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Increasing Use of Railways for the Transport of Petroleum Products in Sri Lanka

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1. Introduction

Petroleum is among the most prominent industries in Sri Lanka. In order to fulfil the country's petroleum demand, the Ceylon Petroleum Corporation (CPC) has outsourced the storage and distribution function to Ceylon Petroleum Storage Terminals Limited (CPSTL). Currently CPSTL distributes petroleum products from two installation plants to eleven regional depots using both bowsers and rail wagons. When considering the distribution function from the Kolonnawa installation plant to the regional depots, bowser transportation dominates over rail. Even though rail transportation is more economical, efficient and environmentally friendly, only around 35-40% of the daily bulk petroleum volume is carried using rail while the rest is transported using the road network. The reason for lesser utilisation of railways for the distribution of petroleum products is investigated in this research and a new distribution model which maximises the utilisation of rail, while maximising savings for CPC and profits for Sri Lanka Railways (SLR) is also proposed.

2. Methodology

In this research, the linear programming methodology, adopted also by Gunaruwan and Sannasooriya (2013) in their research on macroeconomic impacts of the haulage of petroleum by rail [1], was used to determine the optimum benefits to CPSTL and SLR, and the corresponding volumes that should be transported to each regional depot using rail. Primary data were collected through unstructured interviews and through discussions with industry leaders in order to identify the constraints that limit better utilisation of railway for petroleum bulk distribution purposes. Secondary data were obtained from the ERP system of CPSTL and records from SLR.

The data related to the petroleum distribution operation during May, June and July of 2015 have been considered using the objective function,

Max B = ∑ (1)

Subject to:

∑ $V_j \leq \alpha. 50000 + \beta. 45400 + \chi. 26370$ (2)

∑ ≤ (3)

$\sum$ —≤ 156 (4)

≤V (10 constraints for 10 destinations) (5)

—≤N (10 constraints for 10 destinations) (6)

Where, B is the overall benefit to both CPSTL and SLR and V_j is the volume carried to j^{th} destination. D_j denotes the rail distance to j^{th} destination from Kolonnawa, P stands for SLR's profitability per kilo litre (kl) per km for j^{th} destination and S represents CPC's savings per kl for j^{th} destination if carried by rail. In the constraints V_t is the capacity of the Kolonnawa terminal, V_{dj} represents the capacity of the j^{th} depot, is the capacity of the wagon allocated to j^{th} destination and denotes the maximum number of wagons per engine that can be hauled to j^{th} destination. In the linear program j varies from 1 to 10, representing the ten regional depots. The coefficients α, β and χ stands for the number of 50,000, 45,400 and 26,370 litre oil wagons respectively.

2. Results

Through the primary data, lack of oil wagons was identified as the prominent reason for poor utilisation of trains. Further data proved that the existing distribution operation allows only 43% of the daily volume to be carried by rail.

Based on the linear program solution given in equations (1) to (6), the priority, when transporting petroleum using rail wagons and the resulting distribution model for existing resources, could be worked out, as presented in Table 1. The analysis assigns higher volumes of petroleum to destinations at further distances over flat terrain while lesser volumes are allocated to hill country destinations increasing overall rail allocation to 63.5%. The reason is that, to low country destinations, a single rail engine can haul up to approximately15 oil wagons while to hill country destinations only a limited tonnage of between 4- 6 wagons can be hauled along the incline, reducing economies of scale. The revenue optimising liner programming assignment shows how railway's efficiency can be improved by around 50% with the same resources by reassigning its current fleet of 156 wagons and trains to more profitable destinations such as Anuradhapura, Batticaloa and Matara where 100% of

their requirements should be supplied, while only around 30% of the demand of Galle can be met by rail. This means that the remaining destinations, such as Vavuniya, Peradeniya, Badulla, Haputale and Kotagala cannot be served without additional wagons. The total petroleum transport demand can be met with a fleet of 372 wagons and a fleet of engines to haul them.

Table 1- Proposed distribution operation

Regional Depot	Rail Distance (km)	Volume (kl)	Cost per kl per km	Revenue per kl per km	Profit LKR/day	Road Distance (km)	Charge per l per km (LKR)		Saving (LKR)/day
							Rail	Road	
Anuradhapura	207	682	3.162	3.589	60,241	202	0.003589	0.01159	1,089,721
Batticaloa	351	212	3.162	3.589	31,761	321	0.003589	0.01159	521,658
Matara	154	395	3.162	3.589	25,964	154	0.003589	0.01159	486,701
Galle	127	114	3.162	3.589	6,180	127	0.003589	0.01159	115,838
Kurunegala	97	0	3.162	3.589	-	104	0.003589	0.01159	-
Vavuniya	256	0	3.162	3.589	-	255	0.003589	0.01159	-
Peradeniya	30	0	3.678	4.187	-	25.5	0.004187	0.01381	-
	86	0	3.162	3.589	-	112	0.003589	0.01159	-
Badulla	208	0	3.678	4.187	-	85	0.004187	0.01381	-
	86	0	3.162	3.589	-	150	0.003589	0.01159	-
Haputhale	164	0	3.678	4.187	-	43.3	0.004187	0.01381	-
	86	0	3.162	3.589	-	150	0.003589	0.01159	-
Kotagala	96	0	3.678	4.187	-	83.2	0.004187	0.01381	-
	86	0	3.162	3.589	-	55.1	0.003589	0.01159	-
		Total profit for SLR			124,146	138.3	Total saving		2,213,918

Since the results of the model prove that destinations along a flat terrain with longer distances are favourable for rail transport, CPC should invest on building rail delivery facilities at Kankasanthurei. Even though Kankasanthurei already has a regional depot, it does not facilitate train deliveries. Both CPC and SLR can improve their gains by developing the regional depot st Kankasanthurei which is the furthest away from Kolonnawa. Privately owned depot at Vavuniya has a limited storage capacity of only 244 kl, and therefore, does not become an attractive regional centre unless the CPC expands its capacity.

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