Case Study: Optimizing Delivery Scheduling at a Large Restaurant Chain

By Michael Liebson, Curtis Ying and Chao-Ming Ying

EXECUTIVE SUMMARY | Supply chain organizations typically plan purchase orders without regard to distribution center receiving capacity on planned delivery dates. This leads to bottlenecks on some days and underutilized labor on others. In this case study of a $10B+ quick service restaurant chain, a novel methodology we call Master Purchasing Receipt Scheduling (MPRS) provides a solution. The methodology schedules deliveries at the time of purchase order creation, resulting in a steady volume of deliveries and lower planning and logistics costs.

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Supply chain organizations typically plan purchase orders (POs) by forecasting demand and then creating a purchasing schedule using an ordering policy such as reorder point or min-max. Such ordering policies consider parameters like order lead times and safety stock requirements. However, this approach rarely takes into account whether there is enough distribution center (DC) receiving capacity to receive the ordered items on the scheduled delivery dates, taking into account the available loading docks, material handling equipment, and receiving staff. This results in significant variations in daily delivery volume, with logjams on some days and underutilized capacity on other days, a sure sign of inefficiency. Given the increasing prevalence of high-velocity DCs, this represents a real blind spot in supply chain practices that is increasingly causing disruptions and inefficiencies in inbound logistics for many manufacturers, wholesalers, and retailers.

Working with one of the top quick service restaurant (QSR, also known as fast food) chains in the U.S., we developed a novel solution to this problem that we call Master Purchasing Receipt Scheduling (MPRS). Just as manufacturing organizations use the well-established process of Master Production Scheduling to plan production in a way that respects manufacturing capacity constraints and aligns supply and demand, MPRS plans POs to align the supply and demand for DC receiving capacity. This methodology is now in production at the QSR chain. While the development of this methodology was prompted by the needs of a QSR chain, it addresses a problem that is broadly relevant to any business with an interest in reducing DC receiving bottlenecks and increasing cost efficiency.

THE MISMATCH BETWEEN SUPPLY AND DEMAND FOR DC RECEIVING CAPACITY

Mismatches between inbound delivery volume and available receiving capacity are a significant problem. A 2019 study published by the American Transportation Research Institute (ATRI) showed that for 49% of warehouse visits (both inbound and outbound shipments), drivers have to wait over two hours before loading or unloading their trucks. Waits can be quite a bit more, with waits of 4-6 hours 14% of the time and 6 or more hours 9% of the time. Note this was just before the pandemic, so none of this was caused by the supply chain hiccups of the last few years. While the ATRI study lumped together inbound and outbound shipments, in our experience the problem of inbound receiving is a thornier challenge. This is because outbound shipping receives more management attention since it is a customer-facing activity.

As the ATRI study indicates, inadequate DC receiving capacity results in bottlenecks at the receiving docks. For transportation operations, this increases labor costs, decreases truck utilization, causes problems with federal hours of service compliance, and interferes with downstream appointments. For the receiving company, bottlenecks can lead to material shortages, contractual detention penalty fees levied on the buyer, cutting corners in the receiving process, and worker injuries.

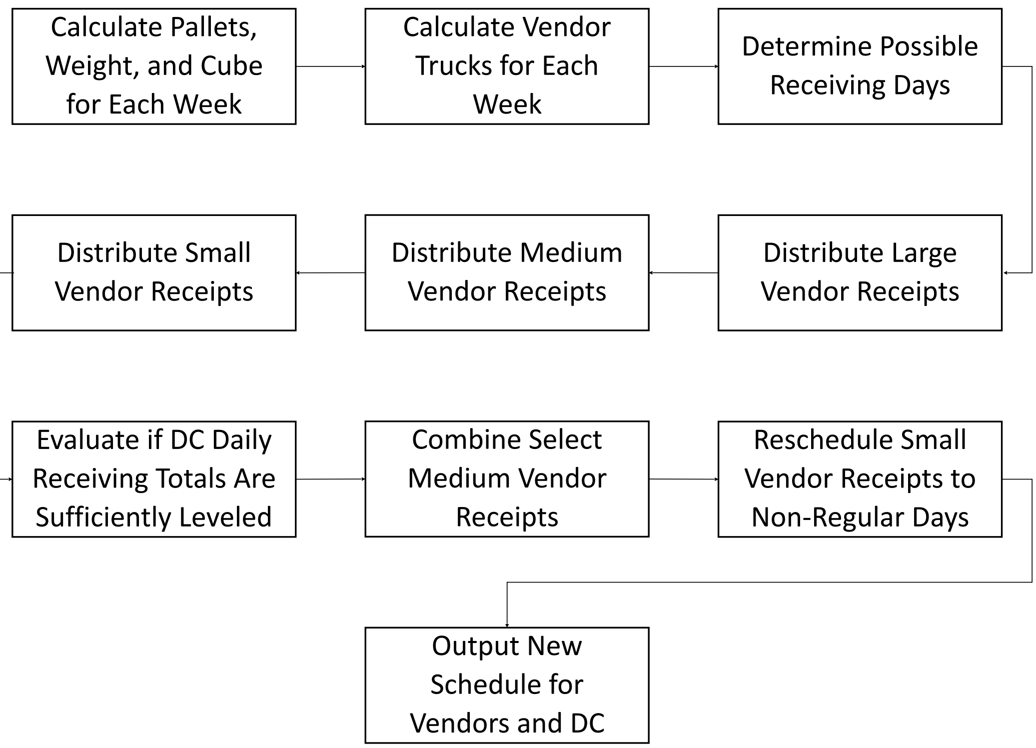
Just as there are days when there's not enough receiving capacity, there are also days when there's too much. In this situation, the receiving company suffers from the inefficiency of having idle workers and low resource utilization, which decreases profitability.

THE CHALLENGE AT A $10B+ QUICK SERVICE RESTAURANT CHAIN

The restaurant chain that is the subject of this article is an iconic QSR chain with over $10B in system-wide sales. They procure hundreds of food and non-food items for a network of DCs that supply thousands of their restaurants across the U.S.

Prior to implementing the new MPRS solution, the company's supply chain systems would generate POs in a way typical of most companies. Delivery dates were planned for when products were needed, on a just-in-time basis, without taking into account DC receiving constraints on a given day. Like many companies, the QSR chain uses calendars with designated receiving days of the week for each vendor. Usually, the number of days available to a vendor depends on the quantity of goods being delivered, the vendor's workdays, and the receiving DC's workdays. Buyers place POs with the vendors several weeks ahead of time and communicate the desired delivery dates. Because there was no explicit process for matching daily delivery volume with DC receiving capacity, the receiving workload on a DC could swing significantly from day to day, causing bottlenecks on some days and underutilization of resources

Figure 1 | **MPRS Algorithm**



and staff on other days. The problem was particularly bad during holiday weeks, when schedules had to be adjusted to adapt to vendor and DC shutdowns.

To minimize bottlenecks and inefficiencies, the QSR chain had a manual process to adjust the delivery schedule to account for warehouse receiving constraints. However, fluctuating product demand and holidays made smoothing out delivery volumes a time-consuming process with suboptimal results. In the QSR chain's case, they had a senior Planner spend a quarter of their time manually replanning deliveries. The company wanted to have an automated process to optimize delivery planning and eliminate the time, cost, and inefficiencies of manual replanning.

A NEW APPROACH: MASTER PURCHASING RECEIPT SCHEDULING

To automate the planning process in a way that optimally matches delivery volume with receiving capacity, we developed the MPRS methodology. MPRS is used to schedule delivery dates at the time of PO creation. The goal is to minimize bottlenecks and maximize labor utilization by planning a steady volume of deliveries to match receiving capacity over the course of the week. MPRS must consider various factors, such as vendor shipping calendars, DC receiving calendars, shipment sizes, and the inherent unpredictability of transportation. This is conceptually similar to level loading in a manufacturing context. Note that MPRS should not be confused with dock scheduling. Dock scheduling is a short-term scheduling process for transportation providers to select a specific delivery time slot shortly before a driver departs to make a delivery. It is an important process but happens too late to play a role in matching daily delivery volume with receiving capacity.

Figure 1 above outlines the MPRS algorithm for leveling delivery volumes across the days of a week. MPRS starts by calculating weekly vendor shipments in terms of pallets, weight, and cube. Next, MPRS converts these figures into the number of trucks required each week for each vendor. It then categorizes the vendors as large, medium, or small, based on the number of trucks. Lastly, MPRS calculates possible DC receiving days based on each vendor's available shipping days, the transit time, and the DC's workdays. MPRS offsets and balances the DC's workload—spreading out deliveries, starting with large vendors before identifying time slots for medium and smaller vendor deliveries within the constraints of daily receiving capacity. Through iterative refinements, MPRS reduces daily intake variance to promote the most efficient receiving schedule possible.

PERFORMANCE UNDER A WIDE RANGE OF REAL-WORLD CONDITIONS

Because of variations in order quantities and transportation performance, the new algorithm needs to level deliveries in a wide range of circumstances. To test the robustness of MPRS, a Monte Carlo simulation of 1,000 trials was tested by varying each vendor's number of trucks between 90% to 110% of the original value and restricting vendors to deliver only on days available in the new receiving calendar generated by the algorithm.

The results of the simulation demonstrated that the algorithm held up under a wide variety of conditions. The random variation of +/-10% in vendor order quantities produced a schedule with a maximum daily variation from the mean (for the 1000 trials) in truck volume of 12% and a mean variation of 7% vs. the average daily volume, indicating that the daily volume was fairly level. A simulation during a holiday week (the week of July 4) yielded higher but acceptable variability in daily truck volume, as the maximum daily variation from the mean was 13%, with a mean variation of 8% vs. the average daily volume. An analysis of pallet volume yielded similarly acceptable results.

RESULTS

In developing the MPRS methodology, we established three criteria for an effective planning system: consistency, accuracy, and adaptability. The methodology is now in production at the QSR chain and has proven itself with respect to these criteria as follows:

Consistency: Because the algorithm follows the same logic and optimizes each week separately, the results for each week are consistent.

Accuracy: As shown in the previously-mentioned Monte Carlo analysis, the algorithm produces receiving schedules that can generally account for variability in truck volume and transportation performance without significantly impacting the leveling across DC workdays, though some manual balancing may be necessary for extreme cases.

Adaptability: Since the algorithm uses several inputs, such as workdays and delivery preferences, it can easily adjust and create new schedules for a variety of situations.

While the methodology is not without limitations, it has made a tremendous impact on inbound delivery scheduling at the QSR chain. The algorithm can be easily run using existing data in the company's software systems, and the process has been automated to produce schedules weekly. By automating the process, MPRS has consistently saved 8-12 hours each week (about 500 hours per year) for the lead Planner, depending on the demand variation and the number of holidays. The resulting plans reduce bottlenecks at DCs, increase DC labor utilization, and thus significantly reduce overall receiving costs.

CONCLUSION

Taking into account DC receiving capacity when placing POs is not common practice, but it should be. It can play a vital role in ensuring smooth and efficient inbound logistics. This paper introduces a novel methodology we call MPRS that optimizes the scheduling of PO delivery dates. The methodology helps level DC receiving calendars while accounting for holidays, transportation uncertainty, and vendor and DC workdays. While described here for a large QSR chain, the methodology is sufficiently flexible to work for a wide range of retailers, wholesalers, or manufacturers operating high-velocity DCs.

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