EURO – Lisboa 2010

An ILS to solve a Multiobjective Integrated Distribution Problem

Helena R. Lourenço

Universitat Pompeu Fabra
Barcelona, Spain

Centro de Investigação Operacional, FCUL
Lisboa, Portugal

helena.ramalhinho@upf.edu

Angel A. Juan

Universitat Oberta de Catalunya
Barcelona, Spain

ajuanp@uoc.edu

Rita Ribeiro

Catholic University of Portugal (Porto),
Porto, Portugal
Indera, Estudos Económicos Lda., Porto,
Portugal

rmribeiro@porto.ucp.pt

UNIVERSITAT POMPEU FABRA

1

EURO – Lisboa 2010

Outline of the Presentation

- Motivation and introduction
- Three different strategies for routing
- The iterated local search approach
- Some computational results
- Conclusions and directions of future work.

UNIVERSITAT POMPEU FABRA

2

EURO – Lisboa 2010

Distribution Strategy trends

- Better customer service
  - Deliveries on time and right quantity.
  - Better customer relationship.
- Just-in-time distribution
  - Less quantity.
  - More frequent deliveries.
- Easy ordering systems
- Integrated SCM
  - With customers providers.
  - With other functions inside firm.
- Reduce costs
  - Transportation costs

Distribution Management and Marketing Management

UNIVERSITAT POMPEU FABRA

3

EURO – Lisboa 2010

Motivation and Introduction

- Transportation / Logistics
  - One of the largest logistic costs.
  - Significant part of the price.
  - Adds value when products arrive on time, undamaged, and in the required quantities.
- Marketing & Sales
  - Drivers perform sales activities too.
  - Customer orientation and interpersonal relationship may reinforce the quality-loyalty linkage (Chao, Fu & Lu 2007).
  - The literature of service marketing has continuously emphasized the importance of human interactions in the process of service delivery

UNIVERSITAT POMPEU FABRA

4

EURO – Lisboa 2010

Motivation and Introduction

- Research question…

What is the best strategy for an efficient distribution?

UNIVERSITAT POMPEU FABRA

5

EURO – Lisboa 2010

Motivation and Introduction

- Define the distribution strategies.
  - Three different strategies are proposed.
- Optimize each different strategy.
  - Use the same tool for a fair comparison.
- Analyze the impact of integrating two areas of the firm.
  - Distribution / Logistics and Marketing.

UNIVERSITAT POMPEU FABRA

6

EURO – Lisboa 2010

Motivation and Introduction

- Food & Beverages industry.
- Customers order 2 or 3 times a week.
  - Demand is known in advance.
- Actual system…
  - The same driver goes to the same customers always...
    * A personal relations between driver and client speeds up the delivery process and improve the sales.
    * Most common applied distribution strategy (Ribeiro, 2004)

UNIVERSITAT POMPEU FABRA

7

EURO – Lisboa 2010

The Distribution Strategies

- Strategy 1 – distance / transportation costs minimization
  - Lowest transportation costs (based on distance traveled).
  - Classical VRP repeated for each day of the planning horizon.

Typical OR approach

UNIVERSITAT POMPEU FABRA

8

EURO – Lisboa 2010

The Distribution Strategies

- Strategy 2 - Master routes
  - Each driver always serve the same customer.
  - Marketing principles: a close relationship between firm (driver) and customers adds value.
  - Easier to introduce new products, improve sales and speeds up the delivery process.
  - Obtain **master routes** for all customers and adjust the routes daily in function of the demand.

Common management approach

UNIVERSITAT POMPEU FABRA

9

EURO – Lisboa 2010

The Distribution Strategies

- Strategy 3 – Multi-Objective
  - Bi-objective and multi period approach:
    - Minimization of the distribution costs.
    - Minimize the number of times a driver is assigned to different customers during a period of time (a week).
  - Takes into account the two previous strategies.
  - Best solution to the transportation problem may conflict with the best solution to the marketing objective.

Integrated approach

UNIVERSITAT POMPEU FABRA

10

EURO – Lisboa 2010

The Distribution Strategies

- Strategy 3 – Multi-Objective
  - Minimize the number of times a driver is assigned to different customers during a period of time (a week).
  - Weighed by the customer sales.

$$Min \sum_{i=1}^{n} \sum_{k=1}^{m} \sum_{\substack{g,h \in T_i \\ g<h}} \left[\left(\sum_{t=1}^{p} q_i \right) \times \left| y^g{}_{ik} - y^h{}_{ik} \right| \right]$$

$$y_{ik}^t = \begin{cases} 1, & \text{if customer } i \text{ is visited by vehicle } k \text{ on day } t \\ 0, & \text{otherwise} \end{cases}$$

EURO – Lisboa 2010

The Distribution Strategies

- What is the **best** strategy to plan the distribution?
- How to evaluate these strategies?
- Common tool…
  - Heuristic methods based on Iterated Local Search

Use OR for Strategical Decisions

EURO – Lisboa 2010

The Iterated Local Search

- Iterated Local Search (ILS)
  - s_0=Generate Initial Solution
  - s*=Local Search(s_0)
  - Repeat
    - * s'=Perturbation(s*, history)
    - * s*'=Local search(s')
    - * s*=Acceptance Criterion(s*,s*',history)
  - Until termination condition met

UNIVERSITAT POMPEU FABRA

13

EURO – Lisboa 2010

ILS for VRP

- Iterated Local Search for VRP (Kunz & Stützle 2000)

1 - Savings heuristic – initial solution
2 - ILS for TSP on each tour:
  2.1 - Local Search for TSP
  2.2 - Kick move for TSP
  2.3 - Acceptance criterion
3 - ILS for the VRP
  3.1 - LS for the assignment problem
  3.2 - Kick move for VRP
  3.3 - Acceptance criterion
4 - ILS for the TSP on the new routes

UNIVERSITAT POMPEU FABRA

14

EURO – Lisboa 2010

Optimize each different strategy

- Strategy 1
  - ILS - VRP for each day of the planning horizon.
- Strategy 2
  - ILS - VRP obtain the master routes (all customer and average demand).
- Strategy 3
  - Modify the ILS - VRP to use a weighted function of both objectives.
  - Output all non-dominated solutions seen during the search.

UNIVERSITAT POMPEU FABRA

15

EURO – Lisboa 2010

Computational results

- Strategy 1 gives always the lowest transportation cost and highest objective B when compared with Strategy 2;
- In Strategy 2 costs of the routes increase significantly;
- In most of the cases we find more than 1 non-dominated solution;

UNIVERSITAT POMPEU FABRA

16

EURO – Lisboa 2010

Computational results

N	Example	Strategy 1 a	Strategy 1 b	Strategy 2 a	Strategy 2 b	Startegy 3 a	Startegy 3 b
50	4	11710,85	32341	15597,20	5950	11850,30	25753
						11811,55	31776
						11710,85	32341
						11788,70	32289
100	9	17062,82	70744	24874,82	5045	17236,27	59365
						17036,71	70838
						17220,50	69385
						17167,73	70579
200	13	38484,12	151187	49881,28	19803	38498,67	131916
						38423,13	150677

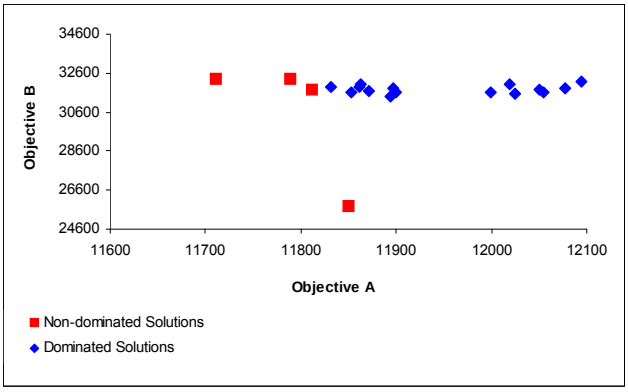
UNIVERSITAT POMPEU FABRA

17

EURO – Lisboa 2010

Computational results

- Set of all solutions obtained: dominated and non-dominated



UNIVERSITAT POMPEU FABRA

18

EURO – Lisboa 2010

Computational results

Number of vehicles

N	*Strategy 1*	*Strategy 2*	*Strategy 3*
200	135	167	135
200(cap=500)	80	99	81

Running Time

N	*Strategy 1*	*Strategy 2*	*Strategy 3*
50	146,19	2,32	142,40
400	3199,07	29,07	3088,93

UNIVERSITAT POMPEU FABRA

19

EURO – Lisboa 2010

Summary

- Three distribution strategies to analyze an integrated distribution problem
  - Classical VRP
  - Customer oriented
  - Multi-objective

Results from the integration process.

UNIVERSITAT POMPEU FABRA

20

EURO – Lisboa 2010

Conclusions

- The multi-objective model gives several non-dominated solutions which are a good balance between optimizing the transportation cost and customer service.
  - Solutions with business sense.
    - * Compromised solutions.
  - Importance of alternative scenarios.
- Decision maker decides based on his business needs.

UNIVERSITAT POMPEU FABRA

21

EURO – Lisboa 2010

Further Research

- Adapt the SR-GCWS-CS algorithm to solve previous problems (Juan et al. 2010).
- Improve running times.
- Multi-objective population based metaheuristics.
- Other objectives.
  - Inventories
  - Human resources department.

SR-GCWS-CS: SimoRouting Clarke and Wright's Savings with Cache an Splitting.

UNIVERSITAT POMPEU FABRA

22