



MIT SCALE RESEARCH REPORT

The MIT Global Supply Chain and Logistics Excellence (SCALE) Network is an international alliance of leading-edge research and education centers, dedicated to the development and dissemination of global innovation in supply chain and logistics.

The Global SCALE Network allows faculty, researchers, students, and affiliated companies from all six centers around the world to pool their expertise and collaborate on projects that will create supply chain and logistics innovations with global applications.

This reprint is intended to communicate research results of innovative supply chain research completed by faculty, researchers, and students of the Global SCALE Network, thereby contributing to the greater public knowledge about supply chains.

For more information, contact
MIT Global SCALE Network

Postal Address:

Massachusetts Institute of Technology 77
Massachusetts Avenue, Cambridge, MA 02139 (USA)

Location:

Building E40, Room 267
1 Amherst St.

Access:

Tel: +1 617-253-5320
Fax: +1 617-253-4560

Email: scale@mit.edu
Website: scale.mit.edu

Research Report: ZLC-2011-1
Engine spare parts distribution strategy in Africa
Dilshod Achilov and Sharmishtha Biswas

For Full Thesis Version Please Contact:

Marta Romero

ZLOG Director

Zaragoza Logistics Center (ZLC) Edificio

Náyade 5, C/Bari 55 – PLAZA 50197

Zaragoza, SPAIN

Email: mromero@zlc.edu.es

Telephone: +34 976 077 605

Engine spare parts distribution strategy In Africa

By DilshodAchilov and SharmishthaBiswas
Thesis Advisor: Professor Mustafa GurbuzCagri

Summary:

Our research presents an analysis of the current engine spare parts distribution network in Africa and presents recommendations for changes in distribution network design over next 10 years, in order to meet the growing demand of the distributors and their customers in 16 countries in Africa and to ensure cost minimization. We have devised a mathematical tool for proposing a distribution network design with various input parameters such as sales growth rate in Africa, rate at which operating and transportation cost would increase etc.



DilshodAchilov

Master of Business Administration, Brigham Young University, Utah (USA)



SharmishthaBiswas

Bachelor of Engineering, National Institute of Technology, Raipur (India)

KEY INSIGHTS

1. With the introduction of regional distribution centers (RDC), demand can be fulfilled with shorter lead times and higher service level.
2. The tool will decide which country will be served by which RDC in which year.
3. Current transportation cost of supplying from master distribution centre (MDC) directly via air shipment will be reduced to ocean shipment to RDC and then road / air / ocean transport to end customer.

Introduction

Post recession, major businesses are growing globally at a fast pace. Emerging markets like Africa are among the chosen locations for all the businesses to explore compared to the otherwise saturated European and American markets. Handling expansion and growing demand entails a clear vision of a company coupled with a sustainable supply chain strategy. These supply chain strategies include many elements that should aim at reassessing the

impact of globalization on the business. One of the major elements of globalization that impact businesses across the world today is a robust and sustainable supply chain distribution network. The various known factors of an optimal distribution network include identifying optimal routes, facility allocation and location, inventory levels, and transshipment facility within the friendly transport corridors.

Problem Definition and Approach

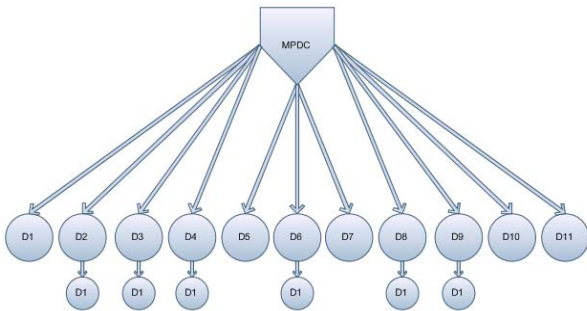
The multi-customer network that the company has developed in Africa combines end-customers and distributors alike, to place engine spare part orders to the master distribution center in Europe and USA. This entails huge transportation expenses borne by the customers.

Thus, to reduce the total network cost, this thesis investigates the possibility of introducing new distribution facilities in various regions in Africa and resulting cost minimization. Also, one of the key elements of this research is to determine the monetary and logical sustainability of such an idea.

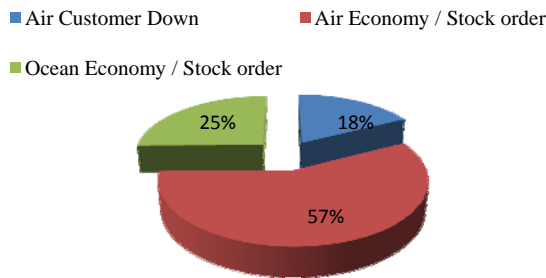
The primary questions answered by us in this research are the following:

1. What is the optimal supply chain network for spare parts in Africa given the demand growth in the region?
2. Given that the company's business is expected to grow with set percentages across the various countries in Africa, how can the suggested network sustain this growth over the coming years?

Baseline Scenario



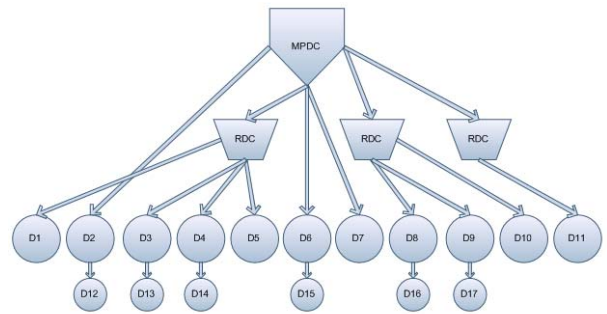
Baseline Scenario - Transportation Cost Distribution



In the above figures, we show the baseline or current network in Africa and the distribution of transportation costs between the various types of shipments and modes in which they are brought to Africa. Emergency or Customer Down constitutes 18% while even the stock orders are shipped via air, increasing the cost of the entire network by manifolds.

We identified 16 major demand countries, and within them, 5 countries were selected as prospective RDC locations based on good logistics location, ability to have bonded store, political stability, good corruption score, ease of doing business, available infrastructure in the country and also the availability of educated staff. We also considered the finer factors like availability of a friendly transport corridor, which is an issue particular to Africa.

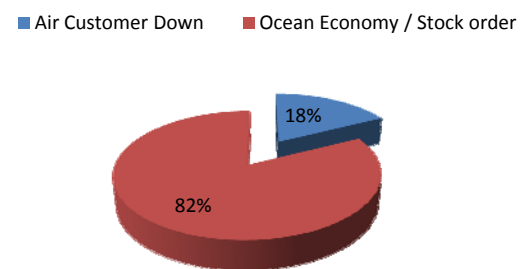
Proposed scenario (Example)



The above figure is the transportation cost distribution under the proposed network. We have dealt only with stock orders considering that the emergency orders will continue to be fulfilled via air/

The final mathematical formulation that models the company's network involves 1 product, 6 RDCs, 1 MDC and 16 demand countries.

Proposed network - Transportation Cost Distribution



The costs associated are [Can you put this list together and put figure above or below?]

- Transportation costs (air, ocean and road freight)
- Operating costs
- Facility costs
- Inventory holding costs (periodic review policy)
- Back ordering costs (without loss of sales)

Primary Input parameters of the model

- Sales growth rate
- Transportation cost as % of FOB of the shipment
- Operating cost as % of FOB of the shipment

Secondary input parameters of the model

- Cycle service level
- COGS as % of sales
- Capital costs of establishing RDC
- RDC size
- Review period
- Lead time
- Tax rates
- Useful life of assets

The network was modeled as a minimum cost network flow problem, and a mixed integer programming (MIP) formulation was solved for many different scenarios for changes in primary and secondary input parameters.

This research project was not limited to identifying the effects of introduction of new facilities but also includes simulations based on economic and other growth changes in the next 10 years to help the decision maker arrive at an educated judgment.

Model Solution

The output of the model that we have developed is based on the value of the input parameters given by the user. One of the solutions has been discussed below.

Network matrix:

Initial Year

Country	Port-city	FROM RDC:							
		IRDCs Base-line	Ghana Accra	Senegal Dakar	Kenya Nairobi	Kenya Mombasa	South Africa Johannesburg	South Africa Durban	
Congo	Pointe Noire	1	0	0	0	0	0	0	0
Dibouti	Dibouti	1	0	0	0	0	0	0	0
Ethiopia	Addis Ababa	1	0	0	0	0	0	0	0
Gabon	Libreville	1	0	0	0	0	0	0	0
Ghana	Accra	1	1	0	0	0	0	0	0
Kenya (Nairobi)	Nairobi	1	0	0	1	0	0	0	0
Madagascar	Antananarivo	1	0	0	0	0	0	0	0
Mali	Bamako	1	0	0	0	0	0	0	0
Nigeria	Lagos	1	0	0	0	0	0	0	0
Senegal	Dakar	1	0	1	0	0	0	0	0
Tanzania	Mwanza	1	0	0	0	0	0	0	0
South Africa (J)	Johannesburg	1	0	0	0	0	1	0	0
South Africa (D)	Durban	1	0	0	0	0	0	1	0
South Africa (CT)	Cape Town	1	0	0	0	0	0	0	0
South Africa (PE)	Port Elizabeth	1	0	0	0	0	0	0	0
South Africa (B)	Bloemfontein	1	0	0	0	0	0	0	0
Number of countries served		1	0	0	0	0	0	0	0
Open RDC		1	0	0	0	0	0	0	0

Initial year is the current year with the baseline scenario. It can be seen that all the countries are being served (highlighted in dark gray) by Master Distribution Center.

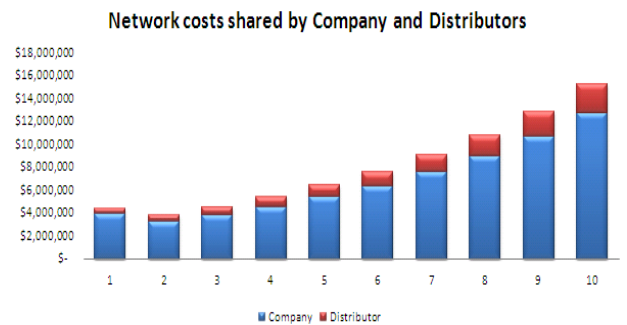
Going forth, we present an example of one of the scenarios when the sales growth rate is 5%, operating cost rate is 3%, and transportation surcharge over the baseline is 0%.

Consecutive years (growth rate 5%, operating cost 3%, transportation surcharge 0%)

Country	Demand city	FROM RDC:							
		IRDCs Base-line	Ghana Accra	Senegal Dakar	Kenya Nairobi	Kenya Mombasa	South Africa Johannesburg	South Africa Durban	
Congo	Pointe Noire	1	0	0	0	0	0	0	1
Dibouti	Dibouti	1	0	0	0	0	0	0	1
Ethiopia	Addis Ababa	1	0	0	0	0	0	0	1
Gabon	Libreville	1	0	0	0	0	0	0	1
Ghana	Accra	1	1	0	0	0	0	0	1
Kenya (Nairobi)	Nairobi	1	0	0	1	0	0	0	1
Madagascar	Antananarivo	1	0	0	0	0	0	0	1
Mali	Bamako	1	0	0	0	0	0	0	1
Nigeria	Lagos	1	0	0	0	0	0	0	1
Senegal	Dakar	1	0	1	0	0	0	0	1
Tanzania	Mwanza	1	0	0	0	0	0	0	1
South Africa (J)	Johannesburg	1	0	0	0	0	0	0	1
South Africa (D)	Durban	1	0	0	0	0	0	0	1
South Africa (CT)	Cape Town	1	0	0	0	0	0	0	1
South Africa (PE)	Port Elizabeth	1	0	0	0	0	0	0	1
South Africa (B)	Bloemfontein	1	0	0	0	0	0	0	1
Number of countries served		1	4	0	2	0	0	0	10
Open RDC		1	0	0	0	0	0	0	0

The above chart shows the proposed network solution for the input parameters discussed before.

The country assignments along with the cost allocations will change, depending on the solution provided by the model.



Another part of the solution provided by our model is the sharing of network costs between customers/distributors and the company. The current scenario entails the distributors or customers placing the order at an international MDC and paying for the transportation costs (INCO term – Ex-Works). With the proposed network, although the total cost of the network gets reduced by introduction of RDCs, the costs borne by the company increase because these RDCs will be owned by the company. In the scenario given in the example, 86% of the network costs will be borne by the company.

Results & Recommendations

- Air shipments should be used only for emergency orders and backorders. RDCs should fulfill all stock orders.
- Network costs go down, but company costs go up. This can be compensated by charging a higher price to distributors who will end up paying less than what they would otherwise pay for air shipping all orders (current scenario).
- Inventory pooling can be utilized if this model is extended to include more SKUs.
- The model is very sensitive to transportation cost changes while less sensitive to sales growth changes. This can help the decision-maker select the suitable model based on the business environment in Africa.