UNIVERSITY OF THESSALY
SCHOOL OF ENGINEERING | DEPARTMENT OF MECHANICAL ENGINEERING

An exact algorithm for the **Stochastic Inventory Routing Problem** with **Transshipment**

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European Union
European Social Fund
OPERATIONAL PROGRAMME EDUCATION AND LIFELONG LEARNING
investing in knowledge society
MINISTRY OF EDUCATION & RELIGIOUS AFFAIRS
MANAGING AUTHORITY
NSRF 2007-2013
EUROPEAN SOCIAL FUND
Co-financed by Greece and the European Union

Transportation Research Board
94th Annual Meeting
January 11–15, 2015 ▪ Washington, D.C.

Introduction

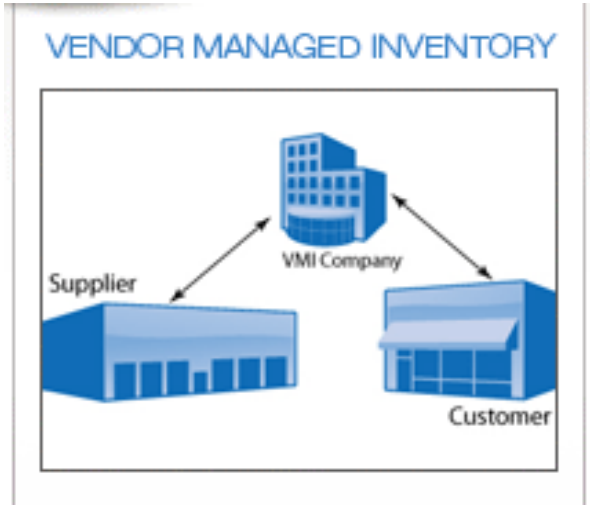
Vendor Managed Inventory (VMI) systems seems to be at the core of most global supply chains . **Inventory Routing Problem (IRP)** constitutes the backbone of the VMI systems.

Concept: The replenishment & the distribution making process is centralized at supplier level. Supplier acts as central decision maker. This policy leads to an overall reduction of logistic cost.

Advantage: More efficient resource utilization. Often described as a win – win situation.

Decision to be taken are:

1. **When** to deliver to each customer
2. **How much** to deliver to each customer each time it is served
3. **How to route** the vehicles so as to minimize the total cost.



Motivation

- Need of major electronics multinationals with production both in Asia and Europe and various warehouses throughout their global supply chain management for more **efficient** resource utilization .
- Need to adjust their operations to meet the requirements of their clients.
- Need to account the uncertainty of demand .

State of the art

The problem was first introduced by **Bell et al.(1983)** and **Federgruen & Zipkin (1984) .**

To the best of our knowledge there are two seminal papers regarding literature review on the IRP **Andersson et al.(2010)** related to business models and classification of problems and **Coelho et al. (2014)** related to methods and algorithms.

On the other hand **Geisen, Mahmassani and Jaillet (2009)** and **Rabah and Mahmassani (2002)** provide an excellent reference for applications of VMI policies with stochastic demand.

Bertazzi ,Paletta and Speranza(2002) introduced a practical VMI policy the deterministic Order – Up – to level policy.

Arhetti et al. (2007) developed the first exact method based on the OU-Policy.

Coelho & Laporte (2012) introduce the transshipment cost within IRP and developed an exact method as well as an ALNS metaheuristic for large scale instances.

Contribution

- Introduce a stochastic programming model for the IRP and propose an L – Shaped algorithm that efficiently solves the SIRP using transshipment as recourse action.

- Introduce new valid inequalities for the first stage decision process which accounting forthcoming time period demand to determine the delivered quantities

Methodology

A two stage stochastic programming model :

$$\min_x C^T x + E_\omega(x, \omega)$$

s.t.

$$Ax = b$$
$$x > 0,$$

where

$$Q(x, \omega) = \min_y d_\omega^{\mathrm{T}} y$$

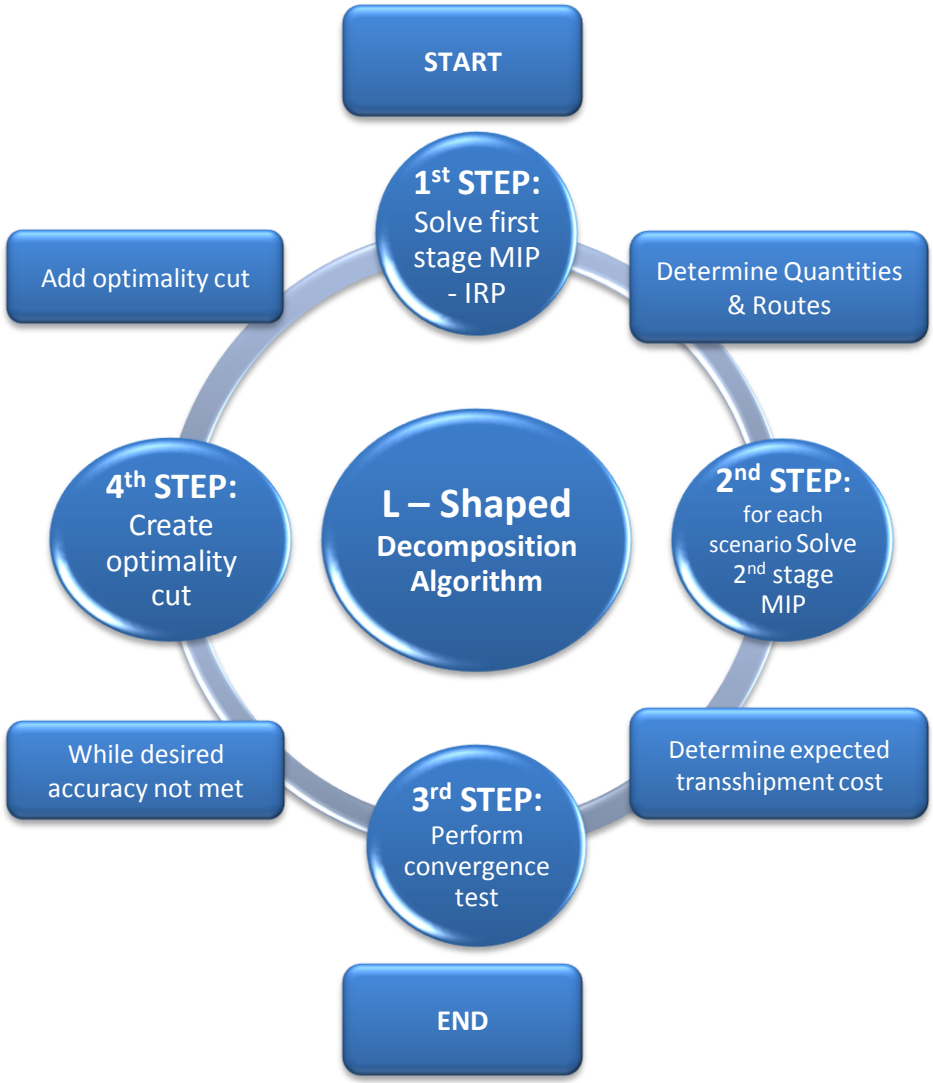
s.t.

$$T_\omega x + W_\omega y = h_\omega$$

$$y > 0.$$

First stage model constitute an mixed integer inventory routing problem

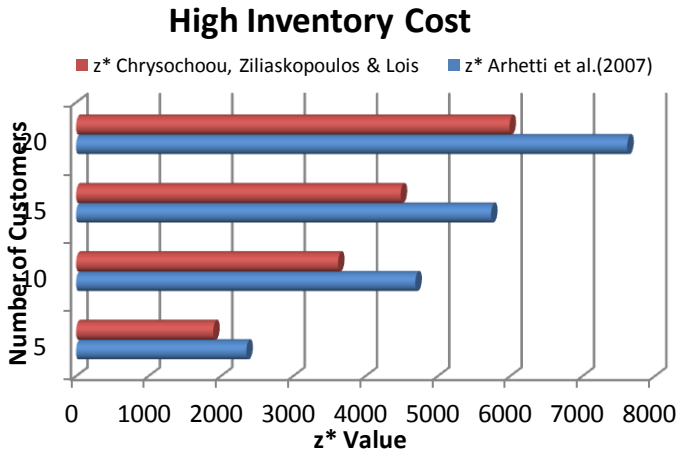
Second stage model constitute the assignment of lateral transhipment

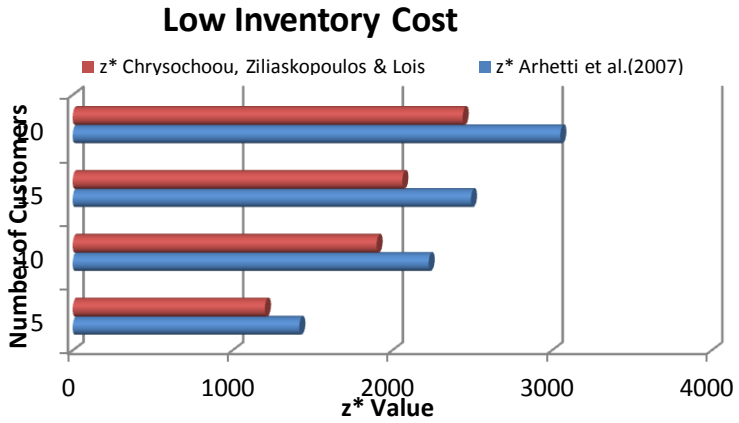


Results

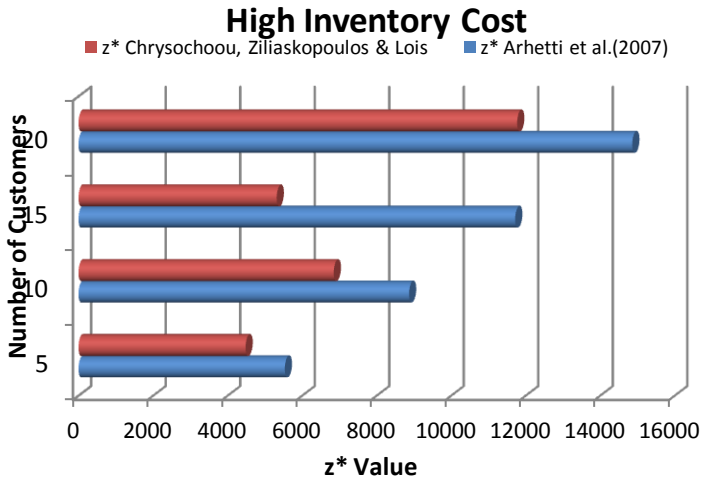
Algorithm was coded in C++ using Concert Technology and CPLEX 12.4. Benchmark instances of Arhetti et al. (2007) were used to evaluate the proposed valid inequalities.

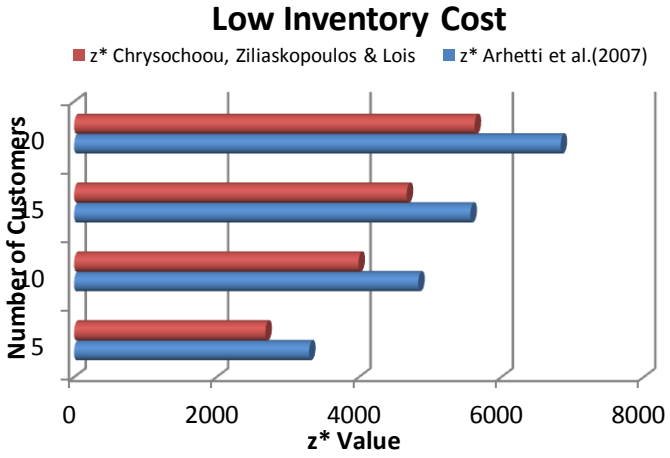
H = 3 periods





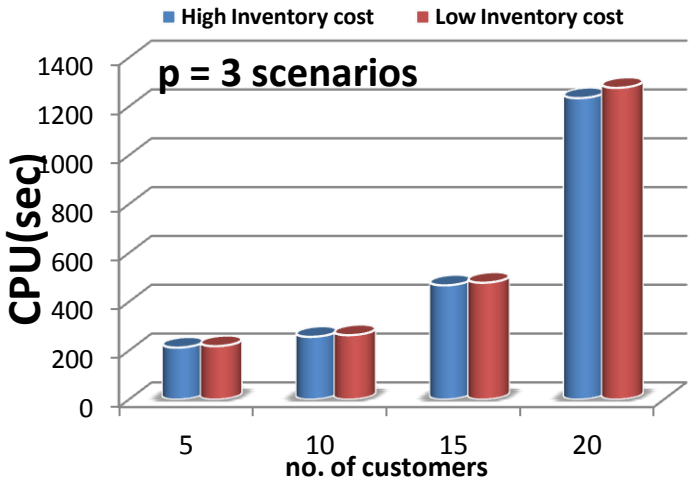
H = 6 periods

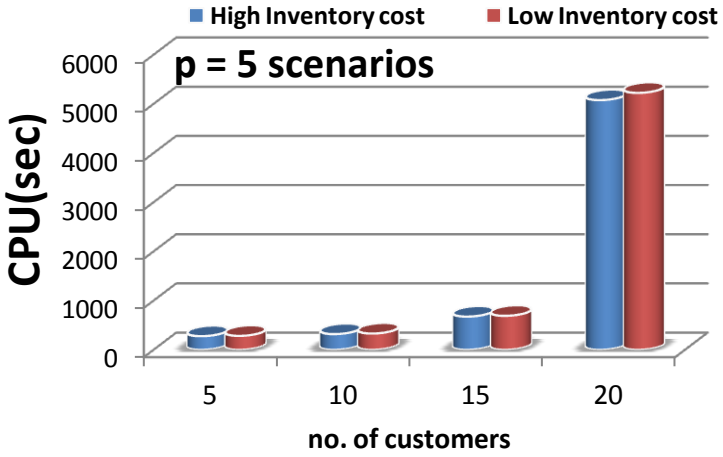




Results

Computational results of L - Shaped





- Transshipment significantly improves the overall performance of vendor managed inventory supply chain.

- Relaxation of the Order – Up to level policy in coherence to the decision of accounting forthcoming demand to determine the quantity of shipments demonstrate savings of 15% on an average.

Conclusion

- Nowadays of **unstable global economic conditions** the demand of products become highly uncertain in many business areas.
- **Sustainability** of business depend on the ability to handle market uncertainties.
- Research should focus on development of models and methods that fit the industries needs of **robust flexible plans to handle the uncertainties.**

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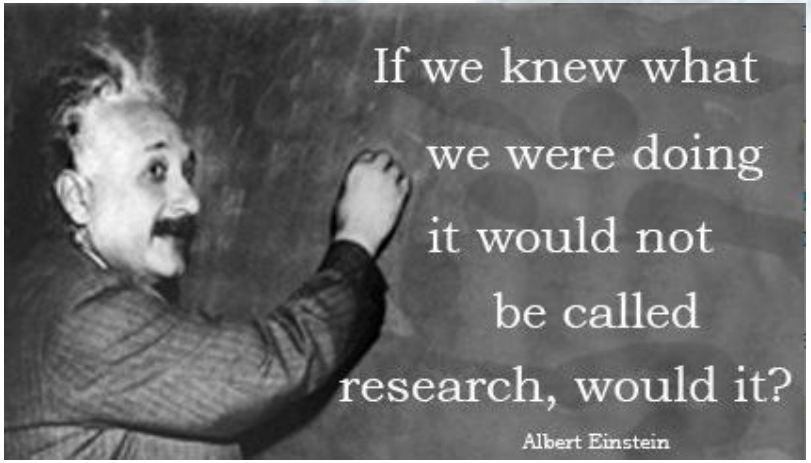

Poster session : 846 Network Modeling
1/14/15, 2:45PM – 4:30 PM.

Thank you for your attention

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ACKNOWLEDGEMENT
This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Heracleitus II. Investing in knowledge society through the European Social Fund.

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