A TAXONOMY FOR SUPPLY CHAIN MANAGEMENT LITERATURE

Ismail Capar[a], Fusun Ulengin[b], Arnold Reisman[c1]
[a]Mississippi State University, MS, USA
[b]Istanbul Technical University, Istanbul, Turkey
[c]Graduate School of Management, Sabanci University, Istanbul, Turkey
Reisman and Associates, Shaker Heights, OH. US

Abstract

This paper presents a scheme for classifying the Supply Chain Management (SCM) literature. SCM is broadly defined to include all classical business functions and theoretic management disciplines impacting this ever emerging field. SCM relevant literature is very disjoint and disparate. It transcends several academic disciplines and professions. SCM's domain is defined in its entirety and all of its facets are delineated in a manner that is parsimonious yet discriminating. Sample articles are classified to illustrate the descriptive power and parsimony of th taxonomy and a number of previously published SCM taxonomies are shown to be special cases of what is presented.

Key words: Supply chain management; SCM; Taxonomy; Classification
Topic Area: B6 Integrated Supply Chain Management

1. Introduction

Supply chain management (SCM), in general, is a synthesis of what was previously considered to be the management of a number of separable business functions on the one hand, and several relatively independent theoretic domains on the other. Among others these domains include; purchasing, inbound/outbound logistics, inventory control, contracting, manufacturing/outsourcing, performance/efficiency theory, relationship management, information systems, systems theory, mathematical and computer modelling, optimization etc. SCM- content articles appear in rather disparate journals ranging from *Management Science* to *Industrial Marketing Management.* Consequently, its literature is very disjoint. Hence this paper is an attempt at a synthesis to show how the threads or strains and weaving patterns of the various contributions fit together as part of the total tapestry.

2. SCM Literature

2.1 Epistemology of SCM

The literature of SCM has exploded during the last decade. It has become a major subtopic of production and operations management. Although today, SCM encompasses all activities involved in producing and delivering a final product or service, from the various sub-tiers to end-customers, its theoretic framework emanated from multi-echelon inventory models (Clark and Scarf 1960). Several trends in logistics management have emerged subsequently. Each of these broadened while improving the focus of the previous. The notion of *cost-cost* tradeoffs was introduced showing that the lowest total cost might not be

[1] Corresponding author, reismana@cs.com

achieved by pursuing the lowest cost of each logistics process constituent. Hence, the concept of logistics integration was introduced by Bowersox (1969).

In their practice, many companies recognized the fact that in optimizing logistics costs it was compulsory to include all relevant sub-tiers inside and outside of the firm, in terms of physical and information flows. These include all suppliers, and the entire distribution network. The challenge for logistics managers became to integrate logistical performance across all operating facets of a business. Meanwhile, researchers such as Houlihan (1985, 1988), Lee and Billington (1993), Cooper and Ellram (1993), and Thomas and Griffin (1996) started to introduce and implement the SCM concept.

Contributing to the SCM literature today, are knowledge domains such as operations research (OR), operations management, management science (MS), system dynamics, economics, marketing, and information technology.

Among others, the following OR/MS and Operations Management subfields impact SCM:

(i) *multi echelon inventory models* (Clark and Scarf 1960, 1962, Chen 1998, Chen and Zheng 1994, 1997, Erkip et al. 1990, Bessler and Veinott 1966, Graves 1985, Lee and Moinzadeh 1987a and 1987b);
(ii) *location models* (Cohen and Lee 1988, Geoffrion and Graves 1974, Revelle and Laporte 1996);
(iii) *performance measurement* (Harper 1984, Rolstadås 1995, Miller 2001, Bowersox and Closs 1996, Basu 2001, Beamon 1998, 1999);
(iv) i*nventory and distribution* (Federgruen and Zipkin 1984, Blumenfeld et al. 1985, Burns et al. 1985, Chan and Simchi-Levi 1998).

There are also some exemplary contributions to the SCM literature from outside the traditional OR/MS industrial engineering fields. Among these are:

(i) Forrester (1961) contributed to the SCM literature from the economics and system dynamics point of view. He analysed the growth, decline, and growing variation in a supply chain which is known as "bullwhip effect" (Lee et al. 1997);
(ii) Cachon and Zipkin (1999) applied the Nash equilibrium for competitive inventory policies in a two-stage supply chain;
(iii) Postponement (Alderson 1950). Today postponement is widely used in inventory control and production system (Jones and Riley 1984, Zinn and Levy 1988, Zinn and Bowersox 1988, Lee and Billington 1995, Aviv and Federgruen 2001);
(iv) Price incentives (Blattberg et al 1981);
(v) Relationship management (Pyke and Johnson 2002);
(vi) Social responsibility (Carter and Jennings 2002).

2.2 SCM literature growth

The accumulation of SCM articles listed on the *PROQUEST* and *ELSEVIER* databases as of end June 2003 is shown in *Figure 1*. During the last five complete years of record the literature accumulated 4.5 times the number of articles published up to and including 1997. In the first half of 2003, the number of published articles exceeded 70% of those published in throughout 2002.

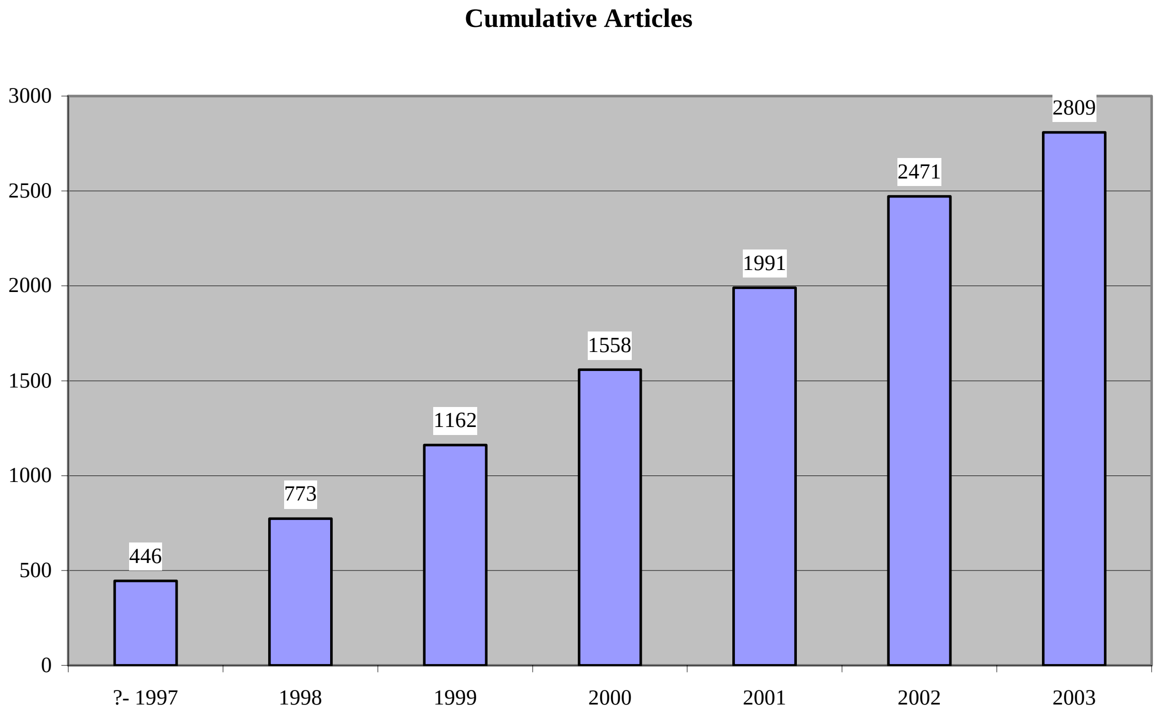

Figure 1: Number of SCM articles published in refereed journals

2.3 Paper organization

Section 3 of this paper discusses the need for a taxonomy at this stage of SCM literature development and taxonomies in general. *Section 4* provides a taxonomy that can be used to classify any and all contributions to the literature of SCM. Several well known and rather disparate papers were used to calibrate both the taxonomy and the respective classifiers' – authors of this paper - judgments. *Section 5* illustrates this classification. *Section 6* provides abstracts of most if not all previously published SCM taxonomies, and succinctly shows each to be a special case (a subset of the literature) of the taxonomy provided in this paper. *Section 7* offers some concluding remarks.

3. Need for a SCM taxonomy: A discussion

As important as it is to publish the results or findings of good research in a given field of knowledge it is also important to systematically review the totality of such publications on some periodic basis (Goffman 1980, Abbott 1988, and Gupta 1997). Systematic reviews of the literature represent research on research or what is sometimes called meta research (MR). The objectives of this MR are to unify the domain of SCM knowledge and or to expand or generalize it while at the same time consolidating this field of knowledge and practice. There are at least two efficient and effective ways of consolidating knowledge in a given field. One of these is to create a taxonomy and the other is to create a generalized framework (a general model or theory) that subsumes all existing models facts or theories within the field. The above two modes are not mutually exclusive. In fact they are complimentary. At times, as was the case with the *Periodic Table of Chemical Elements* (Mendeleev 1889), an underlying theory is imbedded within a taxonomy and such is the case with SCM.

A taxonomy for a given field of knowledge displays the field's domain in terms that are easy to understand, to communicate, to teach, to learn, and to work with. The taxonomy can be used:

1. To efficiently and effectively classify any and all contributions/ for purposes of storage, recall, sorting, and or statistical analyses and because such classification results are meaningfully machine readable they in turn clearly enable further meta research publications (Reisman 1992).
2. To identify voids in the literature and hence directions/specifications for research in need of being performed publications (Reisman 1988, 1989)
3. Classification of papers based on a taxonomy makes similarities and differences among the respective studies very clear. Significantly, it does so in a most efficient and effective manner.

The evolution of SCM from the early articles of Clark and Scarf (1960) up to and including June 2003 shows at least 2909 articles[2]. Consequently, the time is now ripe for a general mapping of this literature in a manner that will vividly provide a panoramic view of what exists and will clearly identify any existing gaps in the state of the art as suggested by Reisman (1989, 1994, and 1992). Hence there is a need for an SCM taxonomy which:

> Graphically, symbolically or both, will vividly display the similarities and the differences among the various contributions, thus demonstrating the relationship of all contributions and the practical applications of each to other. It will provide a framework by which all of the existing knowledge can be systematically filed and therefore recalled efficiently and effectively. By providing what amounts to an aerial view- a picture of the territory- it will identify the voids in the literature... Knowledge consolidation is a means to various ends, and it is also an end itself. It is a means toward the end of more efficient and more effective teaching and learning of new or existing knowledge. It is a means toward the end of more efficient storage and more effective recall and/or retention of knowledge. It is a means toward a more efficient and more effective processes of research leading to the yet unknown, to the design of the yet unavailable, and it is a means toward more efficient problem solving… (Reisman 1979)

Morever,

> The key to taxonomy effectiveness rests on criteria of comprehensiveness, parsimony and usefulness. Obviously, to be effective, a taxonomy must represent the full spectrum of the research chosen for categorization. Thus, comprehensiveness is a necessary condition for effectiveness. It is, however, not sufficient. To further be effective, a taxonomy should be parsimonious. It should not include unnecessary categories. Finally, to be considered effective, the taxonomy should be robust and generally useful. The categories should be reasonably if not mutually exclusive, i.e., non-overlapping, reasonably distinct, meaningful, commonplace, and descriptive to allow utilization by a wide variety of interested persons. (Vogel and Weterbe 1984)

A taxonomy is not only a tool for systematic storage, efficient and effective teaching/learning and recall for usage of knowledge but it is also a neat way of pointing to knowledge expansion and building. It identifies voids, potential theoretical increments or developments and potential applications for the existing theory. SCM has already generated a large enough literature allowing it to be considered as a separate and distinct field of knowledge. The increasing interest in SCM as an alternative tool for performance

[2] This number represents only that part of the SCM literature that appears on the *PROQUEST* and *ELSEVIER* databases

measurement makes a systematic elaboration of this field more crucial in helping researchers on-board as well as in attracting potential newcomers to the field.

As in the case of the greatest and best-known taxonomies, the Periodic Table of Elements (PTE), (Mendeleev 1889), the schema presented herein must evolve to reflect any modifications to the boundaries of SCM's universe. Alternately stated, the classification developed in this study is open to expansion as the scope of SCM enlarges. With the PTE as a role model, one can discuss the usage of a taxonomy to knowledge building. The PTE has always indicated cells which described with great efficiency elements yet to be discovered. Thus if and when the SCM taxonomy is used to classify the entire set of extant articles, the cells remaining empty will vividly show the voids in the literature. To be sure some of those void "cells" have a greater research interest than others; however, they (the empty cells) will all create a full set of specifications for the researcher to pursue. This is amply demonstrated in Reisman (1992). If, on the other hand, only a sample of the extant papers are classified then the probability that a void identified is truly so increases with the sample's richness and representativeness.

The current attempt to define a taxonomy for SCM may have its own disadvantages but it does not suffer from ambiguity. In fact, it may be too detailed in terms of branching levels. Though this makes its application cumbersome, it does increase its descriptive powers. Moreover, it is easy to aggregate sub-classifications and/or pruning outer branches. The inverse, e.g., having to deaggregate classifications once made, typically requires much effort. The authors are open to suggestions. The taxonomy proceeds in an arborescent way (Reisman 1992), as illustrated in *Figure 2*.

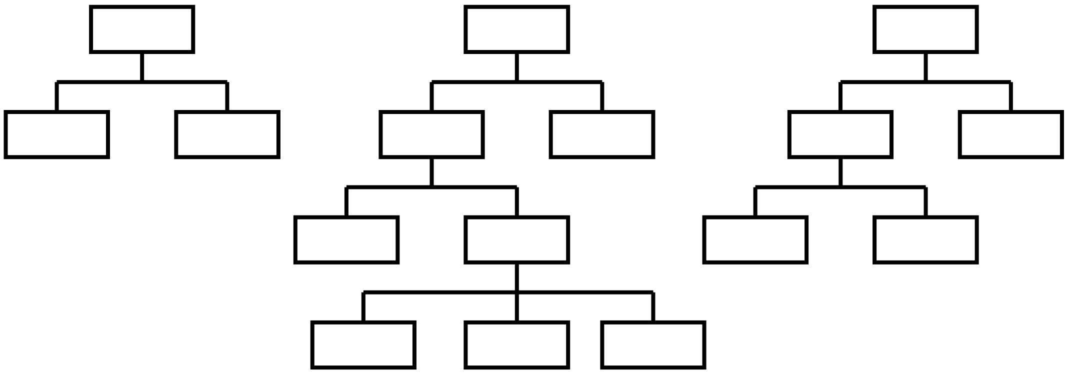

Figure 2: Attribute Vector Description Based Taxonomy

4. A Taxonomy for SCM

The SCM related literature is first classified based on six basic factors; the *type of study* reported on, the *structure of the SC* involved, *product properties*, the *SC activities* addressed, *decision making and degree of information sharing*, and *solving procedures* used. Under each of these factors, the most discriminating attributes are listed. The full taxonomy is illustrated in *Figure 2*. In the proposed taxonomy, each contribution can be given an identification code based on several uniquely defined domains within each of the above six classes or keys for classification:

Key 1: *Type of Study.* This is subdivided into five domains. These domains classify the paper considered according to its general characteristics. These include extensions to *theory*, an *application of theory*, or as is some times the case, an advance to *theory* is presented along with its *real world application. Surveys* or *literature reviews* are provided for as well. Because the SCM literature involves a diversity modeling methodologies the last domain describes the *nature of the model*, *complexity* and *solution methodology*, and the *efficiency measure* used.

Key 2: *Supply Chain Environment.* This is subdivided into two domains characterizing the SC involved. The first sub-key specifies its *structure* and the second key its *stability* or variability.

Key 3: *Supply Chain Activities.* This is subdivided into nine domains identifying the different SC activities e.g., *sourcing* and *procurement*, *production*, *inventory management*, *transportation*, *pricing*, *performance measurement*, and *return and after-sales*. Because this key addresses the very essence of supply chains e.g., its variety of operations, it is by far the most extensive and detailed.

Key 4: *Decision Making and Degree of Information Sharing.* This is subdivided into two domains identifying SC *decision making* processes and degrees of *information sharing*.

Key 5: *Product Properties* This key is subdivided into eight product(s) related domains. These are; *product classification*, *demand patterns*, *number(s) and relationships*, *life cycle*, *production strategy*, *status*, *priority of delivery*, and *packaging and handling*.

Type of Study

1. Theoretic
2. Applied
    - 2.1. Real world data based
        - 2.1.1. Case studies
        - 2.1.2. Bench marking
    - 2.2. Using synthetic numbers
3. Mixed theoretic and applied
4. Surveys, and Literature Reviews
5. Modeling
    - 5.1. Type of Model
        - 5.1.1. Mathematical model
        - 5.1.2. Simulation model
        - 5.1.3. Mixed model
    - 5.2. Convexity of Model
        - 5.2.1. Convex linear model
            - 5.2.1.1. Linear programming model.
            - 5.2.1.2. Discrete or mixed linear programming model.
            - 5.2.1.3. Dynamic programming model
            - 5.2.1.4. Fuzzy linear programming model.
            - 5.2.1.5. Chance constrained or stochastic linear programming model.
            - 5.2.1.6. Graphical presentation
        - 5.2.2. Convex non-linear model.
            - 5.2.2.1. Polynomial hard problem.
            - 5.2.2.2. Non-polynomial hard problem
            - 5.2.2.3. Ratio Form.
        - 5.2.3. Non-convex linear model.
        - 5.2.4. Non-convex non-linear model.
        - 5.2.5. Graphical presentation
    - 5.3. Solving Procedure
        - 5.3.1. No solving method proposed or standard method is used.
        - 5.3.2. Single stage solving method.
            - 5.3.2.1. Exact method explicitly presented.
            - 5.3.2.2. Approximated method.
            - 5.3.2.3. Heuristic method.
            - 5.3.2.4. Meta-heuristic method.

5.3.2.5. Graphical
5.3.3. Multi-stage.
5.3.3.1. Exact method explicitly presented.
5.3.3.2. Approximated method.
5.3.3.3. Heuristic method.
5.3.3.4. Meta-heuristic method.
5.4. Efficiency Measures Provided by the Solution.
5.4.1. Single-valued measures.
5.4.2. Multi-valued measures.
5.4.2.1. Exact multi-valued measures
5.4.2.2. Fuzzy multi-valued measures
5.4.3. Stochastic measures
5.4.3.1. Stochastic single-valued measures
5.4.3.2. Stochastic multi-valued measures

Supply Chain Environment

1. Structure of SC
   1.1. Two stage SC
      1.1.1. One Vendor, One buyer
      1.1.2. One Vendor, Multiple Buyers
      1.1.3. Multiple Vendors, Multiple Buyers
      1.1.4. Multiple Vendors, One Buyer
   1.2. Serial SC (n stages (more than two), one member at each stage)
   1.3. Network SC (multiple stages (more than two), at least one of the stage has more than one member)
2. Stability of Supply Chain
   2.1. Fixed
   2.2. Variable but predictable
   2.3. Uncertain

Supply Chain Activities

1. Sourcing / Procurement
   1.1. Make or Buy Decision
   1.2. Supply Source Selection
   1.3. Purchase Timing and Quantities
   1.4. Supplier Evaluation
2. Production
   2.1. Type, Number, Size, Location, and Layout of Production Points
   2.2. Production and Capacity Planning
   2.3. Product Design for Manufacture and Distribution
   2.4. Process Design
   2.5. Product Mix Selection
   2.6. Sequencing and Scheduling
3. Inventory Management
   3.1. How much inventory to produce/order
   3.2. Inventory control policies
      3.2.1. Continuous Review Models
      3.2.2. Periodic Review Models
   3.3. Storage Policies
      3.3.1. Stock-keeping unit (SKU) storage
      3.3.2. Job-lot storage
      3.3.3. Crossdocking
   3.4. Type, number, size, and location of stocking points
   3.5. Product mix at stocking points
   3.6. Forecasting
      3.6.1. Qualitative forecasting methods
      3.6.2. Time Series forecasting methods
      3.6.3. Causal Forecasting Methods
      3.6.4. Simulation forecasting methods
4. Transportation and Delivery
   4.1. Geographic Characteristics

- 4.1.1. Intercity transportation
- 4.1.2. Intercountry transportation
- 4.2. Transportation Modality
  - 4.2.1. Air
  - 4.2.2. Sea
  - 4.2.3. Truck
  - 4.2.4. Rail
  - 4.2.5. Pipeline
  - 4.2.6. Intermodal transport
  - 4.2.7. Package carriers (e.g. FedEx, UPS)
- 4.3. Freight Consolidation and Load Building
  - 4.3.1. Mode
  - 4.3.2. Lane
  - 4.3.3. Location
- 4.4. Carrier Type, Carrier, and Carrier Service Selection
- 4.5. Vehicle-Carrier routing
  - 4.5.1. Number of Points of Origin
    - 4.5.1.1. Single origin
    - 4.5.1.2. Multiple origin
  - 4.5.2. Number of Vehicles
    - 4.5.2.1. Single vehicle
    - 4.5.2.2. Multi vehicle
  - 4.5.3. Vehicle Homogeneity (Capacity)
    - 4.5.3.1. Similar vehicles
    - 4.5.3.2. Different vehicles
  - 4.5.4. Capacity Consideration
    - 4.5.4.1. Capacitated vehicles
    - 4.5.4.2. Uncapacitated vehicles
  - 4.5.5. Load Splitting Constraint
    - 4.5.5.1. Splitting of load
    - 4.5.5.2. Unsplitting of load
  - 4.5.6. Precedence/Coupling Constraint
    - 4.5.6.1. Precedence constraints
    - 4.5.6.2. Coupling constraints
  - 4.5.7. Trip Type
    - 4.5.7.1. Round trip
    - 4.5.7.2. One way
  - 4.5.8. Transportation Cost
    - 4.5.8.1. Neglected
    - 4.5.8.2. Linear cost
    - 4.5.8.3. Nonlinear cost
    - 4.5.8.4. Fixed cost plus linear transportation cost
    - 4.5.8.5. Fixed cost plus nonlinear transportation cost
  - 4.5.9. Transportation time
    - 4.5.9.1. Neglected
    - 4.5.9.2. Changes with respect to distance
  - 4.5.10. Distance/Cost Properties
    - 4.5.10.1. Asymmetric
    - 4.5.10.2. Symmetric
  - 4.5.11. Other Properties
    - 4.5.11.1. Time Window
    - 4.5.11.2. Backhauls
- 4.6. Picking and Packing

5. Return / After Sales
- 5.1. Claim processing
- 5.2. Spare parts inventory management
- 5.3. Recall Campaign
- 5.4. Reverse Logistics
  - 5.4.1. Defective product shipment
  - 5.4.2. Return shipment

5.4.2.1. Excess inventory
5.4.2.2. Serviceable/repairable products
5.4.2.3. Obsolete products
5.4.2.4. Reusable parts
5.5. Scheduling and managing the individual return
6. Pricing and Incentives
6.1. Pricing
6.1.1. Centralized
6.1.2. Decentralized
6.2. Quantity discounts
6.3. Rebates and price discounts
6.4. Incentives
7. Performance Measurement
7.1. Balanced Scorecard Based Approaches
7.2. SCOR Based Approaches
7.3. Other Performance Measures
7.3.1. Operational performance measures
7.3.2. Financial measures
7.3.3. Customer satisfaction related measures
8. Relationship Management
8.1. Supplier- Buyer Relationship
8.1.1. Strategic alliances / partnership / collaboration
8.1.2. Contract management
8.1.3. Conflict resolution
8.1.4. Negotiation
8.1.5. Integration Management
8.1.6. Risk & Benefit Sharing
8.2. Supplier Development
8.3. Buyer – Supplier Coordination
8.4. Customer Relationship Management
8.5. Relationship with Environment
9. Technology and Information Management
9.1. Areas of IT Usage
9.1.1. Demand Data Collection
9.1.2. Distribution and retailing management
9.1.3. Manufacturing management
9.1.4. Orders processing
9.1.5. Information sharing
9.2. Types of Technologies
9.2.1. Internet
9.2.2. EDI
9.2.3. Other ITs used for increasing SC competitiveness

Decision Making and Degree of Information Sharing

1. Decision Making
1.1. Decision Type
1.1.1. Coordinated
1.1.2. Uncoordinated
1.2. Decision Maker
1.2.1. Buyer
1.2.2. Vendor
1.2.3. Collaborative decision making
2. Information sharing
2.1. Information not shared
2.2. Partial information sharing
2.3. Full information sharing

Product Properties

1. Product Classification
1.1. Durability and Tangibility

- 1.1.1. Durable Goods
- 1.1.2. Perishable/Dated Goods
- 1.2. Product
  - 1.2.1. Functional Products
  - 1.2.2. Innovative Products
- 1.3. Consumer Goods[3]
  - 1.3.1. Convenience goods
  - 1.3.2. Shopping goods
  - 1.3.3. Specialty goods
  - 1.3.4. Unsought goods
- 1.4. Industrial Goods
  - 1.4.1. Raw Materials
  - 1.4.2. Manufactured Materials
  - 1.4.3. Supplies
  - 1.4.4. Accessories

2. Demand
   - 2.1. Stochastic
     - 2.1.1. Stationary
     - 2.1.2. Non-Stationary
   - 2.2. Deterministic
3. Product Numbers and Relationships
   - 3.1. Single Product
   - 3.2. Multi Product Independent Demand
   - 3.3. Multi Product Dependent Demand
4. Product Life Cycle
   - 4.1. Introductory Stage
   - 4.2. Growth Stage
   - 4.3. Maturity Stage
   - 4.4. Decline Stage
5. Production Strategy
   - 5.1. Make to Stock
   - 5.2. Make to Order
   - 5.3. Engineer to Order
6. Product Status
   - 6.1. Finished Goods
   - 6.2. WIP and Subassemblies
   - 6.3. Raw Materials
   - 6.4. MRO Products
   - 6.5. Spare Parts
   - 6.6. Pipeline Inventory
7. Delivery Priority
   - 7.1. High Priority Goods
   - 7.2. Regular Priority Goods
   - 7.3. Not Prioritized
8. Packaging and Handling
   - 8.1. Bulk
   - 8.2. Container
   - 8.3. Boxed
   - 8.4. Special Handling Required
     - 8.4.1. Hazardous Material
     - 8.4.2. Refrigerated Goods

Figure 3: A Taxonomy of Supply Chain Management Literature

---

[3] *Convenience Product* – Consumer products are products a consumer needs but isn't willing to spend much time or effort shopping for. These products are bought often, require little selling, don't cost much, and even be bought by habit.
Shopping Product – Shopping product are products that customer feels are worth the time and effort to compare with competing products.
Specialty Product – Speciality products are consumer products that the customer really wants and is willing to make a special effort to find.
Unsought Product – Unsought products are products that potential customers don't yet want or know they can buy (McCarthy and Perreault, 1990)

5. Illustrative classifications

At the outset, the authors tested the taxonomy of *Figure 3* for robustness, and ability to discriminate in a parsimonious manner, by using a group of articles known to represent rather different approaches to and addressing different issues of SCM. The articles used for that purpose are identified below as *Exhibits 1-6* along with a paragraph providing a rationale for the classification indicated[4].

Exhibit 1.

The Value of Information Sharing in a Two-Level Supply Chain
Hau L. Lee, Kut C. So, and Christopher S. Tang

Many companies have embarked on initiatives that enable more demand information sharing between retailers and their upstream suppliers. While the literature on such initiatives in the business press is proliferating, it is not clear how one can quantify the benefits of these initiatives and how one can identify the drivers of the magnitudes of these benefits. Using analytical models, this paper aims at addressing these questions for a simple two-level supply chain with nonstationary end demands. Our analysis suggests that the value of demand information sharing can be quite high, especially when demands are significantly correlated over time.

Management Science
Vol 46 No: 5, 2000

Using mathematical modelling this article investigates the value of (demand) information sharing in a bi-level SC using EDI technology. Demand faced by the retailer is correlated over a time horizon and each member uses the periodic inventory review policy. The authors compare the effect of information sharing on buyer-vendor decisions. The model used for the problem is a stochastic model with an approximate solution and the results are compared based on inventory and cost reductions. Hence, the paper is classified as:

(5.1.1/5.2.1.5/5.3.2.2/5.4.1) (1.1.1) (3.2.2/9.1.5/9.2.2) (1.2.1/1.2.2/2.1/2.2) (2.1)

Exhibit 2.

Near-Optimal Echelon-Stock (*R*, *Nq*) Policies in Multistage Serail Systems
Fangruo Chen and Yu-Sheng Zheng

We study echelon-stock (*R*,*nQ*) policies in a multistage, serial inventory system with compound Poisson demand. We provide a simple method for determining near-optimal control parameters. This is achieved in two steps. First, we establish lower and upper bounds on the cost function by over- and under-charging a penalty cost to each upstream stage for holding inadequate stock. Second, we minimize the bounds, which are simple, separable functions of the control parameters, to obtain heuristic solutions. We also provide an algorithm that guarantees an optimal solution at the expense of additional computational effort. A numerical study suggests that the heuristic solutions are easy to compute (even for systems with many stages) and are close to optimal. It also suggests that a traditional approach for determining the order quantities can be seriously suboptimal. All the results can be easily extended to the discrete-time case with independent, identically distributed demands.

Operations Research
Vol. 46, No.4, 1998

A serial supply chain is mathematically modeled to determine (Q, R) values for a continuous inventory review system with Poisson end-item demand. The authors offer a

[4] In applying the above taxonomy to classify a specific document some keys may remain empty e.g., **()**. This means that the paper does not address or involve that key's attributes.

coordinated decision making strategy for overall supply chain in a full demand information-sharing environment. They present a stochastic model solved by a multi stage algorithm, which uses approximation and heuristics. In addition, they present an exact solution methodology. Thus its classification based on *Figure 3* as:

(5.1/5.2.1.5/5.5.2.1/5.3.2.3/5.4.3.2) (1.2) (3.1/3.2.1) (1.1.1/2.3) (2.1.1)

Exhibit 3.

Optimizing Strategic Safety Stock Placement in Supply Chains

Stephen C. Graves and Sean P. Willems

Manufacturing managers face increasing pressure to reduce inventories across the supply chain. However, in complex supply chains, it is not always obvious where to hold safety stock to minimize inventory costs and provide a high level of service to the final customer. In this paper we develop a framework for modeling strategic safety stock in a supply chain that is subject to demand or forecast uncertainty. Key assumptions are that we can model the supply chain as a network, that each stage in the supply chain operates with a periodic-review base-stock policy, that demand is bounded, and that there is a guaranteed service time between every stage and its customers. We develop an optimization algorithm for the placement of strategic safety stock for supply chains that can be modeled as spanning trees. Our assumptions allow us to capture the stochastic nature of the problem and formulate it as a deterministic optimization. As a partial validation of the model, we describe its successful application by product flow teams at Eastman Kodak. We discuss how these flow teams have used the model to reduce finished goods inventory, target cycle time reduction efforts, and determine component inventories. We conclude with a list of needs to enhance the utility of the model.

Manufacturing & Service Operations Management
Vol. 2, No. 1, 2000

This article presents a mathematical formula for determining how much inventory should be kept in each stage and member of a complex supply chain with an application at Eastman Kodak. WIP, subassemblies, and pipeline inventories are managed with a periodic inventory review policy. All information is presumed known by the central decision maker who makes a coordinated decision. It is a dynamic programming model solved with existing methods. The efficiency measure is a single-valued exact solution. Hence,

(2.1.1/5.1.1/5.2.1.3/5.3.2.1) (1.3) (3.1/3.2.2) (1.1.1/2.3) (1.4.2/6.2/6.3)

Exhibit 4.

What is the Right Supply Chain for Your Product

Marshall Fisher

Never has so much technology and brainpower been applied to improving supply chain performance. Point-of-sale scanners allow companies to capture the customer's voice. Electronic data interchanges lets all stages of the chain hear that voice and react to it by using flexible manufacturing, automated warehousing, and rapid logistics. And new concepts such as quick response, efficient consumer response, accurate response, mass customization, lean manufacturing, and agile manufacturing offer models for applying the new technology to improve performance.

Harvard Business Review
March – April 1997

This paper classifies SC strategies and relationships among operational performance, customer satisfaction related performance measures, and product properties which can be applied to all SC structures. Moreover, the author shares the experience of different cases and classifies the products as either functional or innovative. Other topics discussed in the article are product design for manufacture and distribution, base stock continuous inventory control application, qualitative forecasting, and pricing. Its classification is:

(1/3/4) ( ) (2.3/3.2.1/6.1/7.3.1/7.3.3) ( ) (1.2.1/1.2.2)

Exhibit 5.

Quantifying the Bullwhip Effect in a Simple Supply Chain: The Impact of Forecasting, Lead Times, and Information

Frank Chen, Zvi Drezner, Jennifer K. Ryan, and David Simchi-Levi

An important observation in supply chain management, known as the *bullwhip effect*, suggests that demand variability increases as one moves up a supply chain. In this paper we quantify this effect for simple, two-stage supply chains consisting of a single retailer and a single manufacturer. Our model includes two of the factors commonly assumed to cause the bullwhip effect: demand forecasting and order lead times. We extend these results to multiple-stage supply chains with and without centralized customer demand information and demonstrate that the bullwhip effect can be reduced, but not completely eliminated, by centralizing demand information.

Management Science
Vol 46, No.3, 2000

This paper presents both a mathematical and a simulation model for one vendor, one buyer and a serial supply chain. They determine how much inventory should be kept based on a time series forecasting method. Two cases (information not shared and information fully shared), are compared resulting in a ratio-form model. The model is solved by approximation and a lower bound is derived for the exact solution with a single-valued measure.

(5.1.1/5.1.2/5.2.2.3/5.3.2.2/5.4.1) (1.1.1/1.2) (3.1/3.2.2/3.6.2) (2.1/2.3) ( )

Exhibit 6.

Coordinating Production and Delivery Under a (*z*, *Z*)-Type Vendor-Managed Inventory Contract

Michael J. Fry, Roman Kapuscinski, and Tava Lennon Olsen

This paper models a type of vendor-managed inventory (VMI) agreement that occurs in practice called a (*z*, *Z*) contract. We investigate the savings due to better coordination of production and delivery facilitated by such an agreement. The optimal behavior of both the supplier and the retailer are characterized. The optimal replenishment and production policies for a supplier are found to be up-to policies, which are shown to be easily computed by decoupling the periods when the supplier outsources from those when the supplier does not outsource. A simple application of the newsvendor relation is used to define the retailer's optimal policy. Numerical analysis is conducted to compare the performance of a single supplier and a single retailer operating under a (*z*, *Z*) VMI contract with the performance of those operating under traditional retailer-managed inventory (RMI) with information sharing. Our results verify some observations made in industry about VMI and show that the (*z*, *Z*) type of VMI agreement performs significantly better than RMI in many settings, but can perform worse in others.

Manufacturing & Service Operations Management
Vol. 3, No. 2, 2001

A mathematical model is used to evaluate the effect of contract on coordination of production and delivery in a two stage - one buyer one vendor- supply chain. The authors assumed demand distribution to be known and seek to find purchase timing and quantities and how much inventory should be kept under a periodic inventory review policy. The article evaluates the optimal replenishment and production policies when buyer and vendor fully share information but decisions are made in an uncoordinated fashion. They propose a stochastic model for this problem and solve it with previously known solution methods. Results are compared according to single valued measures. Hence,

(5.1.1/5.2.1.5/5.3.1/5.4.1) (1.1.1) (1.3/3.1/3.2.2/8.1.2) (1.1.2/1.2.1/1.2.2/2.3) (2.1.1)

Exhibit 7.

Supply Chain Modelling and Its Analytical Evaluation

M. Arns, M. Fischer, P. Kemper, and C. Tepper

A model-based analysis of supply chains (SCs) is proposed as a means of estimating performance measures like lead times and resource utilisations. SCs are regarded as discrete event dynamic systems (DEDS), described as process chains in an application-specific formalism, and analysed by state-of-the-art techniques developed for queueing networks (QNs) and Petri nets (PNs). The theoretical approach is accompanied by a toolset that provides automatic translations between a process-chain-specification front end and analysis engines for QN and PN models. In addition, the analysis technique also supports a hybrid approach, in which dedicated sub-models are mapped into a PN model, numerically analysed, and replaced with an aggregate. Finally, the resulting QN models may be analysed using analytical as well as simulative techniques. As an example application, we investigate the impact of an additional SC channel between a manufacturer and web-consumers on the overall performance of an SC. The example was inspired by the trend towards retail trade via the internet and illustrates the new challenges of electronic commerce for SC management.

Journal of the Operational Research Society
53, 2002

The authors develop mixed model to evaluate supply chain performance based on SCOR model. They considered a supply chain where two different suppliers, one manufacturer, and two different customers namely web customer and retail store customers exist. Arns et al. show the graphical presentation of supply chain model and they measure the performance of supply chain based on make-to-order production strategy with single valued measures. Thus, this paper can be classified as,

(5.1.3/5.2.5/5.3.1/5.4.1) (1.3) (7.2/9.2.1) (5.2)

Exhibit 8.

A Bayesian Approach to Service Level Performance Monitoring in Supplier, Provider Relationships

F.P. Wheeler

Techniques are presented for monitoring the performance of a delivery service. The techniques were developed from the practical need to support two parties: a virtual retailer that out-sources the home delivery of its goods and the logistics business that provides its courier service. The techniques are relevant to contractual negotiations and performance monitoring. A graphical tool for hypothesis testing is presented as an aid to contract negotiation and a dynamic model is developed to track performance over time for operational management. The approach is based upon the beta-binomial distribution, within a Bayesian decision context.

Journal of the Operational Research Society
Vol. 52, 2001

This article presents evaluation methods which show how to monitor and measure the performance of a delivery system. The author gives information how to use result of delivery performance during the contract management and negotiating. The paper also presents a bayesian model to evaluate on going performance of the delivery system based on dynamic generalized linear model. Its classification is,

(5.1.1/5.2.1.3/5.3.2.1/5.4.1) ( ) (4/7.3.1/8.1.2/8.1.4) ( )

5.1. Summary and discussion of the illustrative classifications

The above classifications for the illustrative examples are reproduced in ***Table 1.*** Viewed this way it can be seen that all but one (*Exhibit 4*) involve a *mathematical model*. Namely, all others have **(1.1…..)** as the first entry in key 1. The fourth paper does not but concentrates on discussing *performance* and *customer satisfaction measures*. Hence the first entry is **(4.3.1….)**, and because there is no mathematical model involved there is no discussion of *solving procedures*. This is recognized by noting the last field to be empty e.g. **( ).** Because this paper also differs from the rest in not addressing *decision making*, and *information sharing, the next to the last field is also empty e.g.,* **( ).** Similarly, *Exhibit 1* and *Exhibit 6* provide *single-valued measures* as part of their solutions while *Exhibit 2*, offers a *stochastic multi-valued measure.* Thus *Table 2* vividly shows the similarities and the differences among the papers included in this sample. Much like the periodic table of chemical elements, it does so in both an effective and efficient manner. If and when all of the extant SCM articles are so classified the result will easily identify the voids in the literature e.g., meaningful combinations of *Figure 3* attributes not present in that extended *Table 2.* A development such as that will be of great help to PhD candidates in search of a topic and to their dissertation committee members in considering proposals.

In the meantime *Figure 3* can be used to define SCM as a field of knowledge and practice in introducing the subject to neophytes. Seasoned SCM researchers, authors and instructors may find it a useful tool for systematically filing and efficiently recalling papers seen. Firms dependent on cost-effectiveness of their SC may use it for purposes of SC configuration redesign/reengineering and logistics firms may use it for proposal generation.

Table 1. Summary of the illustrative classifications

Exibit	Classification
1	**(5.1.1/5.2.1.5/5.3.2.2/5.4.1) (1.1.1) (3.2.2/9.1.5/9.2.2) (1.2.1/1.2.2/2.1/2.2) (2.1)**
2	**(5.1/5.2.1.5/5.5.2.1/5.3.2.3/5.4.3.2) (1.2) (3.1/3.2.1) (1.1.1/2.3) (2.1.1)**
3	**(2.1.1/5.1.1/5.2.1.3/5.3.2.1) (1.3) (3.1/3.2.2) (1.1.1/2.3) (1.4.2/6.2/6.3)**
4	**(1/3/4) () (2.3/3.2.1/6.1/7.3.1/7.3.3) ( ) (1.2.1/1.2.2)**
5	**(5.1.1/5.1.2/5.2.2.3/5.3.2.2/5.4.1) (1.1.1/1.2) (3.1/3.2.2/3.6.2) (2.1/2.3) ( )**
6	**(5.1.1/5.2.1.5/5.3.1/5.4.1) (1.1.1) (1.3/3.1/3.2.2/8.1.2) (1.1.2/1.2.1/1.2.2/2.3) (2.1.1)**
7	**(5.1.3/5.2.5/5.3.1/5.4.1) (1.3) (7.2/9.2.1) (5.2)**
8	**(5.1.1/5.2.1.3/5.3.2.1/5.4.1) ( ) (4/7.3.1/8.1.2/8.1.4) ( )**

Table 1 clearly attests to the fact that the taxonomy of Figure 3 is robust enough to succinctly classify the large diversity of SCM papers.

6. Classification of previously published SCM taxonomies

In this section most if not all known and previously published taxonomy papers are classified to show that they all are special cases of the Figure 3 taxonomy[5].

Exhibit 9.

A Taxonomy of Supply Networks

Harland, C.M., Lamming, R.C., Zheng, J., and Johnsen, T.E.

There has been limited research into how different types of supply networks can be created and operated. This paper develops a taxonomy of supply networks with a particular focus on managing network creation and operation. Based on a review of network literature and extensive empirical data across a variety of industry sectors, the degree of supply network dynamics and the degree of focal company supply network

[5] There are a number of published taxonomies on subjects relevant to SCM that are not included in this set. These typically concern themselves with SCM subfields such as inventory theory, logistics or manufacturing. No matter how comprehensive they might be, by definition they would constitute a subset of the *Figure 3* taxonomy.

influence are identified to be the main differentiators for classifying a matrix of four types of supply network. Network characteristics and patterns of networking activities of each type are discussed. The paper concludes with the contribution of a proposed taxonomy for better understanding the networking contingencies surrounding creation and operation of supply networks.

Journal of Supply Chain Management,
Vol. 37, Iss. 4, 2001

Reviewing current supply network literature and analysing responses to a survey the authors developed a taxonomy which considers supply source selection, partnership, risk and benefit sharing, inventory management, demand management, and decision making. This paper is classified as:

( ) ( ) (1.2/3/8.1) (1) ( )

Exhibit 10.

Internet Based Supply Chain Management: A Classification of Approaches to Manufacturing Planning and Control

Dennis Kehoe and Nick Boughton

Today the Internet provides a real opportunity for demand data and supply capacity data to be visible to all companies within a manufacturing supply chain. Consequently there is a need for manufacturing organisations to explore alternative mechanisms for the management of their operations network, in particular the role of manufacturing planning and control systems. This paper describes current research which examines the classification of manufacturing supply chains and positions Internet-based applications in order to identify the operations management challenges for the next generation of manufacturing planning and control systems.

International Journal of Operations &
Production Management,
Vol. 21 No. 4, 2001

Using previous classifications of inventory management and supply chain management the paper presents a classification which considers different types of supply chain structures to identify features of manufacturing planning and control systems based on internet as an enabling technology.

(1/4) (1) (1/2/3/9.1/9.2.1) ( ) (1)

Exhibit 11.

Developing a Framework for Supply Chain Management

Karen M. Spens and Anu H. Bask

It has been suggested that successful Supply Chain Management (SCM) requires the understanding and management of three important issues: who are the members in the supply chain; which supply chain processes link them; and, what type/level of integration do these supply chain processes require? This article is based on an extended conceptual framework developed by previous researchers and provides an application in a health care setting. The main purpose of this work is to test the usefulness and to increase the understanding of the framework in a case environment. The objective is to assess the applicability of this supply chain framework for managerial purposes.

The International Journal of Logistics Management
Vol.13, Iss.1, 2002

The authors first classify supply chains based on structure showing the number of tiers and position of the members within the supply chain. Then using previously published research they suggest a framework which is tested in the health care sector. The authors mainly consider customer relationship management, partnership, integration management, risk and reward sharing, information sharing for order processing, demand management, production strategy (make-to-order, make-to-stock), product development, procurement, performance measurement, and collaborative decision making. This taxonomy is classified as:

(3/4) ( ) (1/2/7/8.1/8.4/9.1) (1.2.3/2) ( )

Exhibit 12.

Coordinated Supply Chain Management

Thomas Douglas J. and Griffin Paul M.

Historically, the three fundamental changes of the supply chain procurement, production, and distribution, have been managed independently, buffered by large inventories. Increasing competitive pressures and market globalization are forcing firms to develop supply chains that can quickly respond to customer needs. To remain competitive, these firms must reduce operating costs while continuously improving customer service. With recent advances in communications and information technology, as well as rapidly growing array of logistics options, firms have an opportunity to reduce operating costs by coordinating the planning of these stages. In this paper, we review the literature addressing coordinated planning between two or more stages of the supply chain, placing particular emphasis on models that would lend themselves to a total supply chain model. Finally, we suggest directions for future research.

European Journal of Operational Research,
Vol. 94, Iss. 1, 1996

The authors focus on clarifying three different SC coordination mechanisms e.g., buyer-vendor, production-distribution, and inventory-distribution coordination. They also create subcategories for strategic models. This classification considers only the modelling aspect of the supply chain literature and a specific category of models. Hence;

(1/2/5) ( ) (2/3/4/8.3) ( ) ( )

Exhibit 13.

E-Business and Supply Chain Management: An Overview and Framework

M. Eric Johnson and Seungjin Whang

The web is having a significant impact on how firms interact with each other and their customers. Past stumbling blocks for supply chain integration such as high transaction costs between partners, poor information availability, and the challenges of managing complex interfaces between functional organizations are all dissolving on the web. In this paper, we examine how the web is changing supply chain management. We present a survey of emerging research on the impact of e-business on supply chain management including descriptive frameworks, analytical models, empirical analysis, and case studies. We classify the work into three major categories: e-Commerce, e-Procurement, and e-Collaboration.

Production & Operation Management,
Vol. 11, Iss. 4, 2002

The authors provide a classification which includes case studies, models, and internet as an enabling technology for procurement, collaboration, and order processing, pricing, and delivery. Later the authors create a sub section for the cases with location, inventory, marketing and pricing, sourcing, product design, reverse logistics, outsourcing, and performance measurement as sub categories.

(2.1.1/5) ( ) (1/2.1/2.3/3/5.4/6.1/7/9.1/9.2.1) ( ) ( )

Exhibit 14.

A Taxonomic Review of Supply Chain Management Research

Ram Ganeshan, Eric Jack, M.J. Magazine, and Paul Stephens

Quantitative Models for Supply Chain Management, Chapter in book[6],
Kluwer Academic Publishers, 1998

The authors, first, classify SCM research in three groups: i) research on competitive strategy which generally includes long term decisions such as location selection, new product introduction; ii) research on firm focused tactics, under this category papers are classified as systems, relationship management, integrated operations, and distributions and transportation related papers; iii) operational efficiencies which mainly focuses on inventory management; production planning and scheduling; information sharing, coordination, and monitoring; and operational tools. Then the authors categorize research methodologies used as: concept and non-quantitative models; case-oriented and empirical study; framework, taxonomies, and literature reviews; and quantitative models. This textbook based taxonomy is shown to be:

(1/2.1.1/2.2/4/5) ( ) (2/3/4/7/8) ( ) ( )

Exhibit 15.

System Dynamics Modelling in Supply Chain Management: Research Review

Bernhard J. Angerhofer and Marios C. Angelides

The use of System Dynamics Modeling in Supply Chain Management has only recently re-emerged after a lengthy slack period. Current research on System Dynamics Modelling in supply chain management focuses on inventory decision and policy development, time compression, demand amplification, supply chain design and integration, and international supply chain management. The paper first gives an overview of recent research work in these areas, followed by a discussion of research issues that have evolved, and presents a taxonomy of research and development in System Dynamics Modelling in supply chain management.

Proceedings of the 2000 Winter Simulation Conference
J. A. Joines, R. R. Barton, K. Kang, and P. A. Fishwick, eds.

These authors use a two dimensional approach for their taxonomy. The first dimension defines the article’s characteristic e.g., research, practice, or putting research into practice. The second dimension specifies the research area e.g., inventory management, demand amplification, and supply chain network design.

(1/2/3) ( ) (2/3/4) ( ) ( )

Exhibit 16.

Manufacturing Logistics Research: Taxonomy and Directions

S. David Wu, Robin O. Roundy, Robert H. Storer, and Louis A. Martin-Vega

This paper examines research directions and opportunities in manufacturing logistics based on recommendations from an NSF sponsored workshop, and subsequent efforts by the authors to synthesize, extract and revitalize the vision formed in the workshop. To convey this vision we suggest a taxonomy that characterizes research problems in manufacturing logistics by the physical entities (*systems*) involved, the level-of-abstraction, the focus, and the type of decision (*decision scope*) intended, and the broader business context (*business environment)* of which the research can be justified. A main goal of the paper is to envision

[6] No abstract provided

a broader and richer research base in manufacturing logistics through the explicit consideration of business contexts and technological trends. We argue that these renewed directions for manufacturing logistics research offer opportunities for the OR/MS professionals to exert influence on corporate decision making, and to make direct impact on software innovation.

Working paper[7]
Department of Industrial and Systems Engineering, Lehigh University

Wu et al. present their taxonomy in three dimensional space. The system dimension defines the physical entities in manufacturing environment. It ranges from the production unit to the supply chain. Decision scope includes short to long term decisions such as scheduling, inventory control, facility planning, capacity management, information sharing, integration, performance metrics, and decision making. The last dimension specifies the broader context of business environment, e.g., uncertainty, globalization, environmental factors, information technology and e-commerce, human factors, and industry convention are the subcategories of business environment that given as examples. Because the authors do not mention activities such as relationship management, return and after sales these are not included in the classification that follows:

( ) (1/2) (1/2/3/7/9) (1/2) ( )

Table 2. SCM Taxonomy papers: A summary of classifications

Exhibit	Classification
9.	( ) ( ) (1.2/3/8.1) (1) ( )
10.	(1/4) (1) (1/2/3/9.1/9.2.1) ( ) (1)
11.	(3/4) ( ) (1/2/7/8.1/8.4/9.1) (1.2.3/2) ( )
12.	(1/2/5) ( ) (2/3/4/8.3) ( ) ( )
13.	(2.1.1/5) ( ) (1/2.1/2.3/3/5.4/6.1/7/9.1/9.2.1) ( ) ( )
14.	(1/2.1.1/2.2/4/5) ( ) (2/3/4/7/8) ( ) ( )
15.	(1/2/3) ( ) (2/3/4) ( ) ( )
16.	( ) (1/2) (1/2/3/7/9) (1/2) ( )

In viewing *Table 2, it* is interesting to note the keys that remain empty. These represent those parts of the SCM domain that are not addressed by the respective taxonomies. Thus, *Exhibit 9* fails to address issues of the *Supply Chain Environment* as well as those of *Product Properties*. Interestingly, *Supply Chain Environment* is not an attribute of concern in *Exhibits 11, 12, 13, 14 and 15*. Moreover, *Exhibit 10* does not address issues of *Decision Making and Degree of Information Sharing*. This void can also be found in *Exhibits 12, 13, 14, and 15*. Oddly, *Exhibit 16* does not classify according to *Type of Study.*

Clearly, the numeric designations included in an nonempty key specify the subset of that key's attribute describing the taxonomy classified. Thus, *Exhibit 9* in the first key e.g., *Type of Study*, addresses only *Surveys and Literature Reviews. Lastly, Exhibit 15* distinguishes between *Theoretic, Applied, and Mixed theoretic and applied* studies, while *Exhibit 12* distinguishes between *Theoretic, Applied, and Modelling, etc,.*

Thus *Table 2* attests to the fact that the taxonomy of *Figure 3* subsumes all SCM literature taxonomies known to the authors and is robust enough to show that each represents but a subset of that literature e.g., each is shown to be a special case of the *Figure 3* taxonomy. Alternately stated, *Figure 3* is a more general – a more encompassing – SCM taxonomy then any other currently in the public domain.

7. Concluding Remarks

There is always a subjective side to selecting illustrative papers. The above represent different *periods*, different *journals*, differing *paths to theory extension*, differing *application sectors* and differing *research strategies*. Even the respective authors emanate from different *countries*, indeed different *continents*.

As in any new sub-discipline of Management Science, the SCM literature is growing exponentially. This literature is recording advancements in theory and in solution methodology while at the same time expanding its domain of applications.

The taxonomy of *Figure 3* was shown to be robust enough to succinctly classify the large diversity of SCM papers by using a number of rather disparate but well-known contributions to that literature. Additionally, *Figure 3* was shown to subsume all known SCM taxonomies thus indicating that each represents but a subset of that literature or is a special case of the *Figure 3* taxonomy.

Because a major objective for this taxonomy is to systematically identify the voids in the literature[8] of SCM, we erred on the side that might appear to have an excess of detail. It may be that the *Figure 3* taxonomy is too detailed than is necessary for common usage, thus violating parsimony. However, experience shows that it is easier to aggregate data in hand than not to have collected it in sufficient detail in the first place, Reisman (1979). Lastly, no taxonomy should be considered fixed for all time. It should evolve as the field it addresses evolves over time. Even the Periodic Table of chemical elements has been, and remains in the state of evolution.

References

Abbott, A. 1988. The system of professions: an essay on the expert division of labor. University of Chicago Press, Chicago, IL.

Alderson, W. 1950. Marketing efficiency and the principle of postponement. Cost and Profit Outlook 3 Sep.

Aviv, Y., A. Federgruen. 2001. Capacitated Multi-Item Inventory Systems with Random and Seasonally Fluctuating Demands: Implications for Postponement Strategies.Management Science 47(4) 512-531.

Basu, R. 2001. New Criteria of Performance Management: A Transition From Enterprise to Collaborative Supply Chain. Measuring Business Excellence 5(4) 7-12.

Beamon, B.M. 1998. Supply Chain Design and Analysis: Models and Methods. International Journal of Production Economics 55(3) 281-294.

Beamon, B.M. 1999. Measuring Supply Chain Performance. International Journal of Operations & Production Management 19(3) 7-12.

Bessler, S., A.F. Veinott. 1966. Optimal Policy for a Dynamic Multi-Echelon Inventory Model. Naval Research Logistics Quarterly 13(4) 355-389.

[7] http://www.lehigh.edu/~sdw1/papers1.htm
[8] As demonstrated for other OR/MS disciplines in Reisman (1998, 1999, and 1992)

Blattberg, R.C., G.D. Eppen, J. Lieberman. 1981. A Theoretical and Empirical Evaluation of Price Deals for Consumer Non-Durables. Journal of Marketing 45 116-129.

Blumenfeld, D. E., L. D. Burns, J. D. Diltz, C. F. Daganzo. 1985. Analyzing trade-offs between transportation, inventory and production costs on freight networks. Transportation Res. 19B 361–380.

Bowersox, D. J., David J. Closs. 1996. Logistical Management: The Integrated Supply Chain Process, The McGraw-Hill.

Bowersox, D.J. 1969. Readings in Physical Distribution Management: The Logistics of Marketing. Eds. Bowersox, D.J. , La Londe, B.J., and Smykay, E.W., New York: MacMillan.

Burns, L. D., R. W. Hall, D. E. Blumenfeld, C. F. Daganzo. 1985. Distribution strategies that minimize transportation and inventory costs. Operations. Research. 33 469–490.

Cachon, G.P., P. H. Zipkin. 1999. Competitive and Cooperative Inventory Policies in a Two-Stage Supply Chain. Management Science 45(7) 936-953.

Carter, C.R., M.M. Jennings. 2002. Social Responsibility and Supply Chain Relationship. Transportation Research Part E 38 37-52.

Chan, L.M.A., D. Simchi-Levi. 1998. Probabilistic Analyses and Algorithms for Three-Level Distribution Systems. Management Science 44(11) 1562-1576.

Chen, F, Z. Drezner, J. K. Ryan, D. Simchi-Levi. 2000. Quantifying the Bullwhip Effect in a Simple Supply Chain: The Impact of Forecasting, Lead Times, and Information. Management Sciences Vol.46, No.3: 436-443.

Chen, F. 1998. Stationary Policies in Multi-Echelon Inventory Systems with Deterministic Demand and Backlogging. Operations Research 46(3) 26-34.

Chen, F., Y. S. Zheng. 1994. Lower Bounds for Multi Echelon Stochastic Inventory Systems. Management Science 401426-1443.

Chen, F., Y.S. Zheng. 1997. One-Warehouse Multi-Retailer Systems with Centralized Stock Information. Operations Research 45 275-287.

Chen, F., Y.S. Zheng. 1998. Near-Optimal Echelon-Stock R,nQ Policies in Multistage Serial Systems. Operations Research 46(4) 592-602.

Clark, A.J, H. Scarf. 1962.Approximate solutions to a Simple Multi-Echelon Inventory Problem. In Arrow, K., Karlin, S. and Scarf, H. Ed. Studies in Applied Probability and Management Science. Stanford University Press, Stanford.

Clark, A.J., H. Scarf. 1960. Optimal Policies for a Multi-Echelon Inventory Problem, Management Science 6(4) 475-490.

Cohen, M.A., H.L. Lee. 1988. Strategic Analysis of Integrated Production-Distribution Systems Models and Methods. Operations Research 36(2) 216-228.

Cooper, M C., L. M. Ellram. 1993. Characteristics of Supply Chain Management and the Implications for Purchasing and Logistics Strategy. The International Journal of Logistics Management 4(2) 13-24.

Erkip, N., W. H. Hausman, S. Nahmias. 1990. Optimal centralized ordering policies in multi-echelon inventory systems with correlated demands. Management Science. 36(3) 381–392.

Federgruen A., P. Zipkin. 1984. A combined vehicle routing and inventory allocation problem. Operations Research 32 1019-1038.

Fisher, M. 1997. What is the Right Supply Chain for Your Product. Harvard Business Review, March-April 105-116.

Forrester, J. W. 1961. Industrial Dynamics. Cambridge, MA: MIT Press.

Fry, M. J., R. Kapuscinski, T. L. Olsen. 2001. Coordinating Production and Delivery Under a z, Z-Type Vendor-Managed Inventory Contract, Manufacturing & Service Operations Management 3(2) 151-173.

Ganeshan R., E. Jack, M.J. Magazine, and P. Stephens. 1998. A Taxonomic Review of Supply Chain Management Research, Quantitative Models for Supply Chain Management, Chapter in book, Kluwer Academic Publishers.

Geoffrion, A.M., G.W. Graves. 1974. Multi-Commodity Distribution Design by Benders Decomposition. Management Science 20: 822-844.

Goffman, W. 1980. Scientific Information Systems and the Principle of Selectivity. Praeger Publishers, New York.

Graves, S.C., 1985. A Multi-Echelon Inventory Model for a Repairable Item with One-for-One Replenishment," Management Science 31 1247-1256.

Graves, S.C., S.P. Willems. 2000. Optimizing Strategic Safety Stock Placement in Supply Chains, Manufacturing & Service Operations Management 2(1) 68-83.

Gupta, U.G. 1997. Using Citation Analysis to Explore the Intellectual Base, Knowledge Dissemination and Research Impact of Interfaces 1970-1992, Interfaces 27(2) 85-101.

Harland, C.M., Lamming, R.C., Zheng, J. and Johnsen, T.E. 2001. A Taxonomy of Supply Networks. Journal of Supply Chain Management, Fall Issue, Volume 37(4), pp.21-27.

Harper, J. 1984. Measuring Business Performance, Gower Publishing Company, Vermont.

Houlihan, J.B. 1985. International Supply Chain Management. Internationa Journal of Physical Distribution & Materials Management 15 22-38.

Houlihan, J.B. 1988. International Supply Chain Management: A New Approach. Management Decision 26(3) 13-19.

Johnson M. E. and S. Whang. 2002. E-Business and Supply Chain Management: An Overview and Framework. Production & Operation Management, Vol. 11, Iss. 4, pp. 413-423.

Jones, T.C., D.W. Riley. 1984. Using Inventory for Competitive Advantage through Supply Chain Management. International Journal of Physical Distribution and Materials Management 15 16-26.

Kehoe D. and N. Boughton. 2001. Internet based supply chain management: A classification of approaches to manufacturing planning and control. International Journal of Operations & Production Management, Vol. 21 No. 4.

Lee, H. L., K. C. So, C.S. Tang. 2000. The Value of Information Sharing in a Two-Level Supply Chain. Management Science 46(5) 626-643.

Lee, H.L. and Billington, C. 1995. The evolution of supply-chain-management models and practice at Hewlett-Packard. Interfaces 25 42-63.

Lee, H.L., C. Billington. 1993. Material Management in Decentralized Supply Chains. Operations Research 41 835-847.

Lee, H.L., K. Moinzadeh. 1987a. Operating Characteristics of a Two-Echelon Inventory System for Repairable and Consumable Items Under Batch Ordering and Shipment Policy, Naval Research Logistics Quarterly 34 365-380.

Lee, H.L., K. Moinzadeh. 1987b. Two-Parameter Approximations for Multi-Echelon Repairable Inventory Models with Batch Ordering Policy, IIE Transactions 19 140-149.

Lee, H.L., V. Padmanabhan, S. Whang. 1997. Information Distortion in a Supply Chain: The Bullwhip Effect. Management Science 43 546-558.

McCarthy E. J. and Jr. W. D. Perreault. 1990. Basic Marketing: A Managerial Approach 10th Ed.. Richard D. Irwin Inc., Boston-USA.

Mendeleyev, DI. 1889. The periodic law of chemical elements Faraday lectures. Journal of the Chemical Society 55 643-656.

Miller, T. 2001. Hierarchical Operations and Supply Chain Planning, Springer-Verlag, London.

Pyke, D.F., M. E. Johnson. 2002. Sourcing Strategy and Supplier Relationships: Alliances vs. eProcurement, forthcoming in The Practice of Supply Chain Management. Kluwer Publishers, C. Billington, H. Lee, J. Neale, T. Harrison editors.

Reisman, A. 1979. Systems Analysis in Health-Care Delivery, Lexington Books, Lexington, Mass.

Reisman, A. 1989. A System Approach to Identifying Knowledge Voids in Problem Solving Disciplines and Professions: A Focus on the Management Sciences. Knowledge in Society: An International Journal of Knowledge Transfer 14 67-86.

Reisman, A. 1992. Management Science Knowledge: It's Creation, Generalization and Consolidation. Westport CT: Quorum Books Publishing Company.

Reisman, A. 1994. Creativity in MS/OR: Expanding Knowledge by Consolidating Knowledge. Interfaces 24(3) 91-99.

Reisman, A. l988. Finding Researchable Topics Via a Taxonomy of a Field of Knowledge. Operations Research Letters 7(6) 295-301.

Revelle, C.S., G. Laporte. 1996. The plant location problem: New models and research prospects. Operations Research 44 864-874.

Rolstadås, A. 1995 Performance Management: A Business Process Benchmarking , Chapman & Hall, London.

Spens K. M.and A. H. 2002. Bask Developing a Framework for Supply Chain Management. The International Journal of Logistics Management Vol.13, Iss.1.

Thomas, D.J., P.M. Griffin. 1996. Coordinated supply chain management. European Journal of Operational Research 94 (1) 1-15.

Vogel, D.R., J.C. Weterbe. 1984. MIS research: A profile of leading journals and universities. Data Base Fall: 3-14.

Wu S. D., R. O. Roundy, R. H. Storer, and L. A. Martin-Vega. Manufacturing Logistics Research: Taxonomy and Directions. Department of Industrial and Systems Engineering, Lehigh University, Working Paper.

Zinn, W., D.J. Bowersox. 1988. Planning Physical Distribution with the Principle of Postponement. Journal of Business Logistics 9 117-136.

Zinn, W., M. Levy. 1988. Speculative Inventory Management: A Total Channel Perspective. International Journal of Physical Distribution & Materials Management 18 34-39.