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LAGGING BEHIND *VERSUS* ADVANCING TOO FAST?

IDENTIFYING GAPS RESEARCH IN SUPPLY CHAIN

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Abstract

The objective of our work is to analyze the evolution and actual trends of research in Supply Chain Management (SCM). We pretend to show how the different topics have been methodologically studied, and to determine how the advent of the so-called 'New Economy' has influenced SCM research. To get this objective, we carry out a literature review of twelve refereed journals in the Operations Management (OM) area for the period 1995-2001. Statistical tools are used to analyze the obtained information.

Keywords: Supply Chain Management, Taxonomy, Literature Review

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Introduction

Nowadays, none may doubt about the relevance of Supply Chain Management (SCM) research in the field of operations. So, by having a look at the tracks of Operations conferences (POMS, EUROMA), some of them are always dedicated to SCM. Besides, most papers that analyze the evolutions and trends of OM research emphasize that SCM is a leading topic into this area; Nof (1999) and St. John *et al.* (2001) cite SCM as one of the most important strategic research topics for XXI Century. Geoffreion and Krishnan (2001) defines SCM, together with financial services, electronic markets, network infrastructure and travel-related services, as one of the causes of the so called digital economy, which is creating abundant opportunities for Operations Research applications, and, therefore, for Operations Management (OM) research. Though, the importance of SCM research is relatively new. For instance, Amoako-Gympah and Meredith (1989) analyzed the issue of OM research agendas for 1990s, and SCM was not included as a relevant topic. Other proof of this sudden appearance of SCM is that only five years ago OM handbooks did not devote specific chapters to SCM.

However, along the nineties, the increase of competitiveness, the advent of globalization and the new information technologies have made OM decisions become a relevant strategic tool for the firm. Pannirselvam *et al.* (1999) examines the state of OM research in the 1990s from the standpoint of topic and methodologies, and one of its findings is the definition of eighteen emerging OM topics, eight ones from which were classified as SCM topics: purchasing, facility layout, forecasting, project management, quality of work life, facility location, distribution and work measurement.

The objective of our work is to analyze the evolution and actual trends of research in Supply Chain Management (SCM). We pretend to show how the different topics have been methodologically studied, and to determine how the advent of the 'New Economy' has influenced SCM research. Specifically, the questions this research tries to answer are:

- Has the advent of the 'New Economy' influenced SCM research?
- Are 'emergent' topics studied with different methodologies than 'traditional' ones?
- Which are the main current research gaps in SCM?

To answer these questions, we carry out a literature review of twelve refereed journals in the Operations Management (OM) area for the period 1995-2001. Our research was based on a sample of 376 SCM papers, and statistical tools were used to analyze the obtained information.

We were conscious that the analysis of SCM research does not limit to OM literature. In fact, one of the main features associated to SCM is that it permits to extend the interface with other fields. St. John *et al.* (2001) emphasizes that SCM research has increased the links with other fields, like economics, sociology and psychology. Grover and Malhotra (1999) focuses on the interface between Operations and Information Systems, and cites SCM as one of the topics where this interface is more relevant. However, our initial analysis allowed us to collect more than three hundred papers, which constitutes a relevant preliminary database for the purpose of developing significant statistical analysis of SCM research, aimed at answering the questions we pose.

Relevance and originality of the research

The strong influence of technological changes, particularly in the information management domain, has made SCM evolve very fast from mid 90's. As a consequence, the content of SCM research field has changed so quickly that it is very common to find taxonomy papers associated to SCM field in OM journals and conferences.

Mabert and Venkataramanan (1998) set the stage for recently completed research concentrating on SCM issues. This paper illustrates the many paths SCM has traveled, and includes important contributions to supply management understanding and decision making. This article also defines future research directions on SCM to be pursued by interested researchers. Similar papers were carried out in an special issue of Industrial Marketing Management, where some authors (Lancioni, 2000, Ballou *et al.*, 2000, and Lambert and Cooper, 2000) try to determine the new challenges from SCM in the marketing area. Carter and Narasimhan (1996), Trent and Monczka (1998) and Carter *et al.* (2000) analyze Purchasing and Supply Management trends and changes throughout the 1990s. All of them rely upon the opinions of purchasing executives to get their conclusions. Ellram and Carr (1994) studies the evolution of the Strategic Purchasing function since the early 1970s, but they do not carry out an exhaustive analysis of literature. Harland *et al.* (2001) develop a taxonomy study, but they focus on supply networks. Beamon (1998) provides a focused review of literature in multi-stage SC modeling.

Finally, we should cite those other research papers wherein an exhaustive analysis of OM literature can be found, such as in our article. Table 1 summarizes them and their aims. Babbar and Prasad (1998), and Croom *et al.* (2000) are the papers most similar to ours because they analyze the main topics associated to SCM research. Though, these papers just focus on the findings of topics developed by OM researchers. Our analysis wants to go one step further and tries to analyze not only which topics are treated in SCM research in the OM area, but how they are methodologically addressed as well

PAPERS (In chronological order)	MAIN RESEARCH TOPIC
Boone *et al.* (1996)	Analysis of international operations networks
Malhotra and Kher (1996)	Institutional research productivity in POM
Babbar and Prasad (1998)	An assessment and an agenda for international purchasing, inventory management and logistics research
Scudder and Hill (1998)	Review and classification of empirical research in OM
Pannirselvam *et al.* (1999)	Agenda for OM research
Pilkington and Liston-Heyes (1999)	Is POM an academic discipline?
Prasad *et al.* (2000)	Comparative analysis of international OM and OM research
Babbar *et al.* (2000)	Empirical assessment of institutional and individual research productivity in international OM
Dangayach and Deshmukh (2001)	Manufacturing strategy research
Croom *et al.* (2001)	Taxonomy analysis of SCM research
Prasad *et al.* (2001)	Current efforts and future directions of international OM

Table 1. Articles devoted to review OM literature.

We may observe that there are papers that analyze literature associated to SCM research, and other ones that try to foresee its future; nevertheless, none of them makes an statistical study of SCM literature, aiming at determining the gaps research in terms of topics and methodological profiles.

Methodology

Babbar and Prasad (1998), Prasad *et al.* (2000), Prasad *et al.* (2001) and Danagayach and Deshmukh (2001) constitute the methodological leading guides of our article, since their contents and approaches have very much inspired our research efforts.

Selection of journals

Goh *et al.* (1996) shows that OM academic and practitioners have three preferred channels for presenting their research results to their colleagues: periodical publication, -the most preferred one, together with handbooks, and scientific conferences. To restrict our sample to journals, we also took into account that the use of journals as a source of data is a methodology is frequently used in the economic sciences (see, for instance, Stahl *et al.*, 1998).

Given this first distinction, second step consisted on the choice of the journals we were going to consult. Our purpose was to include journals considered flagships by OM researchers. One of the best proofs of the growth of OM field is the increase of journals related to this field. This growth has made many authors try to classify journals wherein OM academic and practitioners publish, and determine most significant ones in order to know the state-of-art of OM research.

The journals we include in this paper are twelve: Decision Sciences, European Journal of Operational Research, IIE Transactions, Interfaces, International Journal of Operations and Production Management, International Journal of Production Economics, International Journal of Production Research, Journal of Operations Management, Management Science, Omega, Operations Research and Production and Operations Management. Our choice was made through the comparison and analysis of previous studies that classified and ranked most significant OM journals. Among them, we distinguished two classes of paper. On one hand, the ones whose main aim is to classify and rank the OM journals; on the other hand, the ones that carry out a review analysis of the literature, following a trend similar to the one we are following.

Taking into account papers published since 1995, we may include in the first group, those articles by Goh *et al.* (1996), Vokurka (1996), Young *et al.* (1996), Goh *et al.* (1997), Soteriou *et al.* (1999), Donohue and Fox (2000), and Vastag and Montabon (2002), whose specific objective is to analyze OM journals. In the second group, and also from 1995 on, we may include all the

studies cited in Table 1. We do not consider papers published before 1995 because some relevant journals haven´t appeared as yet, which prevented them from emerging in traditional studies.

To choose the set of journals of our study, we focused on the papers of the first group. Table 2 shows the list of the journals included in all these studies that used some criteria, such as citation reports and surveys to OM researchers (US or European ones), to create a ranking. We have only considered the journals that appear, at least, in two of these articles and the ranking of the journal appears in parentheses. As we may observe, this set of journals does not specifically focus on SCM research, but on OM research instead. All the journals included in our set appear in cursive and, as the rankings show, the most relevant ones are included (MS, JOM, OR, POM, DS and IIE).

Choice of papers

The choice of the papers was carried out after a detailed reading of the title and keywords of all the papers published in our set of journals during 1995-2001. This period was chosen because SCM growth took place mainly in the late 1990s. Thus far, we started our study in 1995 to focus on the second part of 90's and first 2000s. First, we chose the papers that included either in the title or in the keywords one word that could be related to SCM. Once have read the abstract, we decided whether including the paper as a SCM one or not. Anytime there was a doubt, we discussed about it and all together came to the final decision. We have to emphasize that it was usual that some of the papers that included some of the above words, did not take part of the sample as we consider SCM paper those that analyse aspects related to SCM, but also studies co-jointly, at least, the activities, performance measures, and strategies that directly affect to, at least, two members of a SC. The final size of the sample comprises 376 papers, which seems to be an important figure, compared to samples used in similar studies, such as the 141 journals for Babbar and Prasad (1998).

→ Article ↓ Journal	Vokurka (1996)	Soteriou *et al.* (1999)	Donohue and Fox (2000)	Barman *et al.* (2001)
Academy of Management Journal (AMJ)		X (20)		X (18)
Academy of Management Review (AMR)		X (23)		X (20)
Computers and Industrial Engin. (CIE)		X (29)	X (18)	X (21)
Computers and Ops. Research (COR)		X (22)	X (16)	X (19)
Decision Sciences (DS)	*X (2)*	*X (15)*	*X (6)*	*X (4)*
European Journal of Operational Research (EJOR)	*X (12)*	*X (7)*	*X (9)*	*X (12)*
Harvard Business Review (HBR)	X (3)	X (9)		X (7)
IIE Transactions (IIE)	*X (7)*	*X (11)*	*X (3)*	*X (6)*
Interfaces (INTERFACES)	*X (8)*	*X (16)*	*X (14)*	*X (9)*
Int. Journal of Ops. and Prod. Mgmt. (IJOPM)	*X (11)*	*X (2)*	*X (15)*	*X (10)*
Int. Journal of Prod. Economics (IJPE)		*X (8)*		*X (14)*
Int. Journal of Prod. Research (IJPR)	*X (10)*	*X (5)*	*X (13)*	*X (8)*
Int. Journal of Purchasing and Materials Management (IJPMM)		X (25)	X (17)	X (17)
Journal of Operational Res. Soc. (JORS)		X (12)	X (8)	X (16)
Journal of Operations Management (JOM)	*X (5)*	*X (1)*	*X (7)*	*X (1)*
Management Science (MS)	*X (1)*	*X (3)*	*X (1)*	*X (3)*
Naval Research Logistics (NRL)	X (9)	X (17)	X (4)	X (11)
Omega (OMEGA)		*X (14)*	*X (12)*	*X (15)*
Operations Research (OR)	*X (4)*	*X (6)*	*X (2)*	*X (5)*
Prod. and Inv. Management Journal (PIMJ)	X (6)	X (13)		X (13)
Prod. and Operations Management (POM)		*X (4)*	*X (11)*	*X (2)*

Table 2. Set of selected journals.

Taxonomy analysis

To establish a category of topics, we adopted the methodological approach of Malhotra and Kher (1996); accordingly, we commenced by making a preliminary list of topics inspired by the above mentioned keywords and taxonomy studies in SCM. Then, we defined those emergent subjects which may be triggered by the advent of the New Economy. For this purpose, we checked the last

SCM tracks of POMS and EUROMA conferences. This helped us to define two emergent topics: *Information and Time Management (T2)* and *Environmental Issues (T3)*.These emergent topics are also cited in different studies, such as those by Sarkis (2001), Burgos and Céspedes (2001), and Angell and Klassen (1999). Thereby, our list of topics includes the following issues, as described in Table 3.

TOPIC	CONTENTS
Design of Strategies and Models (T1)	How to create and implement a procurement strategy, Coordination strategies, Performance measures, Competitive strategies versus partnership strategies, Sourcing strategies, Cooperative development process, Logistics Chain Modeling, Vertical integration and Extended-Enterprise SCM, JIT Full Business Cycle, JIT purchasing strategies, Freight Collection Model, Location Models and Warehousing conditions, Review, taxonomy and future, Quick response programs, Integrated inventory/transportation and production/distribution system, Integrated distribution, manufacturing and assembly planning, Integrated product development strategy.
Information and Time Management (T2)	Bullwhip effect, Demand information, Asymmetric information, Lead time information, Effects of information feedback and time delays on behavior SC, Delivery windows, EDI, Internet.
Environmental issues (T3)	Quantitative models for reverse logistics, Return plant location, Optimizing models, Effect of decentralized information, Logistics networks
Factors that Affect the Formation of Strong Linked SC (T4)	Power relationships, Inter-firms dependence and environmental uncertainty, Operational interdependencies between the units of SC, Ability to plan the governance structure, Product structure/variety and the nature of the process influence, Exit and entry barrier, Structure of the industry, Culture of one of the parts, Inter-firms asset specificity, Competitive strategy, Asymmetric information, Number of components, Postponement strategy, Demand variability and volume, Quantity discounts, Quality strategies.
Inventory Policies (T5),	.Techniques to select suppliers, Managers' perception of the attributes: theory versus practice, Quantity Flexibility contracts, Effects of local content rules, Supply contracts, Negotiation process, Rating suppliers.
Criteria, Techniques to Choose Suppliers (T6).	Muli-echelon inventory policies, Inventory and pricing models, Multistage production-inventory systems, Lot size under quantity discounts, Role of return policies in inventory, Inventory as a tool performance measure of control and cooperation.

Table 3. Taxonomy of SCM research topics.

As it regards the methodological profile, we classified the papers into four categories: *Descriptive (D), Empirical (E), Mathematical Models (MM), and Literature Review (LR)*. Concerning empirical models, we differentiated among *Case Study (CS), Survey (S) and DataBase(DB*) papers. For this classification we followed previous studies by Filippini (1997), and other studies cited in Table 1.

Results

Table 4 shows the chronological distribution of the 376 papers in our sample, classified by journals. For every journal, the Table displays the percentage that the number of papers represents of the whole yearly papers. In bold, we signal those years where there was an special issue dedicated to SCM. In this sense, we may observe as DS, IJPE, INTERFACES and POM were the only journals that published an specific issue devoted to SCM.

The data analysis brings into the light different conclusions. First, along 1995-96 the relative weight of SCM papers is very low with no percentage values higher than 10%. Between 1997-99, the number of SCM paper increases from 33 in 1997 to 64 to 1999,being usual to observe percentage values higher than 10%. Though, during 2000-01, this increase is even much stronger, and we may conclude that SCM research clearly consolidates into OM literature. Of course, this degree of consolidation varies between journals. So, in OM oriented ones (POM, IJOPM, JOM and POM) this is clearer than for the Operation Research ones (OR and EJOR) and Management Science oriented journals (MS, DS and OMEGA).

Our second analysis pretended to define the behavior of SCM topics along 1995-2001. Table 5 depicts that the advent of the New Economy has led to changes in SCM research, but not so much as we might have figured out. For instance, SCM researches keeps focusing on the Design of both SCM strategies and models, and environmental papers have a secondary role in SCM research. Though, it appears clear that the topic Information and time management research *(T2)* has consolidated as the second topic in importance, and that Inventory papers *(T5)* have clearly reduced their weight. Finally, the study of the factors affecting SCM success (*T4*) and SC relationships (*T6)* have become a well define field research into SCM area.

Journals	1995	1996	1997	1998	1999	2000	2001
DS	4.55%	4.65%	2.08%	**22.22%**	4.35%	5.56%	0.00%*
EJOR	1.71%	1.46%	1.04%	2.02%	1.82%	2.31%	4.07%
IIE	1.15%	0.00%	5.10%	1.22%	6.52%	5.15%	2.13%
IJOPM	5.88%	8.05%	5.56%	12.33%	15.15%	12.33%	22.09%
IJPE	0.81%	3.16%	0.69%	3.54%	8.24%	3.87%	**8.62%**
IJPR	2.45%	0.55%	0.49%	0.50%	3.56%	3.15%	2.88%
Interfaces	2.47%	0.00%	1.09%	0.00%	1.25%	**23.64%**	12.50%*
JOM	2.27%	5.00%	23.81%	5.13%	11.76%	8.57%	20.59%
MS	3.03%	1.71%	1.59%	1.34%	7.56%	5.45%	8.93%
OMEGA	1.79%	0.00%	1.64%	1.85%	0.00%	8.93%	6.38%
OR	1.15%	0.00%	0.00%	2.06%	0.00%	8.93%	7.50%
POM	4.00%	0.00%	**23.53%**	6.25%	7.69%	**43.33%**	18.18%
TOTAL	2.29%	1.77%	2.40%	3.20%	4.59%	6.05%	7.00%

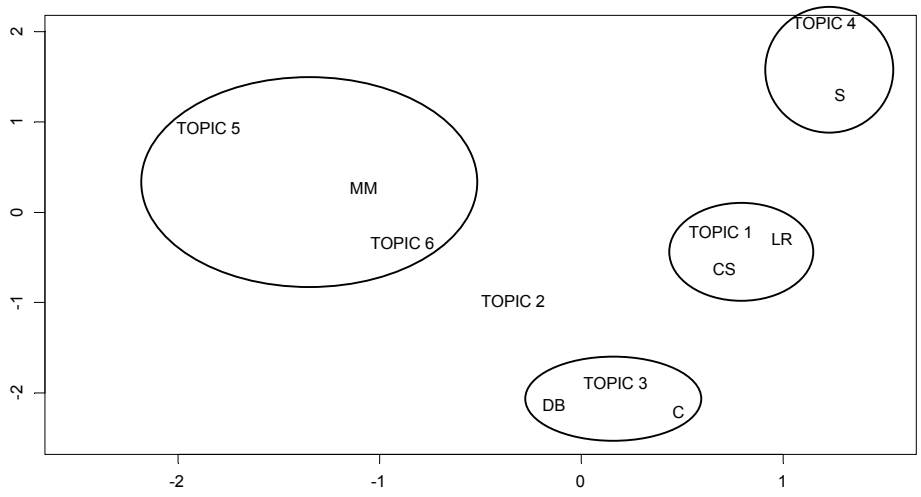
Table 4. Evolution of SCM papers in the analysed journals during 1995-2001.

[*] *Last number of 2001 was not available at the moment of the research analysis.*

	TOPIC 1	TOPIC 2	TOPIC 3	TOPIC 4	TOPIC 5	TOPIC 6
1995	25.00%	21.88%	6.25%	3.13%	28.13%	15.63%
1996	41.67%	4.17%	0.00%	0.00%	37.50%	16.67%
1997	30.30%	21.21%	6.06%	15.15%	15.15%	12.12%
1998	47.73%	11.36%	6.82%	11.36%	13.64%	9.09%
1999	48.44%	18.75%	0.00%	10.94%	12.50%	9.38%
2000	46.91%	18.52%	9.88%	11.11%	7.41%	6.17%
2001	36.73%	14.29%	7.14%	11.22%	18.37%	12.24%

Table5. Distribution of SCM papers in terms of Topics classification.

A third purpose of our analysis consists on identifying how the different research topics has been methodologically faced. To do so, we carried out a correspondence analysis with the aim of finding links between topics and methodological profiles. Figure 1 shows the obtained results.



Most important result based on this Figure is that every methodological profile is clearly biased to an specific topic (or two like.maximum), which enables us to define evident research gaps.

Figure 1. Correspondence analysis Topics – Research methodology.

Most important gaps would include:

i) Empirical paper for environmental issues.

ii) Sectorial analysis of SC desing and strategies, because as far as today, they focus on case studies.

iii) Empirical analysis of SC relationships and not focus so much on mathematical studies of supply contracts.

Finally, we focus our research into empirical papers. Tables 6, 7 and 8 illustrate our results, and they provide us with relevant information concerning empirical research:

i) Case studies are the most common technique to carry out an empirical research, and Data Base methodology has a residual value.

ii) USA is the country where most empirical SCM research is implemented.

iii) Service industry has a low weight compared to manufacturing one. So, papers based on automotive papers are more than all services ones.

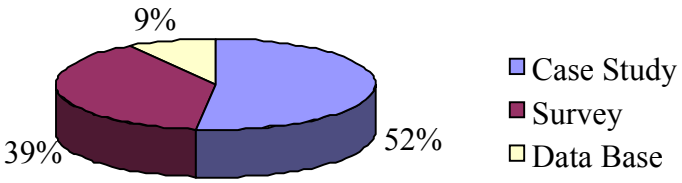


Figure 2. Distribution of empirical paper in terms of methodological profile.

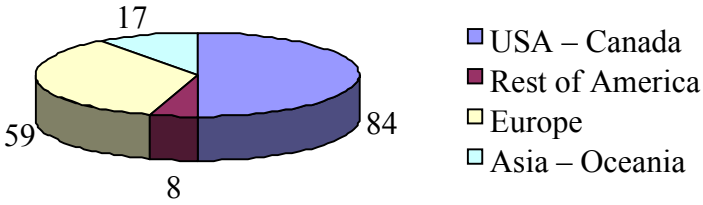


Figure 3. Distribution of empirical paper in terms of geographical implementation.

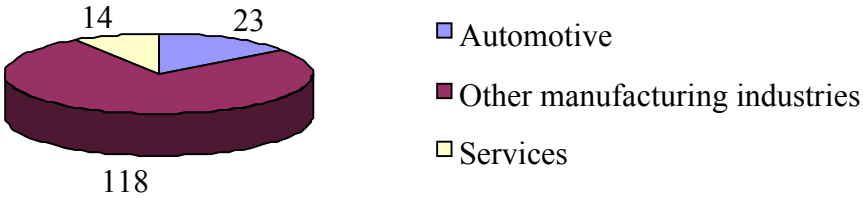


Figure 4. Distribution of empirical paper in terms of sectorial implementation.

Further Research

This study is clearly open to be expanded trough different research lines. First, we could include additional OM journals, as well as SCM specialized ones. This would help us to make a more exhaustive analysis of SCM topics, enlarging their number, -specially for those associated to Topic1, which represents the widest one-. Second, it could be advisable to compare our results with those of similar previous analysis in other fields, like logistics, marketing and information systems. Third, the sample may still be used to gather additional information, such as origin of the authors (university and country), features of the models, and so on, which could enrich the study.

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