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Analyzing logistics cost factors and developing cost optimization tools and techniques for a cement industry (Case study: Lafarge Surma Cement Ltd)

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Abstract This paper aims at providing a better understanding of the concept of logistics cost and its optimization techniques. The goal is to show a comparison between present cost model of bulk carrying vehicle at Lafarge Surma Cement (LSC) and an optimization tool developed using Microsoft excel which will show the percentage of cost reduction and total savings in Bangladeshi Taka (BDT). In this study, it can be seen that considering some identical cost factors the overall logistics cost can be reduced significantly.

Keywords Logistics cost optimization; optimization model; supply chain management; supply chain and logistics management

1 INTRODUCTION

Optimization means maximizing the return at a given risk level or risk is minimized for a given expected return [1]. To be successful in today's highly competitive marketplaces, companies must strive for greatest efficiency in all of their activities and completely utilize any possible opportunity to gain a competitive advantage over other firms. Among many possible activities, cost reduction in logistics is regarded as one of the core areas presenting enormous opportunities [2]. The Council of Supply Chain Management Professionals (CSCMP) defines logistics management as-"[The] part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow[1] and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirement''[3]. The majority of prior research on logistics costs can be grouped into two streams. One stream focuses on strategic aspects of the logistics costs, and the other deals with optimized cost-effective logistics decisions. As reported by Richardson (1995) and later stressed by Gilmore (2002), logistics controls a significant amount of assets and has direct impact on cash flow and the bottom line, adds value through continuous productivity and service improvements, and possesses a strong relationship with a firm's customer service level and revenues. Numerous factors can drive up logistics costs substantially, which may offset the benefits of doing business with the international suppliers. The techniques utilized to analyze the logistics cost can be summarized into four categories: recurrence-based, regression-based, activity-based, and optimization-based [4]. Over the decade logistics has become a key strategic function for the retailers (Bourlakis and Bourlakis, 2001) [5]. Because of the retail revolution logistics becomes retailer driven. Co-ordination between warehouse and transport activities is very important. Re-engineering the entire supply chain plays a major role in logistics performance. In this way, logistics becomes increasingly important in large retailers value chain (Norek, 1997) [6]. According to Parkan and Dubey (2009), significant modernization of logistics is required in Indian manufacturing and services industry. The paper also argues that with increased FDI in agricultural and retail sectors will drive the growth of Indian logistics sector. Organized retail in India has achieved rapid growth at a significant cost [7]. According to Dröge et al (1991), logistics is becoming an increasingly important part of overall retail strategy because it provides opportunities for enhanced profit, market growth and sustainable competitive advantage. The factors which have impact on retail logistics are warehousing/transportation,supplier performance/communication, internal information systems, activity leveling and inventory/cost reduction [8]. According to Olavson et al (2010), in today's volatile economy, one supply chain design is probably not enough. What's really needed is a portfolio of supply chains that at once enables you to be cost effective and yet agile and highly responsive in situations where those competencies are called for [9]. Tracey (2004) stated that transportation is often ignored as a source of competitive advantage. The work stated that transportation performance depends upon the terms like delivery schedules, product quality, satisfactory delivery service and acceptable overall performance [10]. Luo (2007) provided the insight that the delays in transporting, sorting, grading and disposition only serve to reduce the value remaining in the product [11]. Zeng and Rossetti (2003) classified the key logistics cost elements into six categories, namely transportation, inventory holding, administration, customs charges, risk and handling and packaging costs. Transportation cost has been a very common topic of

research. Examples of these include the routing of transportation (Eilon et al.,1971), minimization of transportation cost (Bodin et al., 1983), etc. believed that the transportation cost should relate to the travel distance between the warehouse and destination, and such cost should include the driver's wages, equipment cost and in-transit inventory cost [12] [13] [14].

This paper focuses on analyzing the cost factors and present cost model of single bulk carrying vehicle used by LSC. It tries to show a pathway to optimize the costs by developing an Excel model based on some cost factors. Thus the specific research questions are as follows:

1. To get insight of logistics at LSC
2. To analyze logistics cost factors
3. To analyze previous logistics cost model at LSC
4. To develop a logistics cost optimization model
5. To recommend the best practice for logistics operation

2 COMPANY OVERVIEW

Lafarge Surma Cement Ltd. is a joint venture of Lafarge, a world leader in building materials and CementosMolins, a Spanish Company with strong global presence. The Group portfolio of businesses is as follows: Cement: 63.5%, aggregates and concrete: 35.9%, other: 0.6%. The hierarchy of LSC's supply chain:

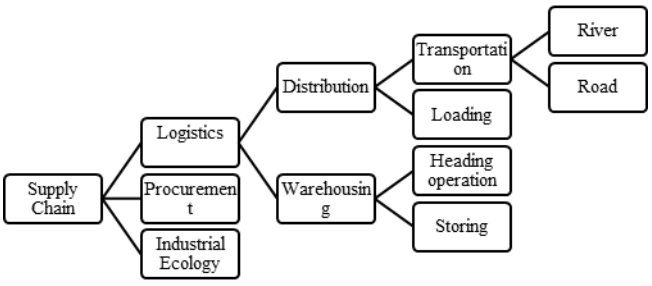

Figure 1 Supply chain hierarchy of LSC

3 METHODOLOGY

Many past studies have been dedicated to determining how to achieve the lowest possible transportation cost. For example, McCann [15] addressed two interrelated questions: the optimum size of a vehicle or vessel and the structure of transportation costs with respect to haulage distance. C. Pilot and S. Pilot [16] focused on minimizing the total costs involved in a transportation problem. Jha et al. [17] considered a joint-location inventory problem and minimized the transportation cost involved in a joint inventory location model by using a modified adaptive different evolution algorithm. Chanas and Kuchta [18] proposed what they see as an optimal solution to the transportation problem, which makes use of fuzzy cost coefficients and an algorithm determining the nature of the solution.

As exploration of transportation problems has developed, multiobjective transportation cost problems have emerged. For instance, Prakash et al. [19] drew attention to a cost-time trade-off bulk transportation problem, which they solve by using Pareto optimal solutions. Ojha et al. [20] formulated a multiobjective transportation solution, with fuzzy relations under fuzzy logic. The objectives of their model are the minimization of the total transportation cost and total time for transportation required for the system.

Sahyouni et al. (2007) developed three generic facility location models for the integrated distribution and collection of products. The models quantified the value of integrated decision making in the design of logistics networks by focusing on facility and transportation costs throughout different stages of a product's life cycle. The trucks used in distribution network can either be owned by retailer or can be rented from 3rd Party Logistics provider. The fixed costs involved in transportation are time related cost. Capital costs (vehicle cost), vehicle taxation, vehicle insurance, driver salary and overhead cost fall under fixed costs. The variable costs involved in transportation are running costs. Fuel cost, oil & lubricants cost, vehicle repair and maintenance, tires & tubes cost, trip allowance to crew, loading and unloading personnel cost, other operating cost [21].

In this work, only transportation related costs (Bulk carrying vehicle) of LSC are considered for optimization. Interviewing as a method of qualitative research has done by face to face meeting with logistics department of LSC. After sorting and analyzing data, four promising cost factors are found which might reduce the cost significantly and they are- Carrying capacity utilization, Trip per day utilization, Fuel economy, and Fuel price. Finally, an evaluation of the present supply chain performance on the basis of existing logistics fixed costs, variable costs, and grand total costs is done.

In this study, rental of single bulk carrying vehicle is considered. Microsoft Excel is used to develop the simulation model.

4 PROBLEM STATEMENT

This section starts with analyzing the scope of the problem which is followed by an extended description through a case provided by the company. The problem is to determine the percentage of cost reduction and total savings in BDT using four identified cost factors in comparison with the present cost model to show a pathway to reduce overall logistics cost.

4.1 Present cost model of LSC

In present cost model of LSC, monthly rental cost for single bulk carrying vehicle is BDT 225,000.00 and tax is 6.5%. The present data of costs collected from logistics department are showing in the below Table 1, 2, & 3.

Table -1 Necessary data from present cost model

Description	Unit	Present mode
Carrying Capacity	MT*	23
Trip Per day	One round trip	1
Fuel Economy**	L/100 km	3
Fuel Price/Litre	BDT	68
Required Running Meter	K.M	100

**MT Metric Ton, ** Fuel economy is the relationship between the distance traveled and fuel consumed; generally expressed as liters per 100 kilometers (L/100 km) [22].*

Variable costs: Variable costs for present cost model are listed in the below table -

Table -2 Variable costs for present cost model

Description	Units	Present mode
Total Fuel Cost*	BDT	2,674.67
Unloading Expense (Labor)	BDT	50.00
Ferry/toll Expenses	BDT	600.00
Police expense	BDT	0
Miscellaneous	BDT	0

**Total Fuel cost = (Required running meter/Fuel economy × Fuel price per litre + Extra fuel cost for safety = (100/3) ×68 + 6 × 68 = BDT 2674.67*

From data of Table 2, total variable cost can be calculated as follows:

Total variable cost (present) = Total fuel cost + Unloading expense (Labor) +Ferry or toll expenses = 2674.67 + 50 + 600 = BDT 3324.67

Fixed costs: Rental charge or depreciation cost per trip can be calculated from the below equation:

Rental charge or Depreciation cost per trip (present) = {Monthly rental + (Monthly rental × Percentage of tax)}/ (Number of working days × Number of trips per day)
= {225000 + (225000 × 0.065)}/ (26 × 1)
= BDT 9216.35

Fixed costs for present cost model are listed in Table 3:

Description	Units	Present mode
Rental charge/Depreciation Cost/Trip	BDT	9216.35
General expenses (Office expense)	BDT	20.00
Spare parts	BDT	0.00
Tyre Cost	BDT	0.00
Interest on lease finance	BDT	0.00
Living accommodation of operator	BDT	200.00

From Table 3,

Total fixed cost (present) = Rental charge or Depreciation cost per trip + General Expenses + Living accommodation of operator

= 9216.35 + 20 +200 =BDT 9436.35

Now,
Grand total cost (present) = Variable cost + Fixed cost + other miscellaneous cost

= 3324.67 + 9436.35 + 100 = BDT 12861.01

Cost per MT (present) = (Grand total cost)/ (Carrying capacity × Number of trip per day)

= 12861.01 / (23×1) = BDT 559.2

4.2 Development of cost optimization model

This section will demonstrate the development of a cost optimization model using Excel worksheet which will show a comparison between present cost model and an optimized model.

First, an excel table need to be constructed where a model can be made considering all the costs involved with bulk carrying vehicle. Sample Calculation for four cost factors are done based on:

- 10% carrying capacity utilization increase
- 10% trip per day utilization increase
- 10% Fuel economy increase
- 10% Fuel price decrease

4.2.1 Considering 1st factor (Carrying capacity of vehicle)

If 10% carrying capacity is increased then,

New carrying capacity of vehicle = Previous carrying capacity + (Previous carrying capacity × percentage of increase)
=23 + (23×10%) = 25.3 MT

The changes due to 10% increase of carrying capacity are shown in **Table 4.**

Now, from the values of Table 4,
Grand Total Cost and Cost per MT can be calculated as follows:

Grand total cost (optimized) = Variable cost + Fixed cost + other miscellaneous cost

= 3324.67 + 9436.35 + 100 = BDT 12861.01

Cost per MT (optimized) = (Grand total cost)/ (New carrying capacity × Number of trip per day)

=12861.01/ (25.3 × 1) = BDT 508.3

Results considering 1st factor (Carrying capacity of vehicle):

% of cost reduction = ((Optimized cost per MT)/ (Present cost per MT)) – 1=

(508.3/559.2)– 1 = -9%

BDT per ton savings = Cost per MT before optimization – Cost per MT after optimization
= 559.2 – 508.3 = BDT 50.83

If 2000 MT volume carried then-

Total savings in BDT = 2000 × BDT per ton savings
= 2000 × 50.83 = BDT 101668.1

Total savings in million BDT = (Total savings in BDT)/1000000=101668.1/100000= 0.10

Table -4 Changes in optimized mode for 10% increase of carrying capacity

Description	Units	Present Mode	Optimized Mode
Carrying Capacity	MT	23	25.3
Trip Per day	One round trip	1.00	1.00
Fuel Economy	L/100 km	3.00	3.00
Fuel Price/Litre	BDT	68.00	68.00
Required Running Meter	K.M	100	100
Variable Cost			
Total Fuel Cost	BDT	2,674.67	2,674.67
Unloading Expense (Labor)	BDT	50.00	50.00
Ferry/toll Expenses	BDT	600.00	600.00
Police expense	BDT	0.00	0.00
Misc.	BDT	0.00	0.00
Total Variable cost	**BDT**	**3,324.67**	**3,324.67**
Fixed Cost			
Rental charge/Depreciation Cost/Trip	BDT	9216.35	9216.35
General expenses (Office expense)	BDT	20.00	20.00
Spare parts	BDT	0.00	0.00
Tyre Cost	BDT	0.00	0.00
Interest on lease finance	BDT	0.00	0.00
Living accommodation of operator	BDT	200.00	200.00
Total Fixed Cost	**BDT**	**9436.35**	**9436.35**

2.2 Considering 2nd factor (Trip utilization)

If increase of 10% trip per day is considered then the changes are shown in the below table:

Table -5 Changes in optimized mode for 10% increase of trip per day

Description	Units	Present Mode	Optimized Mode
Carrying Capacity	MT	23	23
Trip Per day	One round trip	1.00	1.1
Fuel Economy	L/100 km	3.00	3
Fuel Price/Litre	BDT	68.00	68
Required Running Meter	K.M	100	110*
Variable Costs			
Total Fuel Cost	BDT	2,674.67	2,901.33
Unloading Expense (Labor)	BDT	50.00	50.00
Ferry/toll Expenses	BDT	600.00	600.00
Police expense	BDT	0.00	0.00
Misc.	BDT	0.00	0.00
Total Variable cost	**BDT**	**3,324.67**	**3,551.33**
Fixed Costs			
Rental charge/Depreciation Cost/Trip	BDT	9216.35	8378.50
General expenses (Office expense)	BDT	20.00	20.00
Spare parts	BDT	0.00	0.00
Tyre Cost	BDT	0.00	0.00
Interest on lease finance	BDT	0.00	0.00
Living accommodation of operator	BDT	200.00	200.00
Total Fixed Cost	**BDT**	**9436.35**	**8598.50**
Grand Total Cost	**BDT**	**12,861.01**	**12249.83**
Cost per MT	**BDT**	**559.2**	**484.2**

**Required running meter = Previous running meter × New trip per day = 100× (1×10%) = 110 KM*

Results for 10% increase of trip per day are listed in the following table:

Table -6 Results (Considering 2nd factor)

Cost Optimization Factors/tools		Results	
		% of Cost Reduction	**-13%**
Carrying capacity utilization	0%	**BDT/ton Savings**	**74.99**
Trip per day utilization	**10%**	**Volume Carried (MT)**	**2000**
Fuel Economy	0%	**Total Savings BDT**	**149,982.9**
Fuel Price	0%	**Total Savings in mln BDT**	**0.15**

4.2.3 Considering 3rd factor (Fuel economy)

If increase of 10% fuel economy is considered then the changes are shown in table 7.

Results for considering 10% increase of fuel economy are listed in the following table:

Table -8 Results (Considering 3rd factor)

Cost Optimization Factors/tools		Results	
		% of Cost Reduction	**-2%**
Carrying capacity utilization	0%	**BDT/ton Savings**	**8.96**
Trip per day utilization	0%	**Volume Carried (MT)**	**2000**
Fuel Economy	**10%**	**Total Savings BDT**	**17,918.3**
Fuel Price	0%	**Total Savings in mln BDT**	**0.02**

Table -7 Changes in optimized mode for 10% increase of fuel economy

Description	Units	Present Mode	Optimized Mode
Carrying Capacity	MT	23	23
Trip Per day	one round trip	1.00	1
Fuel Economy	L/100 km	3.00	3.3
Fuel Price/Litre	BDT	68.00	68
Required Running Meter	K.M	100	100
Variable Cost			
Total Fuel Cost	BDT	2,674.67	2,468.61
Unloading Expense (Labor)	BDT	50.00	50.00
Ferry/toll Expenses	BDT	600.00	600.00
Police expense	BDT	0.00	0.00
Misc.	BDT	0.00	0.00
Total Variable cost	**BDT**	**3,324.67**	**3,118.61**
Fixed Cost			
Rental charge/Depreciation Cost/Trip	BDT	9216.35	9216.35
General expenses (Office expense)	BDT	20.00	20.00
Spare parts	BDT	0.00	0.00
Tyre Cost	BDT	0.00	0.00
Interest on lease finance	BDT	0.00	0.00
Living accommodation of operator	BDT	200.00	200.00
Total Fixed Cost	**BDT**	**9436.35**	**9436.35**
Grand Total Cost	**BDT**	**12,861.01**	**12654.95**
Cost per MT	**BDT**	**559.2**	**550.2**

4.2.4 Considering 4th factor (Fuel price)

Although fuel price is not under control of any company still it has an impact on the total logistics cost. If 10% fuel price is decreased then-

New Fuel price per litre = Previous fuel price + (Previous fuel price × percentage of decrease)
= 68 - (68×10%) = BDT 61.2

Variable Cost:
Total fuel cost = ((Required running meter)/ (Fuel economy)) × Fuel price per litre + Extra fuel cost for safety = (100/3) ×61.2 + 6 × 61.2= BDT 2407.2

Unloading expense (Labor) = BDT 50
Ferry/toll expenses = BDT 600

Total variable cost = Total fuel cost + Unloading expense (Labor) + Ferry or toll expenses
= 2407.2 + 50 + 600 = BDT 3057.2

Fixed Cost:
Rental charge/Depreciation cost per trip = BDT 9216.35
General expense (Office expense) = BDT 20
Living accommodation of operator = BDT 200

Total fixed cost = Rental charge or Depreciation cost per trip + General expense + Living accommodation of operator
= 9216.35 + 20 +200 = BDT 9436.35

Now,
Grand total = Variable cost + Fixed cost + other miscellaneous cost
= 3057.2 + 9436.35 + 100 = BDT 12593.55

Cost per MT = (Grand total cost)/ (Carrying capacity × Number of trip per day) =12593.55/ (23×1) = BDT 547.5

Results for considering 10% decrease of fuel price are listed in the following table:

Table 9 Results (Considering 4th factor)

Cost Optimization Factors/tools		Results	
		% of Cost Reduction	**-2%**
Carrying capacity utilization	0%	**BDT/ton Savings**	**11.63**
Trip per day utilization	0%	**Volume Carried (MT)**	**2000**
Fuel Economy	0%	**Total Savings BDT**	**23,258.0**
Fuel Price	**10%**	**Total Savings in mln BDT**	**0.02**

5 RESULTS AND DISCUSSION

5.1 Results

The above optimization tool shows, if 10% carrying capacity is increased then cost per MT is reduced (from BDT 559.2 to BDT 508.3) while Grand Total Cost (GTC) remain unchanged (BDT 12861.01). On the other hand, increase of 10% trip per day is increasing total variable cost but fixed cost is decreasing hence both GTC (from BDT 12,861.01 to BDT 12249.83) and cost per MT (from BDT 559.2 to BDT 484.2) is reduced. Now, increase of 10% fuel economy is reducing total variable cost while fixed cost remain same as before hence GTC (From BDT 12,861.01 to BDT 12654.95) and cost per MT (From BDT 559.2 to BDT 550.2) is reduced. Lastly, 10% decrease of fuel price is reducing total variable cost although fixed cost will remain unchanged hence GTC (from BDT 12,861.01 to BDT 12593.55) and cost per MT (from BDT 559.2 to BDT 547.5) is reduced. Generally, no company has control over fuel price but if the fuel price is decreased then overall logistics cost would be reduced significantly.

Now, the percentage of cost reduction and total savings in BDT of four cost factors are listed in Table 10.

Table 10 The % of cost reduction and total savings in BDT of four cost factors

Cost Factors	% of cost reduction	Total savings in BDT
Carrying capacity utilization	9%	101,668.1
Trip per day utilization	13%	149,982.9
Fuel Economy	2%	17,918.3
Fuel Price	2%	23,258.0

Comparison between four cost factors on the basis of percentage of cost reduction and total savings in BDT shows in the plot of Fig 2 that among four cost factors- trip per day utilization is providing highest percentage of cost reduction and total savings in BDT for 10% increase. Also carrying capacity utilization is causing a significant amount of cost reduction for 10% increase.

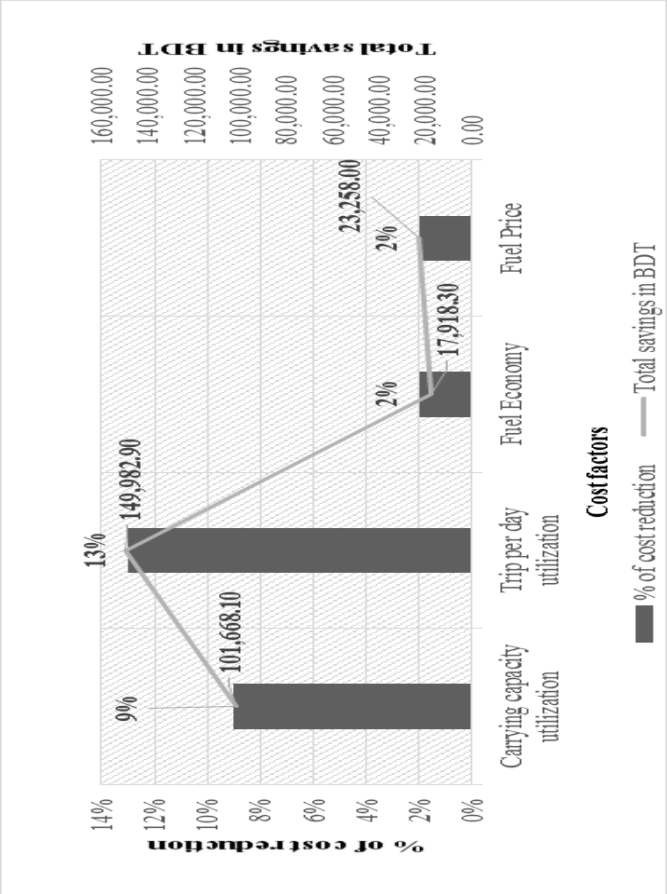

Figure 2 Comparison plot of four cost factors

5.2 Discussion

In this study, some key findings has come out as real fact with respect to industry practices and theoretical aspects of logistics. Full capacity utilizations of vehicles ensure low carrying/distribution cost. For example, if a vehicle with thousand kg capacity can carry exactly thousand kg goods and per trip cost is BDT 1000 then per unit carrying cost is BDT 1.00. Whereas, if it carries 800kg (less capacity utilization) then per unit cost will be BDT 1.25 which is 25% higher. So, ensuring capacity utilization is also a key factor to ensure optimization of logistics cost. LSC generally uses vehicle of 23 MT carrying capacity. If they use higher carrying capacity vehicle like 30-35 MT, they could transport higher amount of bulk cement. Besides, it will reduce the number of trips which consequently reduce the overall logistics cost. General cement carrying vehicle's fuel economy is about 3 L/100 km. If LSC uses higher carrying capacity vehicle it will reduce the fuel cost as well as overall logistics cost. Trip utilization is one of the major factor for higher efficiency and higher responsiveness of logistics. LSC allows one trip per day as per policy. By proper scheduling and managing the obstacles they could increase the number of trips per day.

6 CONCLUSION

This paper tried to show a comparison based pathway using optimization tools and techniques that a company can reduce overall logistics costs by identifying the cost factors and utilizing them properly. It is clear that carrying capacity utilization and trip per day utilization is having a tremendous impact on overall logistics cost. Also fuel economy and fuel price plays an important role on overall logistics cost. According to this study, among all four factors trip utilization is the most feasible solution for LSC. Although, Scheduling and routing optimization was not considered in this research. In future, with proper scheduling and proper route optimization, trip utilization could be achieved more effectively.

7 FURTHER RESEARCH DIRECTION

This optimization model is developed based on four cost factors. In future, more cost factors might be included. This model is developed for single rented bulk carrying vehicle. Owned vehicle might also be taken into account. In this study, Microsoft Excel is used to develop the model which may also be done in Matlab optimization tools. All four cost factors were not considered all together as it is not easy for a company to achieve control over all the four factors together at a time. Further research might be conducted on that.

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