An Optimization Model and DSS for Tactical Supply Chain Planning in a Large Tea Company

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Introduction

A common problem for a large manufacturing firm like Bye-Bye Tea Ltd. (name disguised), with geographically wide distribution network is the need to find a tactical (monthly or quarterly) plan for allocation of various SKUs demand to the various packing centers. The desired optimal plan is the one that simultaneously calculates packaging mix at packaging centers, primary transport allocation and transport mode selection between suppliers and packaging centers, inventory stocking at plants, and secondary transport allocation and transport mode selection between packaging centers and depots.

This paper explains the Decision Support System (DSS) developed for tactical supply chain planning in Bye-Bye Tea Ltd. The DSS uses a Mixed Integer Linear Programming (MILP) model labeled as Manufacturing and Logistics Planner (MLP). DSS with Graphical User Interface (GUI) is useful for middle and higher management to easily use the model for monthly planning without knowing much about the model formulation.

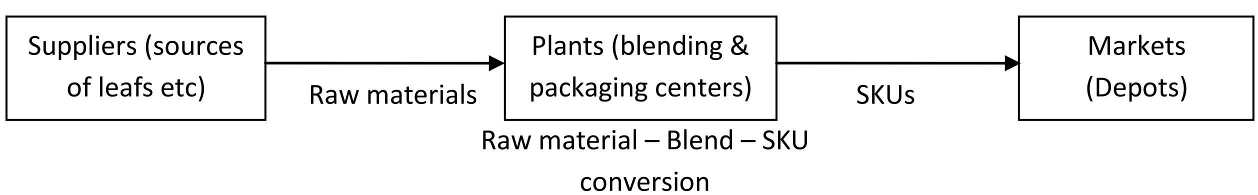

Figure 1: Supply chain of Bye-Bye Tea Ltd.

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MLP model gives monthly or quarterly packaging and distribution plan by considering procurement costs, primary transportation costs and packaging costs of general shift and night shift, secondary transportation costs, various taxes, and practical constraints. This data is provided by Bye-Bye Tea Ltd.

The supply chain of Bye-Bye is broadly depicted in Figure 1. It has 3 echelons – Suppliers, Plants, and Depots. The suppliers supply different raw materials to plants. These raw materials are used to prepare blends or product types as per pre-determined conversion ratios. The blends are packed into different pack sizes which are called as SKUs. The SKUs are transported from plants to depots.

The packaging centers have different packing lines whose capacities are given for different pack sizes. Various SKUs which have the same packing type can share the same packing line capacity. The model considers the mapping of blend with SKU and also pack size with SKU.

Packaging cost varies with the SKU and packing center. General shift packing type capacities can be scaled up by about 25% using the night shift option. Demand can be satisfied from the night shift packaging only if general shift capacity is exhausted.

Model Explanation

The objective of the model is to minimize the sum of costs of inbound transportation, outbound transportation, general shift packaging, night shift packaging, procurement, entry tax and other taxes, inventory at plant, and shortage.

There are different practical constraints like

- Capacity limitations from supplier's side
- Upper and lower limits on the supply to each plant from each supplier
- The sum of supply of a SKU to a market should meet its demand
- Any plant to depot allocation, if it occurs, should have a minimum quantity to complete one truck load
- The number of products in a plant is less than a maximum limit specified by the user
- If a plant is packing a SKU, then that SKU should comprise at least x% of its total packaging volume

The outputs are:

- Quantity of a raw material supplied from a supplier to packaging center by a transport mode
- Quantity of a SKU supplied from a packaging center to depot by a transport mode
- General shift and night shift packaging plan (product mix) for a line in a plant
- Total supply chain contribution margin, total cost and its break-up
- Next best alternate routes for every plant-warehouse-market combination

Conclusions

The MLP DSS aids senior and middle management to make monthly or quarterly packaging and logistics plans in an integrated manner. A user friendly Graphical User Interface (GUI) is developed using Java and Oracle to avail any laymen to use DSS without knowing much about the model formulation. The DSS is also useful to find the possible locations where the improvements in capacities and capabilities give maximum returns. The decisions given by DSS are directly implementable as it recommends the quantity to be supplied by each mode of transport between each O-D pair. The model is useful even for annual budget planning and financial planning. GAMS/CPLEX is used to solve MILP model. There were about 1000 to 1500 binary variables, 0.7 million non-integer variables and 2000 constraints. Average run time on a 64-bit quad-core processor machine was about 15 minutes to reach an optimal solution. This model has yielded good improvement in contribution margin as compared to the rule-of-thumb based planning.