

**Minimizing the Transportation Cost of Dambulla Economic Centre:  
Integration of Process Planning and Scheduling on a Web Base Platform**

**D. G. N. D. Jayarathna<sup>1</sup> and C. J. Jayawardene<sup>2</sup>,**

<sup>1</sup> *Faculty of Management, and Social Sciences, CINEC CAMPUS, Malabe*

<sup>2</sup> *Department of Mathematics, Faculty of Science, University of Colombo*

***Keywords:*** *Vehicle; Linear Programming; Transportation; Cost*

The government of Sri Lanka established economic centres in provinces according to the budget proposals in the year 1998. The Dambulla Economic Centre was the first and was established on the 01st of April 1999. Thereafter, a number of economic centres were established throughout the island. But Dambulla Main Hub remained the central warehouse of vegetables in the island. This paper deals with a vehicle scheduling problem in transportation and investigates a solution to overcome the problem using linear programming (LP).

Marketing Department Logistics (MDL) Ltd needs to distribute vegetables and fruits to different provinces. Its main hub is situated near the Dambulla vegetable and fruit market, and minor hubs are situated in different provinces in Sri Lanka. The main objective of this research is building a cost minimization model to create a suitable method for delivering of vegetables and fruits from the Dambulla major hub through its minor hubs to the outlets in the provinces. Hence, to optimize the cost of outbound distribution, a mathematical model has been developed by using Integer Linear Programming using reliable sources to collect data. Software assistance was obtained using the Lingo 06 optimizer, Java, Ms Access and Ms Excel tools to solve this mathematical model. This study is based on the Dambulla economic centre. This is an initial step to bring a correct protocol to arrange a transport model to distribute the vegetables and fruits from this centre in a cost-effective way. According this study all districts in Sri Lanka could be divided into four clusters.

At the beginning of this research we assumed that each district contains two warehouses and three vendors. This model is flexible enough to re-schedule

for any given request. It helps to create a larger model for solving any type of transportation planning problem.

### **Objectives**

- Using the Mathematical Method of Hamiltonian Cycle to find Optimal Cost Benefit Major Paths to delivering vegetables and fruits from the Dambulla major hub to each warehouse in every district in Sri Lanka.
- Build a Computer Web Based system which delineates the manner of delivering all vegetables and fruits to all vendors from all warehouses in Sri Lanka.

### **Methodology**

This section explains the methods which are used to find the exact location of the new facility, to find an intelligent route plan with truck allocation while maintaining the same service levels of the Dambulla economic centre. These methods will bring quantitative results to achieve objectives and it introduces cost optimized truck allocation. Lingo is a comprehensive tool that can identify Linear, Nonlinear, Stochastic, Integer optimization etc. It reads formulation and automatically selects the appropriate one. Therefore, there is no need to specify or separate the solver. The Lingo User Manual describes all commands and features in an understandable language. Thereby this software selection is justified as an effective tool for this research model. The integer linear programming model which is developed in this research has variables which are assumed to be discrete values classified as integers. Basically, by this research, an attempt is made to minimize the transportation cost of delivering vegetables and fruits to different provinces. Thereafter, the transportation cost of delivering vegetables and fruits to small supermarkets or shops will be minimised. Further, it is expected to introduce some web based interface to certain selected responsible persons in all districts to insert the demanded requirements of each district. Thereafter, a person who operates this database will find out the transport schedule of the country and insert it into the data base. Thus, the selected responsible person has access to the web based system and can see the transport schedule.

## Results and Discussion

This research is based on building a cost optimization model which derives a suitable method for delivering of vegetables and fruits from its Dambulla major hub through its minor hubs to its outlets in the provinces. The final goal of this research is to build an Internet Based System to solve this mathematical problem. However in order to satisfy these major points LINGO 06 solver was used in two locations. Advanced analysis was carried out under the following tasks.

Task 1 : All districts of Sri Lanka were divided into four groups

I. Cluster 1    II. Cluster 2    III. Cluster 3    IV. Cluster 4

Table 1: Details of Clusters

Index	Region	Contained district
1	Cluster 1	Anuradhapura, Vavniya, Mannar, Jaffna, Kilinochchi, Mulaitivu, Trincomalee
2	Cluster 2	Puttalam, Kurunegala, Kegalle, Colombo, Gampaha, Kalutara, Rathnapura, Galle, Matara
3	Cluster 3	Matale, Kandy, Badulla, Monaragala, Hambanthota, Nuwara Eliya
4	Cluster 4	Polonnaruwa, Batticaloa, Ampara

Source: Results of the research

Task 2: Each district contains two warehouses and three vendors. A vendor represents ten supermarkets in a certain area. Locations of the warehouses and distances will be applied to the model accordingly.

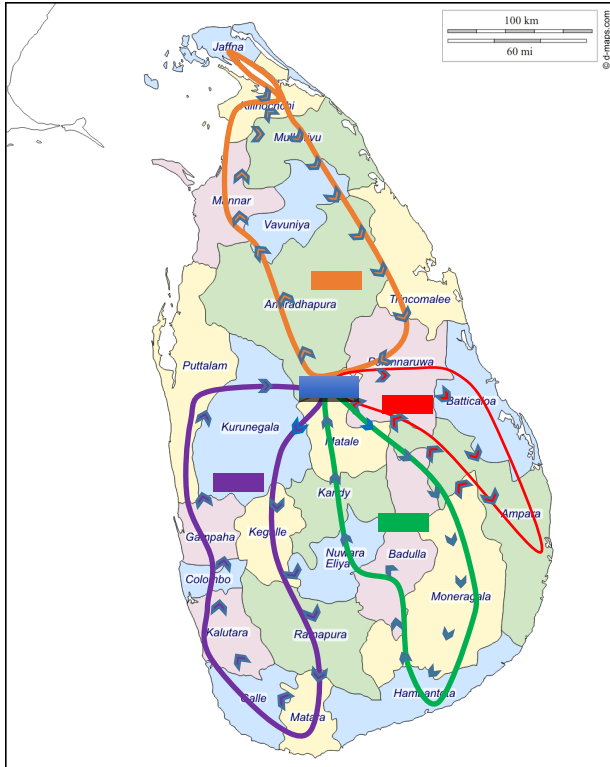
Example: Warehouses and Vendors

Colombo district: Colombo warehouse 1, Colombo warehouse 2

Colombo district: Colombo Vendor 1, Colombo vendor 2, Colombo Vendor 3

Task 3: Under this task, the Hamiltonian cycle is used to find the major paths of each cluster to deliver vegetables and fruits from Dambulla Major Hub to each warehouse in every district in Sri Lanka.

Figure 2: Hamiltonian Path of Each Cluster



Source: Results of the Research

Task 4 : During this step, Excel, Access and Java software were used to build a computer based system which delineates the manner of delivering all vegetables and fruits to each vendor from all warehouses in Sri Lanka.

*Route Analysis - Hamiltonian Cycle:* The first step of the research is to find a route plan where the optimal path is performed using the Lingo software. Lingo is a software package which facilitates the solution of linear and non-linear optimization problems. Through Lingo, the Hamiltonian cycle model is adjusted to this research issue and it is solved by using Lingo software. The Hamiltonian cycle gives the optimal path to each main cluster. The adjusted Hamiltonian cycle problem is given by Appendix A. After solving

the model, when the value is shown to be 1, it is taken as a path. The rows and columns show distance between districts. According to the above model, the other three clusters were also adjusted and solved using the Lingo software. The Hamiltonian cycle has given optimal paths.

Cluster 1: Dambulla, Anuradhapura, Vavuniya, Mannar, Jaffna, Kilinochchi, Mulaitivu, Trincomalee, Dambulla

Cluster 2: Dambulla, Puttalam, Kurunegala, Kegalle, Colombo, Gampaha, Kalutara, Rathnapura, Galle, Matara

Cluster 3: Dambulla, Matale, Kandy, Badulla, Monaragala, Hambanthota, Nuwara Eliya

Cluster 4: Dambulla, Polonnaruwa, Batticaloa, Ampara

After finding the optimal path of each cluster, total vegetable run is calculated.

Table 2 : Daily Vegetable Run in Kilometres

Cluster	Daily Vegetable Run km
1	674
2	804
3	661
4	426
Total	2565

Source: Results of the Research

## **Conclusion**

This study is based on the Dambulla economic centre. This is an initial step to bring a correct protocol to arrange a transport model to distribute the vegetables and fruits from this centre in a cost-effective way. According to this study all districts in Sri Lanka could be divided into four clusters. At the beginning of this research we assumed that each district contains two warehouses and three vendors. This model is flexible enough to re-schedule at any request. It helps to create a larger model for solving any type of transportation planning problem. In this study the model is designed only for

one vegetable or fruit at a time. But it can be extended to apply for more than one item in the same excel sheet. For that purpose, advanced lingo code should be introduced and it is necessary to maintain a sufficient database. At the first task we arranged the optimal path to distribute the vegetables and fruits to the minor hubs. It reduces fuel consumption and waste of time. But in any case, for problems arising in the roads we should have an alternative plan to distribute vegetables and fruits. We recommend carrying out a pilot survey and use the knowledge of the gravity model to find out the optimal places for warehouses in each district. It is recommended that one person be assigned from each district to submit all sub-vendors' requirements. By arranging one person to manage more than one district we can reduce the cost incurred by MDL in Dambulla.

### **References**

- Chalaturny, K. (2008). A Fast Algorithm For Finding Hamilton Cycles, Winnipeg University of Manitoba
- Haythorpe, M. (2000). Markov Chain Based Algorithms for the Hamiltonian Cycle Problem. South Australia: University of South Australia
- Machackova, J. (2009). Economic Evaluation of a Warehouse Investment in Central Europe: Case Study at Nokian Heavy Tyer Limited. Europe: University of Applied Science.
- Sahoo, S. and Pal, D.B. (2012). Truck Allocation Model Using Truck Allocation Model Using Linear Programming and Queueing Theory. Rourkela: National Institute of technology