A Simulation-based Decision Support Framework for Real-Time Supply Chain Risk Management

by

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Agenda

- Traditional Supply Chain Risk Management (SCRM) concept and tools
- The need for new concepts in SCRM
- The role of simulation in SCRM
- Agent-based simulation (ABS) and the concept of agents
- The benefit of ABS for risk management
- Virtual market by using agent-based simulation approach
Supply Chain Risk Management Concept

Company Goals

- Operational Goals
- Environmental Goals
- Financial Goals

Risk Identification

- Brainstorming
- Cause and Effect / Fishbone Diagrams
- Risk ranking and filtering
  - Hazard Analysis and Critical Control Point (HACCP)
- Pareto charts/analysis
  - Fault Tree Analysis (FTA)
- Failure Modes Effect Analysis (FMEA)
- Failure Mode, Effects and Criticality Analysis (FMECA)
  - Root Cause Analysis (RCA)

Risk Analysis

Risk Evaluation

Risk Treatment

Monitoring

Traditional Tools

New Approach

Real-time decision support for risk mitigation with what-if / what-next scenario planning

SIMULATION
The Need for New Concepts in Risk Management

- Collecting appropriate data and transforming them into required information and knowledge
- Being able to detect, decide and act in real-time to dynamic risks
- Quantitative risk assessment
- Right combinations of corrective actions that contribute to risk measures
- Holistic view of supply chain and supply chain visibility
The Need for New Concepts in Risk Management

Real Time Data
Data mining in order to provide useful information to aid supply chain risk management, simulation and visualization

Simulation
Analyse incidents that represent potential risks and actions that can be taken to mitigate these risks.

Supply Chain Visualization
Real time status of the supply chain and risk related data such as natural disasters, manmade crises and financial instability
Integrated Supply Chain Risk Management

Large scale data harmonization

Data Sources
- ERP
- SCM
- Historical

Data Warehouse
- Sensor
- Internet
- Mobile communication networks
- GPS

Data Manager Agent
- Strategic
- Financial
- Operational
- Staff
- Regulatory

Visualization
Supply Chain Visualization

Real-time decision support
Agent-based Simulation Platform
Supply Chain Simulation
Virtual Market

Simulation related data
Simulation output
Risk related data
Risk Identification
Risk Analysis
Risk Assessment
Risk Treatment
**System Dynamics**

- Simulate strategy decisions in the global market place

**Discrete-event Simulation**

- Simulate a factory setting or a materials flow system: reengineering work process

**Agent-based Simulation**

- Simulate market and customer behaviors, such as customers' reaction to price change
The Concept of Agents

- **Autonomy**: agents are able to take decisions without a central controller in order to fulfil their objectives.

- **Social ability**: an agent can interact with other agents or the environment through the use of an agent communication language allowing it to asynchronously send/receive messages to/from other agents.

- **Reactivity**: agents can perceive their environment and be capable of performing fast reactions to specific changes in this environment with their own actions whenever necessary.

- **Pro-activeness**: agents do not simply respond to changes in their environment, but can initiate actions.
Agent-based Simulation (ABS) for Virtual Market

- Creating a virtual market based on ABS
  - A virtual market is an agent-based simulation of the market for a defined set of products being offered for sale by a collection of sellers and available for purchase by a collection of customers.
  - Population of customer agents
  - Seller agent
  - Competitors agent
  - Business environment

- Agent-based simulation of consumer behavior
  - price, promotion, and quality (interactions between consumers and company)
  - Loyalty
  - others’ purchasing decisions (interactions among consumers)
  - technological development (e-commerce, internet)
  - social factors (age, education, income, culture)
  - personality traits (price sensitivity, quality sensitivity, susceptibility, and follower tendency)
A Virtual Market

Environment

- Political
- Financial
- Social
- Technology
- Sustainability

Social Surrounding
- (Recommendation)
- (Disqualification)
- (Rumor)

Purchase decision

Market Strategy
- Market Share

Price
- Quality
- Advertising
- Promotion

Social Surrounding
- (Recommendation)
- (Disqualification)
- (Rumor)
A Virtual Consumer

Neighbors buying the same brand (recommendation)

Interactions between consumers

Price sensitivity
Quality sensitivity
Loyalty
Follower tendency

Personality traits

Interactions between consumer and company

Motivation

Purchase Decision

Age
Income
Education
Culture
Etc.

Socio-demographic

Price
Quality
Advertising
Promotion

Zhang and Zhang | 2007
After gathering all possible change drivers, five main categories are composed. For instance; Shifting Lifestyle, Customer attitudes or Globalization changes are included in Social Effect Category.
The simulation is generated in order to define customer demands by taking account various expected and unexpected effects. These six effects given above can be arranged before simulation run according to effect’s volume and effect’s duration.
These two Bar Charts show the fluctuation of the produced product by Supplier and demanded product by Customer.

3 Suppliers are defined with their special material cost, lead time and quality properties.

5 Regions

2000 customers are created for five different regions in total and each small colourful circle represents a customer.

The effects are happening firstly based on particular rate and secondly manually. These buttons are designed to create manual effect.
After ACP Simulation execution, we obtain the above graph which demonstrates the increases and the decreases on the amount of demanded products by with their reasons i.e. Financial Effects or Supplier Effects.
Thank you for your attention!

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