By applying a combined set of Lean Six Sigma tools, Kroger GLRDC was able to optimize store-to-store routings to not only route more efficiently, but also increase the number of in-store deliveries; an unconventional approach to a common logistics problem.

Define

The opportunity for logistic-based growth at Kroger Great Lakes Distribution Center (GLRDC) seemed huge. Most of this assumed growth came from observations of occurrences where we would route multi-store orders together and travel large and seemingly unnecessary amounts of miles between stops. Hence one of the pain points for the organization and a good starting point; we really didn’t have a way of measuring the efficiency of shipping routes.

One of the initial key elements to the success of this project would be the prevalence of great information and union from stakeholders and subject matter experts. Putting a team together that included SME’s from our routing center would prove to be critical as we currently route all orders from an off-site location. We had representation from routing, logistics on our end as well as complete supply chain support.

Because we were unaware of our routing’s current performance, the initial goal of the project was to strive to lean out the waste of inefficient routing while also examine the potential effects of cross docking some commodity products. However, as the project progressed, the opportunities also progressed.

In terms of project scoping – this project looked at 12 Kroger Stores located in the Ohio/West Virginia Valley. The project was in a sense, an alpha test with the potential to affect all other 249 stores serviced by our DC. One of the main deliverables for the sponsor was not only a toolset for measuring efficiency, but also a complete analysis toolset for isolating and eliminating inefficient routing across our service region.

To begin to understand a systematic picture of the opportunity, the team began to map the complete value stream and also complete high level SIPOC diagrams. With input from our SME’s, the team began to understand the process of route creation and identify what part of the value stream our project would affect.

Another key element to the project’s success was understanding the needs of our internal and primary customer; 12 valley stores and their management. These stores are the direct recipient of our product in its travel downstream to the consumer. VOC collection tools such as CTQC diagrams were employed which identified some critical deliverables:

- Right Quantity of Right Product Type
- Shipments Within Delivery Window
- Delivery at Lowest Possible Cost
- The More Deliveries the Better (Product Visibility and In-Stock Position)

We also identified a lot of pain points for stores such as the un-timeliness of specific commodity products, uncontrolled in-stock inventory levels which lead to cramped store back rooms.

Looking at some initial metrics and comparing that to preliminary target levels, we expected there to be a $248,000 opportunity in decreased transportation costs for these stores by routing more efficiently, i.e., a reduction in trips needed and mileage traveled.
The first step in the measure phase of this project was to move from our “gut feel” on routing efficiency and create a measurement system to quantitatively tell us just how efficiently we’re routing.

One of the great things about this project was the availability of data. We were lucky to have specific routing data for each route driven to and from each store for roughly the past 6 months. However, this data came at a price; some of it overlapped with other sources and some of the data was inconsistent which brought about the need for gage R & R testing. Luckily, the specific sequences of routes turned out to be consistent from gage testing (0% Variation) – unfortunately we were not able to use our OTD data (arrivals and departures) from the results of the gage study.

The next step in this phase was the movement from trustworthy and intensive data to a meaningful interpretation with regard to routing efficiency. We began by identifying two distinct routing zones in the Ohio/West Virginia Valley, a Northern zone (Zone 1) and a Southern zone (Zone 2).

This segmentation of routing zones gave us the ability to actively measure occurrences when we were routing between zones. Operationally, a routing occurrence when we would route between these two zones is classified as an “undesirable route”. However, by classifying a defect as any occurrence where we route between zones, we would be missing out on other pertinent routing information if we want to consider overall routing efficiency.

After much team brainstorming, we operationally defined average weekly routing efficiency as a measure involving 5 different routing parameters:

- Average Truck Cube Utilization
- Average Daily Trips Made to Valley
- Average Mileage Between Stops
- % of Routes Driven Undesirable
- % of Stop Mileage Undesirable

These performance measures were created specific to this unique situation in which we have two different visible geographic zones. Each of these metrics was assigned target or optimal values that the team decided on and their current performance gave us a % of optimal. Similarly, total weekly routing efficiency is an average of its 5 metric sub-components. On a macro level, this metric gave us a quantitative representation of routing efficiency, and would serve as a good indicator of how the system was performing in relation to the business’s desired performance levels.

The final step in the Measure phase was to begin to do some cause and effect analysis as well as a fishbone diagram to get some initial thoughts on the table and lead in to the Analyze phase. This analysis led to some important topics and questions for Analyze:

- Interaction effects of Outputs/Inputs?
- Effects of Cross Docking?
- What Routing Inputs are Significant?
Analyze

The first step in the analyze phase was to map a more detailed version of the process – an explosion of detailed processes built off of our initial high level value stream. By better understanding the inner-workings of route creation we noticed immediately that there was a large amount of manual route creation. Routers would “massage” the output from our routing software as our DC’s constraints would overload our optimization software. Given some of the issues found in our pre-analyze fishbone such as the individual router’s time demand and experience levels, the manual adjustment of routes immediately became a failure mode for inefficient routing.

However, given input from the team and our SME’s in routing – there was more to the story. Routers are trained to create routes that minimize mileage traveled. The software package also aims to minimize overall travel mileage – thus there must be other input’s that are effecting the efficient creation of routes.

The next step the team took was the completion of a detailed gap analysis on our current versus prospective future state. Because our primary metric is comprised of 5 equally weighted sub-performance metrics, we needed to know what was bringing our average weekly efficiency average down. As a visual tool, we created a box-plot showing weekly data averages of each sub-performance metric.

The metrics % of Stop Mileage Undesirable (% of total miles), % of Routes Driven Undesirable (%UR) and Average Mileage between Stops were immediately red flagged as problem areas bringing down our primary metric’s performance.

Next, a complete regression analysis was performed to examine the interaction effects between outputs. From this we found a high correlation between the number of undesirable routes driven, and average mileage between stops (p ≈ 0.000). Examining these interdependencies began to tell us a story of interaction – driving down the number of undesirable routes driven will positively affect all other metrics aside from truck cube utilization.

At this stage in analyze, we wanted to do a much more detailed analysis on cause and effect in regard to customer deliverables and routing efficiency deliverables. The team created multiple cause and effect matrices to nail down those important inputs. Combined with findings from detailed process mapping and regression findings we nailed down 3 critical inputs:

- Manual Route Adjustment/Software Limits
- Delivery Window Constraints
- Scheduled Delivery Constraints

As we examined the relationship between the stores scheduled deliveries and their delivery windows, the team began to have a breakthrough – regardless of human or software-based routing, we can only route multiple stores together if they are both getting shipments, and are in complimentary delivery windows.

After examining a visual breakdown of day-to-day scheduled shipments and delivery windows, we immediately saw the root causes for our inability to route to stores within zones – there was little opportunity to route stores in zones together!

For further confirmation, the team put together pilot tests, changing critical inputs to see what effects this would have on our performance measures. We immediately noticed large shifts thus further confirming our critical inputs.
At this point, the team had developed a breakthrough in analysis and came up with two critical inputs – delivery window structure and scheduled deliveries for our 12 stores. We knew that changing these inputs resulted in significant changes in our primary metric. However, we didn’t know what the right combination of windows and deliveries would be to most positively impact our primary metric. Thus, the team developed a series of pilot tests with varying combinations of delivery windows and scheduled deliveries to see what combination would have the best impact on routing efficiency.

We ended up trying 8 different pilot tests which helped us gain a relative understanding of the interactions. We found that by staggering delivery windows, we could control the way routing creates multi-stop shipments. Those stores expected to receive their goods first would have earlier windows, and we would align other stores later in a complimentary way to encourage routing in zones. We also had to factor in constraints such as stores that had to be routed last due to dock-related challenges.

The next step was to factor in scheduled shipments. Simply aligning delivery windows was only half the battle – there could be (and were) instances where there were few, to no efficient combinations available because of the delivery schedule. We experimented with different combinations of schedules and happened to try one schedule where we put 6 of the stores on 7-day a week deliveries, and the others on 5+ deliveries a week, a 22% increase in scheduled deliveries. We actually received the most favorable results with this schedule which was completely unexpected by our team. We found that by increasing deliveries, we reduced the daily batch size and gave routing more options to route efficiently as they are trained to do. We also noticed a significant increase in truck utilization as there were more combinations of multi-store orders available to combine.

One un-answered question that still lingered was that of cross docking. This was a potential solution element expressed prior to the start of the project and it needed examination as this was important to our sponsor. A complete investigation went into examining all interactions that cross docking of product, specifically our drug GM and bread product, would have from an operational, routing and financial perspective. We also piloted different solutions involving cross docking. We noticed that the added cross-docked product increased truck cube utilization slightly but also increased the overall number of stops required – thus increasing the average trip cost. However, there was a tremendous amount of mileage savings given the fact that trips could be routed to our DC and cross docked with product already going to the valley rather than direct valley trips.

The team conducted FMEA testing on these potential solution elements including the cross docking of product to represent failure modes and risk factors for these solutions. We finalized a set of solutions in 2 phases and created an implementation plan and action register for the completion of these solution elements. Phase 1 would be recommended to be implemented immediately while we expected phase 2 to require further analysis based on FMEA risk findings, ease of completion and cost.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Change Delivery Windows and Delivery Schedule</th>
<th>EOC</th>
<th>Time to Complete</th>
<th>Cost</th>
<th>Overall Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>Easy</td>
<td>&lt; 4 - 5 days</td>
<td>$0</td>
<td>85 - 90% of Target</td>
<td></td>
</tr>
<tr>
<td>Phase 2</td>
<td>Cross-dock drug GM and Bread Product</td>
<td>Medium</td>
<td>&gt; 30 days</td>
<td>$21,715</td>
<td>5 - 10% of Target</td>
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</tbody>
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Control

The control phase of this project involved providing the sponsor with not only a way of ensuring process sustainability, but also a complete analysis toolkit to implement a similar solution for all other stores serviced (249 remaining). The first step of this process was figuring out a way to shorten the amount of time required to analyze routing data. We created a series of Excel© Macro’s which gave us all pertinent routing information at the click of a button for a given week. This toolset could be easily replicated by swapping out different store numbers. What took the team a month in terms of data collection, now took us less than 5 minutes with the creation of this macro.

Another toolset that we created was a map-based visual which aimed to show weekly route inefficiencies. This tool would also serve as a strategic design tool which would help us isolate other service districts we could apply the same zoning methodology to. By using another set of Excel© macros we were able to extract daily routing data in a form that would let us overlay a polygon-based drawing layer for each specific route. The polygon-based line gave us the ability to see shading between those routes in which we were traveling undesirable (non-linear) distances from the DC.

The final aspect of our control plan involved a metric retrieval document in which team members were required to update each weeks updated performance metrics and compare that to the previous weeks. This would serve as a quantitative measure of control and team members would be prepared to respond to a situation in which the system’s metrics began to drift out of control.

Upon implementation, the system realized an immediate positive shift (+27%) in terms of our primary metric, weekly average routing efficiency. Continued performance at these levels would warrant an expected $265,000 in reduced transportation costs for 12 stores in the Ohio/West Virginia Valley. Because of the pilot’s success, we expect to roll out a similar zone-based routing plan for full implementation across all remaining 249 stores regionally within the next 6 months.

Aside from the direct financial reward, we have been able to increase in-store deliveries by 22% driving a Just-In-Time supply chain mentality and heavily decreasing the amount of in-store inventory. We hope this lean focus will pay dividends in terms of decreased out-of-stock levels and drive a routing system that makes frequent, smaller batched, fresh deliveries to its service region.

Kroger is extremely excited about the ramifications of these results. It’s uncommon practice to realize so much benefit by increasing in-store deliveries! A combined lean/six-sigma toolset gave us a systematic approach to solving a common routing conundrum and provided real results for our organization.

Future District Possibilities