploring the status of supply chain management in food processing industry of Punjab has already been presented and the results indicated that the logistics and supply chain management is still in its infancy in food processing sector [17]. The theoretical framework (i.e. resource-based view) was used to investigate causal relationships between the supply chain integration, market orientation, information technology (IT) application and firm performance of container shipping firms in Taiwan [18]. The impact of reverse logistics capabilities on firm performance and mediating role of logistics strategies were examined by reviewing three theories of reverse logistics capabilities: (a) resource-based view of the firm, (b) transaction cost economics, and (c) institutional theory [19]. 13 Performance indicators and 79 sub-performance indicators were identified as responsible for green supply chain management implementation in agroindustry. Ranking of performance indicators is carried out by assigning weights by experts and using Analytic hierarchy process (AHP), [20] that is the process of categorizing and examining the multiplex choices or decisions by using psychology and mathematics. The first literature review of risk management models specifically for agribusiness supply chains was provided by Focusing on specific sources of uncertainty in agribusiness industries and risk management was identified as even more important for agricultural supply chains due to challenges associated with seasonality, supply spikes, long supply lead-times, and perishability [21]. The summarization of 13 key factors that affect the development of agricultural products logistics in China was calculated on basis of the connotation of agricultural products logistics, in combination with actual development and expert opinions [22]. It is already examined the need of the information platform of the agricultural logistics park, and then an exploration of the plans was given for constructing the information platform of the agricultural logistics park in terms of user system and functional flow [23]. The total cost minimization model (optimization model) was established which can better reflect the characteristics of cold chain logistics and provide effective theoretical guidance for food cold chain logistics practice [24]. Several recommendations were developed for the solution of logistics problems using the example of the production of agricultural food products, their transportation, processing and production of functional food products [25]. Development of intelligent logistics reliability control model was completed which has an ability to significantly improve the reliability of fresh food e-commerce logistics systems and provide practical suggestions for fresh food e-commerce enterprises [26].

The problem of logistic costs is one of the most difficult and complex issues, due to their elaborate and vague structure and difficulties in their identification. India has a huge opportunity to become a leading global food supplier if only it has the right marketing strategies and agile, adaptive and efficient supply chain. The food supply chain is complex with perishable goods and numerous small stake holders. In India, the infrastructure connecting these partners is very weak. So, there is a high scope of studying the food processing sector from supply chain management point of view.

From the previous studies conducted in the field of supply chain management in food processing, it can be seen that majority of the studies have been conducted in developed countries like USA, UK, Japan. No particular study has been undertaken in context of studying supply chain management practices in food processing sector in Punjab. So, the present study is aims to fill this existing research gap

2. MATERIALS AND METHODS

2.1 Population and Sample

For checking the relationship between logistics cost and firm performance in food processing sector in India; and to identify the relative performance of selected units on the basis of logistics costs, secondary data was collected from 32 food processing companies (Annexure 1) which were selected from the list of food processing companies listed on BSE/ NSE by using simple random sampling.

2.2 Collection of Data

For the purpose of collecting secondary data, annual reports of the food processing companies from 2007 to 2011 were obtained. The secondary data for computing the relative efficiency of Food processing companies from 2007-2011 was collected from annual reports published by the companies. For carrying out the research DEA SOLVER LV (V5) was used. Data pertaining to the selected companies on input variable: logistics cost to sales ratio and outputs variable: net profit to sales ratio was taken.

2.2.1 Input variables

- **Logistics cost:** Logistics cost includes salaries or wages of the employees of organizations, Rent paid, Freight charges (outward freight), and Average inventory. Freight charges and inventory carrying cost are part of logistics cost. Rent paid and salaries cannot be fully attributed to logistics cost, therefore, these costs have been partially included in the logistics cost. Rent paid by the company includes the rent paid for warehouses, headquarter building and field offices. Hence, half of the rent paid has been included in the logistics cost. For salaries and wages, one tenth of cost has been included in the logistics cost assuming that on an average one tenth of employees are engaged in logistics activities [27].
- **Salaries/ Wages:** Salaries or wages are cash outflows for the companies which they have to pay to their employees on monthly bases for ensuring continuous services from their employees. The value of this input (salaries) is taken in INR 0.1 million.
- **Rent:** Rent is cash outflow for the companies which is paid out by the companies as offices rent, warehouse rent, plant rent and any other rent to the owner of these fixed assets on monthly or yearly bases. The value of this input (rent) is taken in INR 0.1 million.
- **Freight charges:** Freight charges are the charges which the companies incur on transportation of their product to consumers, distribution charges, shipping charges etc. The value of this input (freight charges) is taken in INR 0.1 million.
- **Average Inventory Cost:** Average inventory is basically the average of Opening and Closing stock of the companies and the value of this input (average inventory cost) is taken in Rupees Lakhs.Opening stock is the quantity of stock that is available to sell at the star of accounting year and closing stock is the quantity of stock that is left out or not sold at the end of accounting year. Average inventory cost has been calculated by making a charge on average inventory at 10 percent per annum.

2.2.2 Output variables

- **Net profit to sales ratio:** Net profit is the profit made by companies after deducting all the taxes from gross profit figures. Net profit is divided by the sales to get the output for study.

2.3 Conceptual Framework

Conceptual framework used in the study and the explanation of various terms used in analysis is being discussed in the following section:

2.3.1 Relative efficiency

Relative Efficiency of a DMU consists of two components: technical efficiency which reflects the ability of a firm to obtain maximal output from a given set of inputs, it will take a value between 0 and 1 and hence provides an indicator of technical inefficiency of a firm. A value of 1 indicates the DMU is fully technically efficient and allocative efficiency, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices. These two measures are then combined to provide a measure of overall efficiency. Relative Efficiency is calculated with respect to the most technical efficient company, in terms of minimum input and maximum output.

2.3.2 Decision Making Unit (DMU)

The term DMU was introduced to cover, in a flexible manner, any such entity, with each such entity to be evaluated as part of a collection that utilizes similar inputs to produce similar outputs. In the context of the study DMUs were the companies.

2.3.3 Compound Annual Growth Rate (CAGR)

The rate at which a given present value would "grow" to a given future value in a given amount of time. The formula is:

$$CAGR = \left[\left\{\left(\frac{V_2}{V_1}\right)^{\frac{1}{n}}\right\} - 1\right] * 100$$

Where,

V_2= Final Value after n years.
V_1 = Initial Value.
n= number of years.

2.3.4 Constant Returns to Scale Model (CRS) and Variable Returns to Scale Model (VRS)

The VRS specification has been the most commonly used specification in the 1990's. The CRS is only appropriate when all DMUs are operating at an optimal scale. The CRS allows one to represent the technology using a unit isoquant. Imperfect competition, constraints on finance, etc. may cause a DMU to be not operating at optimal scale [28] suggested an extension of the CRS DEA model to account for variable returns to scale (VRS) situations. The use of the CRS specification when not all DMUs are operating at the optimal scale, will result in measures of Technical Efficiency (TE) which are confounded by Scale Efficiencies (SE).The use of the VRS specification will permit the calculation of TE devoid of these SE effects. The VRS approach forms a convex hull of intersecting planes which envelope the data points more tightly than the CRS conical hull and thus provides TE scores which are greater than or equal to those obtained using the CRS model. The TE scores obtained from a CRS DEA decomposed into two components, one due to scale inefficiency and one due to pure technical efficiency. This may be done by conducting both a CRS and a VRS DEA upon the same data. If there is a difference in the two TE scores for a particular DMU, then this indicates that the DMU has scale inefficiency, and that the scale inefficiency can be calculated from the difference between the VRSTE score and the CRSTE score.

2.3.5 The ınput and output orientations

The Farrell Output Oriented Efficiency would be defined as the amount by which outputs could be increased without requiring extra inputs. The Input Oriented Efficiency would be defined as the amount by which all inputs could be proportionally reduced without a reduction in output. The Input and Output Oriented Measures will only provide equivalent measures of technical efficiency when constant returns to scale exist, but will be unequal when increasing or decreasing returns to scale are present [29]. In Input oriented models the input quantities appear to be the primary decision variables but in output oriented models DMUs may be given a fixed quantity of resources and asked to produce as much as output as possible.

2.3.6 Returns to scale

According to Koutsoyiannis (1979), "The term returns to scale refers to the changes in output as all factors change by the same proportion (what happens to the output rate when each input rate is increased by the same proportion).

2.3.6.1 Increasing Returns to Scale (IRS)

If output increases by a larger percentage than the increase in each input then there is increasing returns to scale i.e. if all the factors are increased in a given proportion, output produced increases in a greater proportion.

2.3.6.2 Decreasing Returns to Scale (DRS)

If output increases by a smaller proportion than the increase in each input then there is decreasing return to scale i.e. if all the factors are increased in a given proportion, the output produced increases in a smaller proportion.

2.3.6.3 Constant Returns to Scale (CRS)

If output increase by the same proportion as increase in input then there are constant returns to scale i.e. if all the factors are increased in a given proportion the output produced increases in exactly the same proportion.

2.3.7 Logistic Regression

For finding out the impact of Logistics cost on firm performance logistic regression was employed.

Pi= E {Y=1|Xi}= β1 + β2 Xi
Pi= E {Y=1|Xi}= 1/1+ e−(β1 + β2 Xi)
Pi= 1/+ e−(β0+ β1 (logistic cost to sales ratio))
Li = ln(Pi/1−Pi)
ln(Pi/1−Pi)=β0+ β1 ($logistics\ cost\ to\ sales\ ratio$)+ ui
Pi=1, if the firm efficient; 0 otherwise
Li =$Log\ of\ odds\ ratio$

2.4 Basic of DEA

Data Envelopment Analysis (DEA) is a methodology that has been used to evaluate the efficiency of entities (e.g., programs, organizations etc.) which are responsible for utilizing resources to obtain outputs of interest. DEA is a fractional programming model that can include multiple outputs and inputs without recourse to a priori weights (as in index number approaches) and without requiring explicit specification of functional relations between inputs and outputs (as in regression approaches). It computes a scalar measure of efficiency and determines efficient levels of inputs and outputs for the organizations under evaluation [29]. Data Envelopment Analysis (DEA) is a decision-making tool based on linear programming for measuring the relative efficiency of a set of comparable units. Besides the identification of relatively efficient and inefficient units, DEA identifies the sources and level of inefficiency for each of the inputs and outputs [30]. The heart of the analysis lies in finding the "best" virtual producer for each real producer. If the virtual producer is better than the original producer by either making more output with the same input or making the same output with less input, then the original producer is inefficient. Relative Efficiency of a Decision making unit (DMU) consists of two components: technical efficiency which reflects the ability of a firm to obtain maximal output from a given set of inputs, it will take a value between 0 and 1 and hence provides an indicator of technical inefficiency of a firm. A value of 1 indicates the DMU is fully technically efficient and allocative efficiency, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices. These two measures are then combined to provide a measure of overall efficiency. Relative Efficiency is calculated with respect to the most technical efficient company, in terms of minimum input and maximum output. The VRS specification has been the most commonly used specification in the 1990’s. The CRS is only appropriate when all DMUs are operating at an optimal scale (i.e., one corresponding to the flat portion of the LRAC curve). The CRS allows one to represent the technology using a unit isoquant. Imperfect competition, constraints on finance, etc. may cause a DMU to be not operating at optimal scale [30] suggested an extension of the CRS DEA model to account for variable returns to scale (VRS) situations. The use of the CRS specification when not all DMUs are operating at the optimal scale, will result in measures of Technical Efficiency (TE) which are confounded by Scale Efficiencies (SE). The use of the VRS specification will permit the calculation of TE devoid of these SE effects. The VRS approach forms a convex hull of intersecting planes which envelope the data points more tightly than the CRS conical hull and thus provides TE scores which are greater than or equal to those obtained using the CRS model. The TE scores obtained from a CRS DEA decomposed into two components, one due to scale inefficiency and one due to pure technical efficiency. This may be done by conducting both a CRS and a VRS DEA upon the same data. If there is a difference in the two TE scores for a particular DMU, then this indicates that the DMU has scale inefficiency, and that the scale inefficiency can be calculated from the difference between the VRSTE score and the CRSTE score.

2.5 Analysis of Data

For carrying out the research DEA SOLVER LV (V5) was used, and DEA technique was used for finding out the relative efficiency of these selected companies. Data pertaining to the selected companies on input variables: logistics cost and outputs variables: net profit to sales ratio for the period of last five financial years (for which data is available) was taken. Using DEA, efficiencies of selected companies, sources of inefficiencies and benchmarks for inefficient DMUs were found. The input-oriented model was used for computing the relative efficiency of companies for each year. Logistic regression was estimated using SAS 9.2.

3. RESULTS AND DISCUSSION

Table 1 presents the summary statistics of companies included in the study.

This section covers the company wise analysis of relative efficiency of DMUs. The relative efficiency of all the DMUs was compared on the basis of CRSTE (technical efficiency from CRS DEA), VRSTE (technical efficiency from VRS DEA) and scale efficiency.

It can be seen from the Table 2 that DMU 1 largely remained inefficient during the period of analysis as its technical efficiency, on the basis of VRSTE, CRSTE and Scale, turned out to be less than 1. Further, it can be seen from the table that DRS was exhibited by the DMU 1 in 2007, 2009, 2010 and 2011. The most suitable benchmarks for DMU 1 were DMU 26, DMU 30 and DMU 24.

It can be seen from Table 2 that except for DMU 24 all other companies were relatively inefficient as technical efficiency score for these DMUs were less than 1.

Table 1. Summary Statistics of DMUs

DMUs	Average Sales (in Rs. Lakhs)	Average Net Profit (in Rs. Lakhs)	Average Logistics Cost (in Rs. Lakhs)	Ratio of Net Profit to Sales	Ratio of Logistics Cost to Sales
1	547816.50	67662.18	33134.22	12.24	6.03
2	17935.98	2709.92	763.44	12.11	5.44
3	52621.50	469.44	973.33	0.91	1.85
4	16494.56	426.21	1493.28	2.70	9.26
5	500191.50	66621.49	20719.42	14.36	4.90
6	92385.00	7077.38	6868.05	8.12	7.32
7	79172.71	-142.63	6817.75	0.01	8.54
8	32230.49	746.90	1620.76	2.60	5.23
9	33054.06	1619.99	1698.20	4.81	5.24
10	318145.60	18552.40	6744.82	5.67	2.09
11	132904.80	2800.00	571.89	2.04	0.44
12	34577.85	2788.60	2604.02	7.18	7.61
13	1715159	207495.68	116119.02	12.20	6.77
14	99162.49	1177.49	4661.45	1.24	4.72
15	165895.60	5923.20	3172.49	3.52	1.90
16	85618.22	4655.34	4045.91	8.00	5.78
17	2588993	368474.40	114550.18	14.11	4.43
18	7195.67	316.77	427.06	3.65	5.65
19	341552.80	13431.73	68896.79	4.15	20.20
20	45460.28	4834.24	1634.63	11.18	3.74
21	83813.10	2203.14	2989.70	2.83	3.72
22	299812.70	41522.39	13513.68	13.77	4.56
23	297878.10	23291.12	15263	6.48	3.35
24	153809.20	5535.45	2717.90	4.18	1.58
25	1256.29	-232.33	11.38	-20.19	0.93
26	611.33	71.30	26.60	11.10	4.32
27	4856.38	170.72	208.98	4.62	4.15
28	15544.90	960.36	797.85	4.81	5.15
29	10851.18	102.95	293.64	0.91	2.75
30	73943.41	1632.41	192.13	2.04	0.46
31	125709.70	7464.42	6247.59	5.77	5.08
32	4466.69	270.32	369.02	6.26	8.25

Table 2. Relative efficiency of DMUs included in the study

DMUs	2007				2008				2009				2010				2011			
	CRSTE	VRST E	Scale	RTS	CRST E	VRST E	Scale	RTS	CRST E	VRST E	Scal e	RTS	CRST E	VRSTE	Scale	RTS	CRST E	VRST E	Scal e	RTS
1	0.24	0.30	0.78	DRS	0.27	0.28	0.95	IRS	0.21	0.61	0.34	DRS	0.19	0.40	0.48	DRS	0.14	0.19	0.73	DRS
2	0.03	0.03	0.84	IRS	0.05	0.05	0.92	IRS	0.06	0.17	0.34	DRS	0.41	0.88	0.47	DRS	0.31	0.44	0.72	DRS
3	0.07	0.18	0.40	IRS	0.06	0.17	0.32	IRS	0.04	0.11	0.34	IRS	0.06	0.13	0.50	IRS	0.03	0.12	0.24	IRS
4	0.06	0.07	0.78	IRS	0.04	0.05	0.78	IRS	0.01	0.02	0.45	IRS	0.03	0.05	0.65	DRS	0.02	0.02	0.75	IRS
5	0.28	0.35	0.80	DRS	1.00	1.00	1.00	CRS	0.29	1.00	0.29	DRS	0.13	0.25	0.52	DRS	0.06	0.07	0.87	DRS
6	0.30	0.30	0.99	IRS	0.34	0.36	0.94	IRS	0.14	0.41	0.34	DRS	0.09	0.17	0.51	DRS	0.01	0.02	0.41	CRS
7	0.05	0.08	0.67	IRS	0.01	0.05	0.23	IRS	0.00	0.02	0.00	IRS	0.00	0.02	0.00	CRS	0.00	0.02	0.00	CRS
8	0.19	0.21	0.92	IRS	0.03	0.07	0.47	IRS	0.06	0.10	0.57	DRS	0.01	0.02	0.52	CRS	0.01	0.05	0.25	CRS
9	0.18	0.21	0.86	IRS	0.06	0.09	0.74	IRS	0.07	0.15	0.51	DRS	0.15	0.29	0.51	DRS	0.04	0.05	0.86	DRS
10	0.34	0.41	0.83	IRS	0.47	0.53	0.89	IRS	0.23	0.49	0.47	DRS	0.19	0.34	0.54	DRS	0.24	0.31	0.79	DRS
11	0.42	1.00	0.42	IRS	0.71	1.00	0.71	IRS	0.48	0.58	0.83	DRS	0.41	0.55	0.74	DRS	0.39	0.49	0.80	IRS
12	0.03	0.06	0.54	IRS	0.06	0.08	0.83	IRS	0.06	0.10	0.54	DRS	0.22	0.46	0.47	DRS	0.09	0.12	0.74	DRS
13	0.26	0.38	0.68	DRS	0.24	0.25	0.95	IRS	0.17	0.51	0.34	DRS	0.17	0.35	0.48	DRS	0.11	0.15	0.74	DRS
14	0.03	0.10	0.36	IRS	0.06	0.09	0.69	IRS	0.02	0.03	0.72	IRS	0.00	0.03	0.14	IRS	0.02	0.04	0.48	IRS
15	0.23	0.35	0.66	IRS	0.26	0.32	0.83	IRS	0.07	0.08	0.91	IRS	0.22	0.39	0.57	DRS	0.18	0.21	0.84	DRS

**RTS means Return to scale*

Table 3. Logistic regression

Parameter	B(SE)	p-value	Wald Chi- square	Odds ratio	95% Wald confidence limits for odds ratio	
					Lower	Upper
Intercept	-0.443 (0.521)	0.395	0.724	0.555	_	_
Logistics cost to sales ratio	-0.589* (0.179)	0.001	10.847	0.642	0.391	0.788

*Likelihood Ratio: 73.143 (p<.0001), R^2: 0.234, *Significant at 1% level*

DMU 2 was found to be most inefficient with VRSTE of 0.030 in 2007. From this table it can be seen that DMU 11 and DMU 20 were found to be inefficient on the basis of CRSTE but efficient on the basis of VRSTE. It can be seen from table that during the year 23 DMUs exhibited IRS, DMU 24 exhibited CRS and 8 DMUs exhibited DRS. It can be seen from the table that except for DMU 5 all other DMUs were relatively inefficient as technical efficiency score for these DMUs were less than 1. DMU 19 was found to be most inefficient with VRSTE of 0.039 in 2008. From this table it can be seen that DMU 11 was found to be inefficient on the basis of CRSTE but efficient on the basis of VRSTE. It can be seen from the table that during the year all DMUs exhibited IRS except DMU 5 exhibited CRS.

Table 2 shows that except DMU 30 all other DMUs were relatively inefficient as technical efficiency score for these DMUs were less than 1. DMU 4 was found to be most inefficient with VRSTE of 0.017 in 2009. From this table it can be seen that DMU 5, DMU 22 and DMU 24 were found to be inefficient on the basis of CRSTE but efficient on the basis of VRSTE. It can be seen from table that during the year 8 DMUs exhibited IRS, DMU 30 exhibited CRS and 23 DMUs exhibited DRS. It can be seen from table that except for DMU 30 all other DMUs were relatively inefficient as technical efficiency score for these DMUs were less than 1. DMU 7 was found to be most inefficient with VRSTE of 0.017 in 2010. From this table it can be seen that DMU 26 was found to be inefficient on the basis of CRSTE but efficient on the basis of VRSTE. It can be seen from table that during the year DMU 3, DMU 14, DMU 25 and DMU 29 DMUs exhibited IRS, DMU 7, DMU 8, DMU 24 and DMU 30 exhibited CRS and rest of the DMUs exhibited DRS.

Table 2 depicts that except for DMU 30 all other dmus were relatively inefficient as technical efficiency score for these dmus were less than 1. DMU 19 Ltd was found to be most inefficient with vrste of 0.009 in 2011. from this table it can be seen that dmu 26 was found to be inefficient on the basis of crste but efficient on the basis of vrste. ıt can be seen from table that during the year DMU 3, DMU 4, DMU 11, DMU 14, DMU 23, DMU 25 and DMU 29 exhibited ırs, DMU 6, DMU 7, DMU 8, DMU 30 and DMU 32 exhibited crs and rest of dmus exhibited drs.

3.1 Relationship between Logistics Cost and Relative Efficiency of DMUs

Logistic Regression was used to find out the impact of logistics cost on the efficiency status of DMUs. For this purpose, binary dependent variable was used. Logistics cost to sales ratio was used as explanatory variable for running the logistic regression. Results obtained from the pooled regression have been presented in Table 3.

Value of Likelihood Ratio came out to be 73.143 ($p < 0.0001$) indicating non-zero logit. It can be seen from Table 3 that there was negative association between efficiency status of the firm and logistics cost to sales ratio. Odds ratio indicates that with unit increase in logistics cost to sales ratio, the likelihood of DMU being efficient decreased 0.642 times.

4. CONCLUSION

Logistics are considered critical for a business organisation on account of substantial contribution to cost and their impact on business efficiency. Given the nature of food processing business, logistics operations assume even greater significance. The present study has investigated the relationship between logistics cost and relative efficiency of food processing organisations. From the logistic regression, it can be seen that increase in logistics cost was negatively affecting the firm performance. The companies like DMU 30, DMU 26, DMU 24, DMU 22, DMU 20, DMU 11, and DMU 5 are comparatively efficient DMUs and DMU 30 is most efficient among them on the basis of VRSTE, CRSTE and Scale due to which it become benchmark for this period of time for inefficient DMUs. DMU 25, DMU 14, DMU 7, DMU 29, DMU 32, and DMU 23 are relatively more inefficient on the basis of VRSTE, CRSTE and Scale and DMU 25 is most inefficient among them. For each year during the period of analysis about 3 to 4 DMUs out of 32 DMUs considered for analysis were found to be efficient on the basis of VRSTE. Relative efficiency values indicate that there is scope for food processing companies to improve their performance through improved logistics performance.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/67369