Evaluation of Different Delivery Policies in the Cement Industry

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Summary: This study explains how we can improve the delivery policy in the cement. We have studied the case where a cement company, Votorantim Cimentos, wants to sell smaller orders and seeks a delivery policy to address this challenge. To tackle this problem, we developed a methodology to analyze different delivery policies. Our methodology includes a simple heuristic to determine when each order is going to be shipped. After assigning each load to a truck we can calculate the transportation cost and the penalty costs. Using this methodology, we run different possible delivery policies and analyze the results.

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KEY INSIGHTS

1. Simple delivery policies can drive significant savings in transportation cost in a commodity industry such as the cement industry.
2. The efficiency of a given policy is highly correlated with the demand of each region.
3. This project presents a cutting-edge business case illustrating how supply chain is increasingly becoming the backbone of companies.

Introduction

The cement industry is one of the oldest and most traditional industries in the world. Archeological evidence suggests that cement was used in 7000 BC (Global Cement, 2011). The industry is also economically relevant in a global context, as it is valued at approximately $450 billion (Birshan, 2015).

Cement is a substance that binds other inert materials together. The most common type is Portland Cement, which is the basic component of concrete, the fundamental material for construction.

Cement production can be divided in two stages. The first stage, see Figure 1, consists of heating limestone (80%-95%) with clay (20%-5%) and small quantities of iron in a kiln, which results in a hard substance called clinker. In the second stage, clinker is ground with small amounts of gypsum and, eventually, some additives to make Portland cement.

Figure 1. Pair of cement kilns.

Votorantim Cimentos is the sponsor company for this project. It belongs to Votorantim Group, one of the largest industrial conglomerates in Latin America, operating in various sectors such as finance, energy, cement, iron, steel, pulp and paper. Votorantim Cimentos is the largest cement company in Brazil and the eighth largest in the world

The challenge

The cement industry in Brazil went through rapid growth during 2009-2013, reaching peak production in 2014. Since the economic recession hit Brazil in 2015, cement consumption started to drop year after year, leading to a scenario with high idle capacity in the cement plants.

In order to succeed in this new environment, cement companies had to adapt their strategies. One new challenge is demand for smaller delivery sizes. Companies used to sell only full truckloads (TL), 14 tons or 7 pallets. Now they are selling smaller orders to gain new markets. Since their supply chains are not designed to support this operation, companies are facing problems such as very low, sometimes negative, margins due to high transportation costs for these type of deliveries. In addition, this context led to another problem where operational units (plants and DCs), trying to reduce the transportation costs, started to delay deliveries to consolidate small orders into economical shipments. This practice has led to a drop in on time in full deliveries (OTIF) and lower client satisfaction.

It is important to emphasize that these two problems, smaller order size and high transportation costs, are interrelated. If the transportation costs keep increasing, the business will not be profitable and then it will not be possible to expand into the small orders market. The challenge here is to lower transportation costs while maintaining a high level of service.

Possible solution

One way to solve the problem is to define a policy that links the committed delivery promises and the ordering process. A policy where the sponsoring company would deliver only some days of the week. By implementing this constraint, we align expectations with the customers about when they are going to receive their products, and they can organize their supply chains to receive cement on the assigned days.

By implementing such a delivery policy, we expect to see many possible upsides:

• Lower total and per pallet transportation cost due to higher occupancy
• Higher margins
• More clients eligible to place small orders, leading to higher volume of sales
• High on time deliveries

The policy does add more rigidity to the system in the initial step (by constraining deliveries to certain days), but in the medium term, it will allow the “small order model” to grow, leading to more flexibility regarding order sizes.

To identify the best policies, we propose two algorithms.

The Naive Algorithm

We develop an algorithm to evaluate different delivery policies. The algorithm has three main tasks: (i) assign a final delivery date for each order, (ii) calculate the penalty cost for each order, and (iii) calculate the transportation cost.

The first task is the most challenging. The question of when an early or a late delivery should be made can become very complex depending on the assumptions made. The second task is simple: identify whether a shipment is late or early, how far the delivery date is from the requested date, and then calculate the penalty cost. The third task involves calculating transportation costs. These costs are a function of the number of orders for each region.

Table 1 shows how the Naïve Algorithm assigns the final delivery date and the penalty cost.

Table 1 Summary of possible delivery cases, the condition for each to happen, and the penalty costs associated.

	Case 1 – On time	**Case 2 - Early**	**Case 3 – Late**
Condition	$RD_i \in A$	$RD_i \notin A$ **AND** $OD < ED$	$RD \notin A$ **AND** $OD \geq ED$
Penalty cost	$C_i = 0$	$C_i = N_i * abs[FD_i - RD_i] * CED$	$C_i = N_i * abs[FD_i - RD_i] * CLD$
Final Delivery Date	$FD_i = RD_i$	$FD_i = ED$	$FD_i = LD$

ODi = date when the ORDERi was placed, RDi = requested (by the customer) delivery date for ORDERi, FDi = final delivery date for ORDERi, Ni = number of pallets of ORDERi. CED: penalty cost of early delivery per pallet per day. Unit: R$ / pallet / day.CLD: penalty cost of late delivery per pallet per day. Unit: R$ / pallet / day. Ci: penalty cost (late or early) per order. Unit: R$.

Once we have assigned a final delivery date to each order, we can calculate the transportation cost by multiplying the number of trucks needed per region per day by the delivery rate. The number of trucks needed is the sum of all orders for the same region with the same final delivery date divided by the truck capacity.

Threshold Algorithm

The second algorithm, the Threshold Algorithm, is a modification of the previous algorithm including a subsequent step. The Naive Algorithm assigns early delivery whenever it is possible. However, often this is not the best decision. For example, we allow deliveries only on Tuesdays and Thursdays for a given region. On a Tuesday, we could have only one order of one pallet booked to be delivered Wednesday. In the Naive algorithm, we would ship this order on Tuesday. However, it could be more interesting to hold this order and deliver it late on Thursday with all the possible orders from Wednesday and Thursday. To avoid costly early deliveries like this, the Threshold Algorithm has a second stage to identify:

• Days where we are making only early deliveries for a given region;

• Days where the sum of the early deliveries for a given region is less than β, the minimum threshold for early delivery.

The orders that we defined as early deliveries in the first phase and that fit the criteria mentioned above will be delivered late, FDi = LD. The dashed arrow in Figure 2 illustrates how it works.

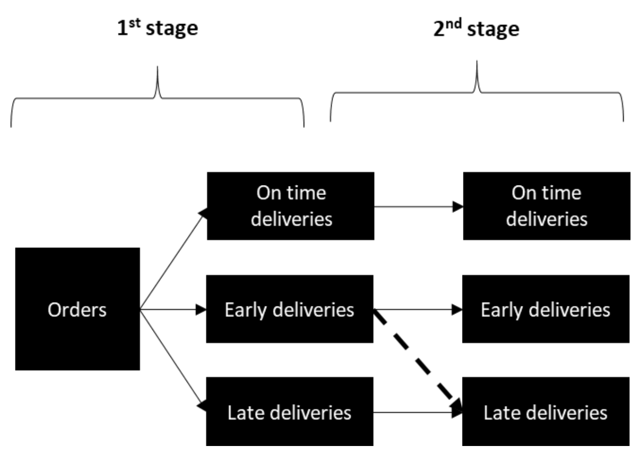

Figure 3 Effect of the second phase.

Conclusions

We used simple heuristics to evaluate different delivery policies, and this methodology led to consistent results. The first analysis showed that applying the same policy for all regions can reduce the transportation costs, but we increased the penalty costs compared to an everyday delivery policy. In this case, the increase in penalty costs were more relevant than the decrease in transportation costs. As a result, the total cost increased by 8%.

When we used the best historical policy for each region, we achieved a result where the extra transportation costs were 77% lower than the everyday policy. In this case, we had a reduction in the total relevant costs by 31%.

We analyzed that the threshold is more efficient in regions with a medium demand (it is not very effective for either large or small regions). Compared to the base case this algorithm led total relevant cost was 2% lower.