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GEST-S407 - Operations management - 202122

CASE GROUP ASSIGNMENT 1: DHL Global Forwarding Consolidation Program

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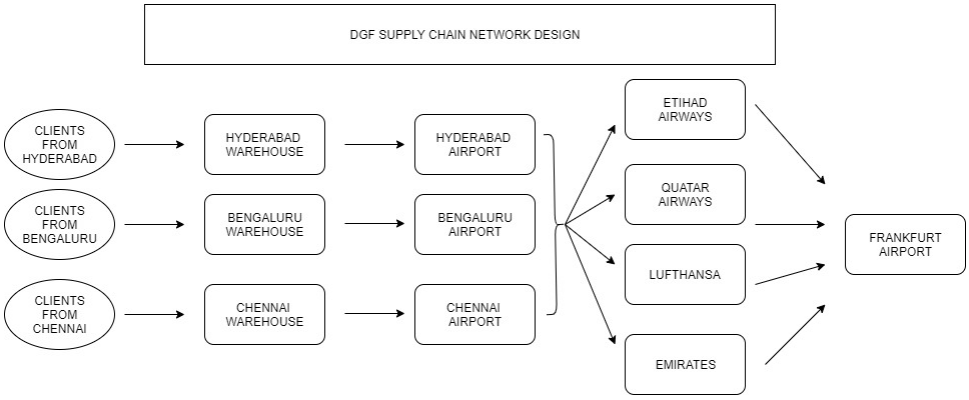
Question 1:

What is DGF's current consolidation freight forwarding approach? And what is the team proposing as new approach? Please explain the benefits of each of these approaches.

DGF is a division of Deutsche Post DHL Group. DGF provide air and ocean freight forwarding services. We will here analyze the India to Frankfurt shipping. The company is operating under three main warehouses in India; Hyderabad, Bengaluru, and Chennai. After receiving the goods from the clients, DGF consolidate, repackage, and ship them to Frankfurt in Europe.

The current consolidation freight forwarding approach of DGF consists of consolidating all the orders of the clients (see excel data) in warehouses based in three cities. Orders from all the clients from Hyderabad are consolidated in Hyderabad warehouse and shipped on scheduled day which are Tuesday, Thursday, and Saturday to Frankfurt. (See excel data). Same is done for the other cities on the same scheduled day.



Orders received Saturday and Monday are shipped on Tuesday, those received on Tuesday and Wednesday are shipped on Thursday and finally those received on Thursday and Friday are shipped on Saturday. Sunday is considered as a holiday day, so we skip it, and this is how the company runs the weekly consolidation shipment schedule.

There are 3 airports matching with the 3 warehouses location (one in Hyderabad, one in Bengaluru and one in Chennai). Those airports are served by 4 airlines company: Etihad Airways, Qatar Airways, Lufthansa and Emirates. The 4 airlines charged DGF based on the weight of these aggregated shipments (see excel data). Besides, there is a schedule with all the possibilities of the available flights for each ship day and each airport (see excel data).

So, the current consolidation freight forwarding approach is based on the lowest cost offered by the airlines and on the availability of the flights. What benefits of this approach?

- The experience customers are facing "working" with DGF is great. DGF try to achieve the cheapest way to deliver their order, which leads to cheaper prices for the customers. We can imagine they use that to get a competitive advantage in the market and it is maybe the reason why DGF is among many leaders in the market.
- This consolidation plan may not be the most cost-efficient, but the quantity received in one warehouse are shipped directly from this city, so it requires less logistic for DGF and less risk to make a mistake. This gives a good experience to the customers with almost no or less risk of delay.

With this consolidation plan we found that the total cost per week 4.196.000 rupees was. (See excel sheet 2)

Amit Datta, regional director of DGF and his team wondered if it was possible to achieve greater economies of scale. This leads to the new consolidation plan. It consists of routing the shipments orders through another airport instead, using overnight road transportation to move the shipments to DGF's warehouse in another city.

This new alternative requires 2 mains considerations:

- The first one is that there is a potential delay due to traffic congestion and/or accidents while moving shipments by road. The probability that this event occurs is no more than 2%. If it occurs DGF must pay to the client a penalty equivalent to the shipping cost.
- The second one is the cost of road transport (see excel data).

The benefits of this new consolidation plan could be:
- decrease the costs of DGF and thus potentially offer to their customers more attractive prices and be more powerful on this segment in the market.
- A disadvantage of this new consolidation plan is that it consumes even more fuel than before. In effect, the road transport has, for sure, an economic cost which can be lower. But with the challenges that the world faces today, we cannot ignore the ecological impact of that kind of decision and it should be taken into account.

Question 2:

Can Datta create a freight forwarding program on a weekly basis using the simplex LP model? Please Specify the decision variables, the objective function, the constraints as well as your assumptions and approach. Please describe it intuitively as well as based on a mathematical formulation.

With this new alternative it is possible to create a freight forwarding program on a weekly basis using the simplex LP model. To do that we will use 3 Linear programming model which are basically the same but for each day of shipment (Tuesday, Thursday and Saturday).

1) Mathematical formulation :
- objective function: Minimize: (C_{ii} * s_{ii}), the same for each day.

- variables : (see excel sheet 3)
- We have i that take H, B or C for the 3 warehouses
- C_{ii} (matrix) = cost of shipping one kg received in $warehouse_i$ from $warehouse_i$
- D_i= demand received in $warehouse_i$
- s_{ii} (matrix) = number of kg received in $warehouse_i$ shipped from $warehouse_i$
- S_i= total number of kg shipped from $warehouse_i$

- constraints:
- D_H=2800 / D_B=5000 / D_C=7000
- $S_i \leq 14800$
- $s_{ii} = D_i$ (example: $s_{HB} + s_{HB} + s_{HC} = D_H$)

- assumptions:
- If a delay or/and accident occur and that the transport isn't on time to be able to ship we will consider that the shipment will be send next week.
- We didn't take the transport road time into account in our calculations because first we don't have it.

We only know that it will take at maximum 5 working days, so, we assume that they will be 100% sur to be ship the following week.
- For the C_{ii} matrix we computed the total cost per kg rather there is a road transport or not. If there is a road transport the risk is included in the computation. We assumed for this calculation that C_{ii} (when there is a road transfer) = 98%*shipment cost + 2%*penalty cost
* shipment cost = ($cost_{/kg}$ + road transfer $\text{cost}_{/kg}$)
* penalty cost = 2*shipment cost : If there is an unexpected delay, DGF would have to send the order the next week so they will have to pay the shipping cost whatever and they will also have to pay the penalty equals to the shipping cost. Therefore, we multiplied the shipping cost by 2.
- Seen the schedule of the airlines it is possible to ship any day of the week but Tuesday, Thursday and Saturday are the cheapest days to flight so we will assume that we only ship those days.

2) Intuitive formulation:

We have at first computed the current average cost matrix with the given information's in the assignment (see excel sheet 3 on the left). Then we computed the C_{ii} matrix for each day (see excel sheet 3) with the assumptions we took. This matrix gives the cost to ship 1 kg to Frankfurt. There are always 3 possible costs depending on where we ship because it is now possible to receive a quantity to ship in Hyderabad but to transfer it by road and ship it from Bengaluru or Chennai for another cost. So for each quantity received and stocked in one warehouse (vertical side of the matrix) it is possible to :
1) ship the quantity from the airport based in the same city as the warehouse. This cost won't include road transport.
2) ship from another airport while using road transport.

After that, we created on the right of the C_{ii} matrix another matrix that gives how much and from where to ship the quantity while minimizing the total cost. To do that first added several constraints:
- The quantity received in a city must be totally shipped. So, the demand of Hyderabad must be equal to 2800 kg, the demand of Bengaluru must be equal to 5000 kg and the demand of Chennai must be equal to 7000 kg. Otherwise, the demand won't be satisfied. (Vertical axis of the matrix)
- The final volume shipped by a city must always be lower or equal to 148000 kg. Indeed, a city could potentially ship all the demand of the day. But this amount can't exceed 2800 + 5000 + 7000 = 148000 kg which is equal to the maximal demand of each shipping day. (Horizontal axis of the matrix)
Given those constrains we ask solver independently for each day to minimize the cost cell in green, or directly the final total weekly cost. This cell is a sumproduct formula of the C_{ii} matrix and the blue matrix s_{ii} and need to be as low as possible.

Solver gives us then the amount to ship and from where to ship. For Tuesday for example, we can conclude that we will have to transfer by road the amount of 2800 kg to ship them from Bengaluru, the 5000 kg received in Bengaluru will ship from there too and the 7000 kg received in Chennai will ship from Chennai.
In conclusion, we will use the road transport 2 times in the 3 days of shipping.
- Tuesday to move 2800 kg from Hyderabad to Bengaluru
- Saturday to move 7000 kg from Chennai to Bengaluru

Question 3 :

Formulate your suggestion based on a comparison of the current and the proposed approach.

With the current approach, the total costs of the company for the given amounts of shipments arises at 4.196.000₹ while with our proposed approach, they amount to 4.167.048₹. Thus, the road transport of some of the shipments allows the company to reduce their costs by 28.952₹ which means a 0,69% decrease.

To reach this objective, DGF must plan a road transport between Hyderabad and Bengaluru on Tuesday night and another road transport between Chennai and Bengaluru on Saturday night. The Tuesday convoy will move the 2800kg of Saturday and Monday while the Saturday convoy will move the 7000kg accumulated in Chennai on Thursday and Friday. Obviously the two weekly convoys will not have the same impact on the cost's reduction because of the weight and the costs of road transport that are not the same, depending on the cities of departure and arrival.

The first one leads to a 112₹ cost reduction which is not a lot. Therefore, we think that a more precise estimation of the percentage of potential delays due to road transport is needed because a slight rise of the 2% can potentially lead to a cost increase in comparison with the current plan. However, seen that our goal is to minimize the costs, we consider the advice of our simplex model that detected a cost reduction possibility and take it for granted.

A major part of the decrease comes from the second convoy with a 28.840₹ cost reduction. DGF can take advantage of the low road transport costs between Chennai and Bengaluru (4₹/kg) to reduce their costs. Moreover, Chennai is the warehouse with the highest consolidated weight of shipments. Put together, these two reasons allow us to advice Datta and his team to add this convoy in their consolidation plan.

To sum up, we advise DGF to plan two road convoys each week in order to reduce their costs by 0,69% for a total amount of 28.952₹.

Question 4:

According to the case, what are the risks of this new consolidation approach? Please discuss the financial implications (based on numbers)

The new consolidation approach for DHL Global Forwarding certainly reduces total cost for the DHL, but it comes with a certain amount of risk which must be including in the calculation before planning. The case states that road transportation can suffer from delays due to traffic congestion or accidents. Datta has found some data that suggested that the probability of such an event is no more than 2% in South India. Furthermore, if such an incident occurs DHL is required to pay a penalty to their client. This penalty is equal to the cost of that order.

We have assumed that the penalty equals the total cost of the entire shipment to Frankfurt airport, even if the risk only applies to road transport. The generated delay will apply on the whole ship. Knowing this we can compute the total cost per week including the risk of delays.

With the new consolidation model DHL will use road transportation for 2 orders per week. Once to bring the Tuesday order from Hyderabad to Bengaluru for a price of 8 rupees per kg and once on Saturday to bring the orders from Chennai to Bengaluru for a price of 4 rupees per kg.

To find total cost including the risk we need to compute the cost of those order in those cities including the risk of 2%.

For Tuesday: Hyderabad to Bengaluru

1. Cost without delay: 98 ₹
2. Cost with delay: 2*98 = 196 ₹

Real cost inc. delay: 98 * 98% + 196 * 2% = 99,96 ₹

For Saturday: Chennai to Bengaluru

1. Cost without delay: 94 ₹
2. Cost with delay: 2*94 = 188 ₹

Real cost inc. delay: 94 * 98% + 188 * 2% = 95,88 ₹
Using these new values for Hyderabad on Tuesday and Bengaluru on Saturday we can compute the total weekly cost including the risk of delay.

Total costs inc. Delay = 4.167.048,00 ₹

In conclusion we see that even by considering the risk of delay and the payment of penalties due to road transportation our new consolidation approach provides a reduction in cost for DHL Global Forwarding.

Question 5:

What would be your suggestion to Datta? Any other models that you would suggest? And how would this impact your LP model and results?

The consolidation program is based on a delivery of 2 business days which is one of the hypotheses of the model (meaning that order of Saturday and Monday are shipped Tuesday, those of Tuesday and Wednesday are shipped Thursday, …). One suggestion would be to change this schedule by being able to delay the shipping day to 6 days. This means that order that had to be shipped on Tuesday can now be ship Thursday, Saturday OR the next Tuesday.

By doing this, DGF can even more decrease their costs (see excel sheet 5). We do a linear programming model using the same reasoning as for the excel sheet 3. The difference is that now we can ship later than before. Warehouses can now at maximum accumulate quantities for 6 days and then ship them the 7th day.
This modification needs a modification in the constraints:
- The quantity received in a city must be totally shipped no more after 2 days but in the week. So, the demand of Hyderabad must be equal to 8400 kg, the demand of Bengaluru must be equal to 15000 kg and the demand of Chennai must be equal to 21000kg. Otherwise, the demand won't be satisfied. (Vertical axis of the matrix).
- The final volume shipped by a city for the whole week must be equal or lower than 44400 kg (8400 + 15000 + 21000). (Horizontal axis of the matrix)

We ask solver to minimize the cost cell in green and the total weekly cost is 4.038.000 ₹.
We see that for Hyderabad the best option is to accumulate from Saturday to Friday all the quantities and then to ship them the next Saturday. For Bengaluru, accumulation of quantities Saturday and Monday and we ship them on Tuesday, and then we accumulate the quantities of Tuesday until Friday and we ship them Saturday. For Chennai, we accumulate from Tuesday to Monday and then we ship them on Tuesday.

This alternative Forwarding program might reduce cost even further but comes with greater waiting times for the clients. We must keep in mind that shipping within 6 business days instead of 2 could cost us some client and therefore maybe our profit would not rise in consequence. Before implementing such a strategy, DGF should do an analysis of their costumer's sensitivity to those aspects to be sure that this change will only rise the group's profits.