Development of Optimization Algorithms for upstream logistics at Renault

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1 Introduction

The industrial environment is becoming increasingly complex for different reasons such as : the diversity of suppliers sourcing in terms of distance and type of transport, diversity of vehicles and mechanical components, and requests to change the schedule of production. In this context, with also 38 factories worldwide, Renault inbound logistics, i.e. supplying Renault factories with parts, represents a major economic challenge for Renault.The current process of defining Renault's upstream transport plan is not optimal. This process is done manually through the expertise of Renault Transport Planners (RTP). Thus, Renault seeks to optimize its inbound transport plans, hence significantly reducing the transportation costs.

2 Problem description

Renault factories are supplied with parts by several hundred suppliers that are dispersed geographically throughout Europe. Based on the forecast volumes, the geographic location of suppliers and factories, and operational constraints, Renault must define its inbound logistic transport plan. This transport plan collects all parts from these suppliers and transport them to Renault factories while seeking to minimize the total logistic costs. The transport plan is composed of two flows : (i) Direct and (ii) Indirect. The direct flow (Milk-run and mono-suppliers flows), is a route with one or more loading point (suppliers) to one or more unloading points (factories). On the other hand, indirect flow is a pick-up from several loading points (suppliers), to a cross-dock, then from the cross-dock to one or more unloading points (factories). The process of defining the transport plan ends with the contractualization of the FCC (Fiches Caractéristique Circuit), which define the possible routes per day of the week with the transporters.

3 Existing Renault Approach vs Algorithm Approach

Existing Renault approach The actual process of creating the FCC is done manually through the expertise of RTP.

Proposed solution approach We propose a three-phase heuristic optimization algorithm. We call it Clustering-First-Routing-Second-Scheduling-Third Algorithm. In the Clustering phase, an integer linear programming was developed to assign suppliers to clusters while minimizing the distance between the suppliers and the centroids of the clusters and the total number of vehicles required for all clusters. In the Routing phase, the MIP decides for each cluster,the suppliers that are in direct flows (Milk-run or mono-supplier) or indirect flows (assigned to a Cross-dock) knowing its forecast volume and the distances, the various variable and fixed costs subject to Renault operational constraints. Finally, in scheduling phase, after obtaining the routes, the third phase consists in assigning routes to days in the week, in order to minimize the maximum number of daily routes that are assigned to a day. After obtaining the initial Clustering - Routing solution, a post-treatment procedure is developed in order to improve the current solution. The procedure considers the suppliers that were assigned to cross-docks and have more than 2 ML in volume, try to insert these suppliers in different clusters according to priority rules.

4 Computational Experiments & Results

To test the efficiency of the developed algorithm, we tested it on a SOVAB plant in Batilly over the demands of the weeks 8 to 11 of year 2021. The case study contains 330 suppliers in Europe. To compare the Algorithm results with the current approach, two criteria were used. First, the total transportation cost (Direct and Cross-dock). Second, various KPIs such as the number of canceled and overhangs vehicles, vehicle filling rate, etc.

4.1 Comparison method with Renault approach

The process of calculating the real transportation cost is shown in the figure below.

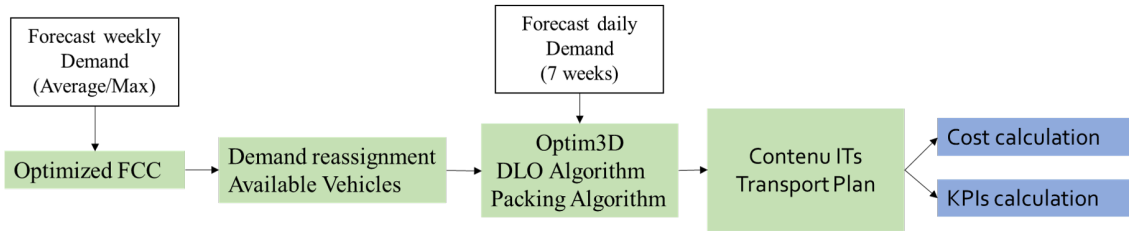

FIG. 1 – The process to calculate the final cost and KPIs.

The table below shows a comparison of the total direct and cross-dock costs between the existing Renault approach and the Algorithm approach on the study case data.

	Renault approach		Algorithm Approach	
	Direct Cost	**Xdock Cost**	**Direct Cost**	**Xdock Cost**
Total cost	2 598 419,954	35 354,954	2 597 721,072	20 983,97939

TAB. 1 – Comparison between Renault and Algorithm approach.

5 Conclusion & Future work

The preliminary results show an improvement in the total transportation costs. Furthermore, for future work,first several parameters must be tuned (for instance the maximum number of suppliers in one cluster). Second, we should include parameters, constraints and objectives with respect to the operational planning (advance of demands to optimize the truck loading). Finally, test the algorithm on other Renault plants.