Supply Chain Fundamentals & Segmentation Analysis

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ESD.260/15.770/1.260 Logistics Systems
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Supply Chain Management Definitions

“Supply Chain Management deals with the management of materials, information, and financial flows in a network consisting of suppliers, manufacturers, distributors, and customers.“

Prof. Hau Lee - Stanford Supply Chain Forum

“Call it distribution or logistics or supply chain management. By whatever name it is the sinuous, gritty, and cumbersome process by which companies move material, parts, and products to customers.”

Fortune (1994)
So, what interesting Supply Chain / Logistics questions should I ask?

Images of athletic shoe and potato chip bag removed due to copyright restrictions.
Supply-Chain Operations Reference (SCOR) Model

**Plan**
- P1 Plan Supply Chain
- P2 Plan Source
- P3 Plan Make
- P4 Plan Deliver
- P5 Plan Returns

**Source**
- S1 Source Stocked Products
- S2 Source MTO Products
- S3 Source ETO Products

**Make**
- M1 Make-to-Stock
- M2 Make-to-Order
- M3 Engineer-to-Order

**Deliver**
- D1 Deliver Stocked Products
- D2 Deliver MTO Products
- D3 Deliver ETO Products

**Enable**

Source: Supply Chain Council
Traditional Functional View

**Purchasing / Procurement**
- What to buy from who
- Corporate vs Group

**Inventory Control**
- How much to stock where
- Trigger points
- Replenishment plan

**Warehousing**
- Storage, Mixing, Break bulk
- Pick Pack and Ship
- What to stock where in WH

**Materials Handling**
- How to move product
- Packaging, containerization
- Storage layout

**Order Processing**
- Receiving, Entry & Status
- Order Management

**Transportation**
- Inbound versus Outbound
- Domestic versus International
- Modal control (Rail, TL, LTL, Parcel, Air, etc.)

**Customer Service**
- Geographic
- Product Line Specific

**Planning Group**
- Facility Location
- Network Design
- Demand Planning
Supply Chain as a System

Take an Engineering Systems Perspective

- What is a variable and what is a constraint?
- Continuous expansion of decision variables
- Increases potential for improvement but increases both complexity and coordination requirements

Objective: Deliver at lowest transport cost

Variable:
- Select carrier to tender each load to

Constraints:
- Ship everything each day
- Must deliver within specified windows
Supply Chain as a System

Take an Engineering Systems Perspective

- What is a variable and what is a constraint?
- Continuous expansion of decision variables
- Increases potential for improvement but increases both complexity and coordination requirements

**Objective**: Deliver at lowest transport cost

**Variables**:
- Select carrier to tender each load to
- Select time windows to deliver
- Select when to ship what from where

**Constraints**:
- Deliver within negotiated time frame

**Objective**: Deliver at lowest total cost

**Variables**:
- Select carrier to tender each load to
- Select time windows to deliver
- Select when to ship what from where

**Constraints**:
- Ship everything each day
Supply Chain as a System

Take an Engineering Systems Perspective

- What is a variable and what is a constraint?
- Continuous expansion of decision variables
- Increases potential for improvement but increases both complexity and coordination requirements

Objective:
- Design, build, and deliver at lowest total cost

Variables:
- Select carrier to tender each load to
- Select time windows to deliver
- Select when to ship what from where
- Determine where to stock which form of product

Constraints:
- Deliver within negotiated time frame
Supply Chain as a System

Take an Engineering Systems Perspective

- What is a variable and what is a constraint?
- Continuous expansion of decision variables
- Increases potential for improvement but increases both complexity and coordination requirements

Objective:
- Maximize on-shelf availability

Variables:
- Select carrier to tender each load to
- Select time windows to deliver
- Select when to ship what from where
- Determine where to stock which form of product
- Select contract relationships
- Select who should control replenishment
- Which channel member should perform which function

Constraints:
- Total delivered cost to shelf

Why is this so hard to do?
Images of athletic shoe and potato chip bag removed due to copyright restrictions.
Supply Chain Segmentation

There is no such thing as a one-size-fits-all supply chain

Most firms/business units operate multiple supply chains

Different supply chains require different methods for:
- Forecasting
- Demand Planning
- Inventory Planning
- Transportation
- Purchasing / Procurement
- Inventory Control
- Warehousing
- Materials Handling
- Order Management
- Transportation
- Customer Service

Why segment?
Segmentation & Portfolio Management

How many segments? (Rules of thumb)

- Homogenous - items within the segment are all similar
- Heterogeneous - items between segments should be very different
- Critical Mass - the segment should have enough number to make it worthwhile
- Pragmatic - the dimensions should be useful and communicable

Segmentation in Supply Chain Management

- Customer, Product, Supplier
- More recently – combinations of these

Source: Prashant Yadav 2005
Supply Chain Segmentation

How can I segment my customers/vendors?
- Lead time requirements
- Service level requirements
- Purchase History
- Order Size and Volume
- Geographical
- Demographic
- Sales Trends
- Channel Segmentation

How can I segment my products?
- Physical characteristics
- Demand characteristics
- Supplier characteristics

Source: Prashant Yadav 2005
Product Segmentation

Example: Grocery Store:
- ~8000 SKUs (only Dry Goods)
- Total SKUs sold within 1 year
  - 1.156 M items (SKUs) sold
  - Number of units sold per SKU
    - Mean 144
    - Median 72
    - Mode 0
    - Std Dev 355

Biggest Sellers?
Biggest Sales Day?

Top 10 Sellers!
1. EVAP MILK 12 OZ
2. ENFAMIL IRON POWDER
3. ENFAMIL W/IRON 13OZ
4. BATH TISS 1PLY
5. SCOT WHT BTH TT
6. P SPRING WTR 1 GALLN
7. SH GR SUGAR5LB FBLT
8. KR MAC N CHEESE
9. PAST KTCH RDY TOM
10. GEISHA SLD WHT TUNA

Top Sales Days!
1. 24 November 2004
2. 1 February 2004
3. 10 April 2004

How are products distributed in terms of sales volume?
Uniform? Normal? Other?
This is an example of the Power Law, $y=ax^k$

Why is this important?

Is this distribution unique?
Power Law \((y=ax^k)\)

- Exceptionally common in physical and social systems
  - Severity of hurricanes and earthquakes
  - Failures of parts due to wear and tear
  - Income within a population (Pareto’s Law)
  - Distribution of volume on traffic lanes
  - Questions from students
  - Visits to websites (Nielsen’s Law) & blogs
  - Frequency of words in any language (Zipf’s Law)
  - Frequency of digits within tables (Benford’s Law)
  - Frequency of authors citations in literature (Lotka’s Law)
  - Animals’ metabolic rates wrt to mass (Kleiber’s Law)
  - Profitability of customers & products
- The important few versus the trivial many

**Fundamental Insight**
Distribution of many phenomena across a population follow a Power Law relationship
### Segmentation: ABC Analysis

- Identify the SKUs that management should spend time on
- Prioritize SKUs by their value to firm
- Create logical groupings
- Adjust as needed

#### Example:
- Sample of 20 SKUs
- Total of 4,677 units
- Total ~$22k

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<th>Annual Demand</th>
<th>Annual $ Value</th>
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**A Items:**
- 80% of Value
- 20% of SKUs

**B Items:**
- 15% of Value
- 30% of SKUs

**C Items:**
- 5% of Value
- 50% of SKUs

Total: 4,677 $21,984
Segmentation: ABC Analysis

Distribution By Value

- **Percent of SKUs**
- **Percent of Annual Value**

**A Items**

**B Items**

**C Items**
Segmentation: ABC Analysis

So, what is different between the classes?

A Items
- Very few high impact items are included
- Require the most managerial attention and review
- Expect many exceptions to be made

B Items
- Many moderate impact items (sometimes most)
- Automated control w/ management by exception
- Rules can be used for A (but usually too many exceptions)

C Items
- Many if not most of the items that make up minor impact
- Control systems should be as simple as possible
- Reduce wasted management time and attention
- Group into common regions, suppliers, end users

But – these are arbitrary classifications
Segmentation: ABC Analysis

- **Economic value**
  - Volatile: Sophisticated techniques; frequent reviews
  - Stable: Less sophisticated techniques; less frequent reviews
  - Unimportant: Unsophisticated techniques; infrequent reviews

- **Demand variability**
  - H: High
  - L: Low

Source: Prashant Yadav 2005
Segmentation: ABC Analysis

So, what should we do with C items?

- Traditional Approach
  - Handle as simply as possible to minimize cost
  - Eliminate if possible to be able to focus on A & B

- Other thoughts?

![Sales Volume By SKU graph]

Top 1% of products = 36% sales
Top 5% of products = 67% sales
Bottom 95% account for 33% sales
Segmentation: The Long Tail

Examples:

Books
- Amazon.com stocks over 3 M titles
- Most brick & mortar stores stock between 40-100k
- 25% - 40% of Amazon.com sales are books not stocked in stores

Music / CDs
- Rhapsody offers >1.5 M tracks
- Wal*Mart offers ~4,500 CDs (or about 55,000 tracks)
- 40% of Rhapsody sales come from titles not stocked in stores

Movies / DVDs
- Netflix offers over 55,000 titles
- Blockbuster offers ~3,000 titles
- 21% of Netflix sales come from titles not stocked in stores
- While 80% of sales for a DVD occur within 2 months of release, margins actually increase for older releases!

When does it make sense to expand the tail?

Sources:
Supply Chain Management is . . .

- An integrated activity,
  - X-functions, X-divisions, X-companies, etc.
  - Coordination of conflicting goals, metrics, etc.

- Involves multiple flows,
  - Physical (raw materials, wip, finished goods)
  - Information (orders, status, contracts)
  - Financial (payment, credits, etc.)

- Requires trade-offs,
  - Across different entities
  - Across metrics: Cost, Service, Time, Risk, Flexibility, etc.

- Deals with uncertainty,
  - Uncertainty in supply, process, and demand
  - Consider both flexibility and robustness

- Portfolio of approaches are usually needed.
  - There is no one size fits all anything in SCM
  - Knowing when to apply which approach is critical to success
Core Concepts of ESD.260

Model Based Approach
- Use fundamental models to gain insights
- Analytical, not necessarily OR, approach
- Extensive use of real examples – but not case studies

Total System Perspective
- Avoid the silo effect of traditional logistics
- Capture and integrate across different players in SC
- Service can be included

Portfolio of Solutions
- Rarely is a single solution sufficient or practical
- A set of solutions is usually more applicable
- The context matters

Management of Uncertainty
- Risk can be measured, monitored, and managed
- Impacts sourcing, contracting, pricing, incentives, etc.
Fit with Other MIT SCMish Classes

- **Strategic** –
  - How does SCM fit into larger company issues?
  - Classes:
    - ESD.261/15.771 – Case Studies in Logistics and SCM (Byrnes)
    - ESD.265/2.965 International Logistics (Marcus & Weiss)
    - 15.769 Operations Strategy (Rosenfield, Novak)
    - ESD.267/15.762 – Supply Chain Planning (Graves & Simchi-Levi)
    - ESD.268/15.763 – Mfg System & SC Design (Graves & Simchi-Levi)

- **Analytical** –
  - How to answer specific, practical SCM questions using analytical tools?
  - Classes:
    - ESD.260/15.770 – Logistics Systems (Caplice & Sheffi)

- **Methodological** –
  - How and why do the underlying methodologies and approaches work?
  - Classes:
    - ESD.273 – Logistics and SCM (Simchi-Levi)
    - 15.764 – Theory of Operations Management (Gallien)
    - 1.203/ESD216 – Log & Transp Planning Methods (Larson, Odoni, & Barnett)
    - 15.081, .082, .083, .084, .085 – ORC track for optimization & probability
Questions?
Comments?
Suggestions?