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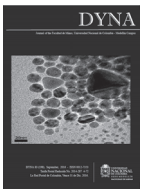

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Characterization of supply chain problems

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Abstract
The current contribution intends to identify, characterize and provide context to the most usual supply chain problems. One hundred and twenty three SC problems were identified and addressed in a specific area that locates them within the context of the fundamental SC components. The conceptual framework developed here identifies different degrees of similarity among SC problems. Finally, as a practical example, the production scheduling problem is characterized. By making the interactions among SC problems and the implications of the available decisions that are likely to solve them clear, the present contribution is not only a useful scorecard for decision makers, but it is also an upgraded conceptual development for theoreticians on the topic. As they are the central object of business competitiveness, SC improvements such as the present one are greatly valuable in terms of the social and economic profit of more efficient chains, sustainable organizations and wealthy stakeholders.

Keywords: supply chain management; logistics.

Caracterización de las problemáticas de la cadena de abastecimiento

Resumen
El trabajo identifica 123 problemáticas cada una de las cuales es vinculada en la estructura mediante una notación. Para ilustrar el desarrollo de trabajos futuros se usa como ejemplo de caracterización el problema de programación de la producción. La estructura aquí definida establece una base que facilita el despliegue teórico de nuevos desarrollos en gerencia de la cadena de abastecimiento y a su vez facilita la labor de los tomadores de decisión. El trabajo representa un esfuerzo por establecer una visión holística para el estudio de la cadena y su mejoramiento en términos de competitividad y sostenibilidad en pro del beneficio de sus *stakeholders*.

Palabras clave: gerencia de la cadena de abastecimiento; logística.

1. Introduction

The Supply Chain (SC) can be seen as an integrated process in which raw materials are transformed into a final product that is delivered to the consumer through distribution centers, retailers or by both [1]. The SC has traditionally been understood as having three stages, namely suppliers (related to procurement), manufacturers (production) and retailers - consumers (delivery). Each of these stages may take place at several facilities or companies distributed in echelons, which are homogeneous groups of specific facilities [2]. Companies and materials within the SC, as well as the information and financial resources flowing through them, are integrated in such a way that changes in one of them affect the performance of the whole chain [1,3].

The importance of the SC lies in its comprehensive and holistic character, which intends to generate and add value. The possibilities of improving the SC are related to effectively managing competitiveness, an aspect the remarkable impact of which has made it object that is sought to constantly be improved. SC management seeks to impact value generation by promoting both efficiency and customer service, which implies component operation and coordination improvement.

Supply chain management (SCM) promotes the efficient planning, execution and control of these systems' operations. The SC is currently becoming more and more complex because of continuous changes in customer needs, the emergence of a global economy and, overall, because the demands set on its performance have been increasing due to rapid escalation of

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competitiveness; all of these constitute a major management challenge. SCM encompasses raw material storage and movement, stock processing, and finished product handling until final delivery [4,5]. It always wants to benefit the stakeholders and efficiently fulfill the chain's purpose.

One of the main objectives of SCM is promoting SC performance improvement. Deficiencies in problem identification and in measuring the performance of solutions have been recognized as being some of the main current limitations of the management processes [6,7]. Conversely, improvements in troublesome areas have been found to improve the whole system [8].

SCM requires a deep understanding of the problems and implications of the SC. Thus, establishing an effective SCM system requires the fundamental characterization of an adequate decision framework to face SC problems, which is actually a basic scorecard that allows for broad contextual vision and controlled and effective management. From this current work's standpoint, the control of SC processes implies that the relation between the different problems they deal with be determined [9]. The SC problems are present at three decision levels, namely strategic, tactical and operational. Strategy influences higher decision levels, frequently requiring thorough research into areas such as business policy, financial planning, competitiveness and organizational goal achievement. Tactical problems deals with two functions: the assignation of resources and the development of strategic objectives. Problem solving at this level requires valuable information about middle level decision management. In turn, the solution to operational problems requires precise data to evaluate the impact of those decisions taken by low-level administrative personnel. This paper intends to develop a comprehensive framework for the decision-making of specific SC problems. This framework allows not only for SC problems to be determined together with their implications and interrelations, but also it identifies gaps in the literature on SCM and provides an new approach to solving them. After a thorough literature review, the first part of the paper defines the fundamental units of the SC, while the second part introduces the characterization of potential SC problems within the framework mentioned.

2. State of the art

We conducted a thorough literature search on the SC problems in question, and we found 82 relevant books from the 1993-2011 period. These are shown in Table 1.

Table 1.
Reviewed books and book chapters.

Year	Author(s)	Title
1993	American Telephone and Telegraph Company	Design's impact on logistics
1999	Anupindi, R., Chopra, S., Deshmukh, S.D., Van Mieghem, J.A. and Zemel, E.	Managing business process flows
1998	Arnold, J.R.T.	Introduction to materials management
2004	Ballou, R.H,	Business logistics/Supply chain management
2001	Bauer, M.J., Poirier, C.C., Lapide, L. and Bermudez, J.	e-Business: The strategic impact on supply chain and logistics
1976	Bender, P.	Design and operation of customer service systems
2004	Blanchard, B.S.	Logistics engineering and management
2007	Blanchard, D.	Supply Chain Management – Best Practices.
2002	Bloomberg, D.J. Lemay S. and Hanna J.B.	Logistics
2000	Bovet, D. and Martha, J.	Value nets: Breaking the supply chain to unlock hidden profits
1978	Bowersox, D.J.	Logistical management
1996	Bowersox, D.J. and Closs, D.J.	Logistical management: The integrated supply chain process
2002	Bowersox, D.J., Closs, D.J. and Cooper, M.B.	Supply chain logistics management
1992	Bowersox, D.J., Daugherty, P.J., Dröge, C.L., Germain, R.N. and Rogers, D.S.	Logistical excellence: It's not business as usual
1999	Boyson, S., Corsi, T.M., Dresner, M.E. and Harrington, L.H.	Logistics and the extended enterprise: Benchmarks and best practices for the manufacturing professional
2006	Bozarth, C.C., Handfield, R.B.	Introduction to Operations and Supply Chain Management
1997	Bramel, J. and Simchi-Levi, D.	The logic of logistics: Theory, algorithms, and applications for logistics management
1990	Brunet, H. an d Le Denn, Y.	La démarche logistique
2010	Burt, D. N., Petcavage, S. D., & Pinkerton, R. L.	Supply management
2004	Cohen, S. and Roussel, J.	Strategic Supply Chain Management: The five Disciplines for Top Performance.
2004	Chopra, S. and Meindl, P.	Supply chain management Strategy, planning, and operation
1983	Colin, J., Mathe, H. and Tixier, D.	La logistique au service de l'entreprise
1997	Copacino, W.C.	Supply chain management: The basics and beyond
2003	Coyle, J.J., Bardi, E.J., Langley Jr., C.J.	The management of business logistics: A supply chain perspective
2004	Chang, Y.S., Makatsoris, H.C., Richards, H. D.	Evolution of Supply Chain Management – Symbiosis of adaptive value networks and ICT.
1998	Dornier, P.-P., Ernst, R., Fender, M. and Kouvelis, P.	Global operations and logistics: Text and cases
1997	Eymery, P.	La logistique de l'entreprise
1992	Fawcett, P., Mcleish, R. an d Ogden, I.	Logistics management
2000	Fernandez-Ranada, M., Gurrola-Gal, F.X. and Lopez-Tello, E.	3C: A proven alternative to MRPII for optimizing supply chain performance
2001	Fleischmann, M.	Quantitative models for reverse logistics
1992	Francis, R.L., McGinnis, L.F. Jr. an d White, J.A.	Installation layout and location: An analytical approach
2001	Fredendall, L.D. and Hill, E.	Basics of supply chain management
1998	Gattorna, J., editor	Strategic supply chain alignment: Best practice in supply chain management
1990	Gattorna, J., Trost, G. and Kerr, A., editors	The Gower handbook of logistics and distribution management
2003	Giard, V.	Gestion de la production et des flux

2012	Giese, A.	Differenziertes performance measurement in supply chains
2001	Gourdin, K.N.	Global logistics management: A competitive advantage for the new millennium
1993	Graves, S.C., RinnooyKan, A.H.G. and Zipkin, P.H.	Handbook in Operations Research and Management Science. Volume 4 — Logistics of production and inventory
1999	Handfield, R.B. and Nichols, E.L. Jr.	Introduction to supply chain management
1973	Heskett, J.L., Glaskowsky, N.A. and Ivie, R.M.	Business logistics
2007	Hubner, R.	Strategic supply chain Management in Process Industries – An application to Specialty Chemicals Production Netrwork Design.
2008	Huo, Y., Jia, F.	Supply Chain - The Way to Flat Organization
1987	Hutchinson, N.E.	An integrated approach to logistics management
2012	Jacobs, F. R., & Chase, R. B.	Operations and Supply Chain Management: The Core
1999	Johnson, J.C., Wood, D.F., Wardlow, D.L. and Murphy, P.R. Jr.	Contemporary logistics
1998	Kasilingam, R.G.	Logistics and transportation: Design and planning
1978	Kearney, A.T.	Measuring productivity in physical distribution
2007	Kogan K. and Tapiero C.S.	Supply chain games: Operations management and risk valuation
2008	Kordic, V.	Supply Chain - Theory and Applications
2005	Riopel, D., Langevin, A., and Campbell, J.F.	The Network of Logistics Decisions, in Logistics Systems: Design and Optimization
1998	Lambert, D.M., Stock, J.R. and Ellram, L.M.	Fundamentals of logistics management
1976	Lambillotte, D.	La fonction logistique dans l'entreprise
1995	Langford, J.W.	Logistics: Principles and applications
2003	Lawrence, F.B., Jennings, D.F. and Reynolds, B.E.	E-Distribution
2005	Lawrence, F.B., Jennings, D.F. and Reynolds, B.E.	ERP in distribution
2007	Lee, H., Lee, C.	Building Supply Chain Excellence in Emerging Economies
1993	Leenders, M.R. and Fearon, H.E.	Purchasing and materials management
2011	Li, J., Chen, J., and Wang S.	Risk management of supply and cash flows in supply chains
1999	Lowson, B., King, R. and Hunter, A.	Quick response: Managing the supply chain to meet consumer demand
2000	Lynch, C.F.	Logistics Outsourcing: A management guide
2002	Miller, T.C.	Hierarchical Operations and Supply Chain Planning.
2002	Monczka, R., Trent, R. and Handfield, R.	Purchasing and supply chain management
2004	Murphy Jr., P.R. and Wood, D.F.	Contemporary logistics
1973	Muther, R.	Systematic layout planning
2001	Pimor, Y.	Logistique: Techniques et mise en œuvre
1993	Pons, J. and Chevalier, P.	La logistique intégrée
2000	Ptak, CA and Schragenheim, E.	ERP: Tools, techniques and applications for integrating the supply chain
2002	ReVelle, J.B., editor	Manufacturing handbook of best practices: An innovation, productivity, and quality focus
1994	Robeson, J.F., Copacino, W.C. and Howe, R.E., editors	The logistics handbook
2009	Röderstein, R.	Erfolgsfaktoren im supply chain management der DIY-Branche
2003	Seifert, D.	Collaborative planning, forecasting, and replenishment: How to create a supply chain advantage
2001	Shapiro, J.F.	Modeling the supply chain
2003	Simchi-Levi, D. and Kaminsky, P., Simchi-Levi, E.	Designing and managing the supply chain: Concepts, strategies and case studies
1973	Smykay, E.W.	Physical distribution management
1997	Southern, R.N.	Transportation and logistics basics: A handbook for transportation and logistics, professionals and students
2008	Stadtler, H. and Kilger, C.	Supply Chain Management and Advanced Planning, concepts, models, software and case studies.
2004	Stevenson, W.J. and Hojati, M.	Operations management
1998	Stock, J.R.	Development and implementation of reverse logistics programs
2001	Stock, J.R and Lambert, D.M.	Strategic logistics management
2011	Swink, M., Melnyk, S. A., Cooper, M. B., & Hartley, J. L.	Managing operations across the supply chain
1999	Tayur, S., Ganeshan, R. and Magazine, M., editors	Quantitative models for supply chain management
1997	Tilanus, B.	Information systems in logistics and transportation
2010	Waters, D	Global logistics: New directions in supply chain management
2011	Waters, D	Supply chain risk management: Vulnerability and resilience in logistics
2005	Wisner J.D. Leong, G.K. and Tan, K.-C.	Principles of supply chain management: A balanced approach
1992	Womack, J.P., Jones, D.T. and Roos, D.	Le *système* qui va changer le monde
2007	Zhang. Q.	E-Supply Chain Technologies and Management

Source: The authors

In summary, these works present concepts, definitions, functionalities, planning processes and case developments, among other considerations. Nevertheless, none of them includes a framework that allows the problems confronted by the SC to be identified and organized.

According to the literature review presented in Table 2, the most frequent problems that are associated with the SC are: (i) customer satisfaction, (ii) delivery management, and (iii) costs/finances. The least covered areas are those dealing with markets and production.

Table 2.
Studied Supply Chain areas.

Item	Supply chain area or measurement construct	Related references
1	Markets	(Frohlich and Westbrook, 2001), (Li et al., 2005).
2	Production	(Brun et al., 2006), (Berrah and Cliville, 2007).
3	Customer (satisfaction)	(Frohlich and Westbrook, 2001), (Sabri and Beamon, 2000), (Bhagwat and Sharma, 2007), (Beamon, 1999), (Brewer and Speh, 2000), (Li et al., 2005), (Lai et al., 2002), (Angerhofer and Angelides, 2006), (Yeh et al 2007), (Berrah and Cliville, 2007), (Chen and Paulraj, 2004), (Otto and Kotzab, 2003).
4	Delivery management	(Frohlich and Westbrook, 2001), (Beamon, 1999), (Li et al., 2005), (Van der Vorst et al., 2000), (Lai et al., 2002), (Brun et al., 2006), (Yeh et al 2007), (Berrah and Cliville, 2007), (Chen and Paulraj, 2004), (Otto and Kotzab, 2003).
5	Costs/Finances	(Sabri and Beamon, 2000), (Bhagwat and Sharma, 2007), (Beamon, 1999), (Brewer and Speh, 2000), (Van der Vorst et al., 2000), (Krause et al., 2001), (Angerhofer and Angelides, 2006), (Chen and Paulraj, 2004), (Otto and Kotzab, 2003).
6	Flexibility in volume or delivery	(Sabri and Beamon, 2000), (Beamon, 1999), (Angerhofer and Angelides, 2006).
7	**Internal business processes: a set of measures related to production, human resources, quality, procurement and distribution.**	(Bhagwat and Sharma, 2007), (Beamon, 1999), (Brewer and Speh, 2000).
8	Process and/or product innovation.	**(Beamon, 1999), (Brewer and Speh, 2000), (Yeh et al 2007), (Otto and Kotzab, 2003).**
9	Communication with customers and suppliers	(Barut et al., 2002), (Li et al., 2005), (Schmitz and Platts, 2004).
10	Supplier flexibility	(Krause et al., 2001), (Chen and Paulraj, 2004).
11	**Supplier efficiency (quality and fulfillment)**	(Krause et al., 2001), (Lai et al., 2002), (Berrah and Cliville, 2007), (Chen and Paulraj, 2004).
12	Human resource management	(Bhagwat and Sharma, 2007), (Yeh et al 2007), (Berrah and Cliville, 2007).

Source: The authors

A few works cover the three stages of the SC (delivery, manufacturing and procurement). When they do, they usually focus on a specific logistic or manufacturing area [8,10-12]. Table 3 classifies SCM contributions according to the stage of the chain they deal with, namely customers, suppliers or internal functioning of the company.

Table 3.
Supply Chain Areas are classified according to the supply chain stage(s) they deal with.

Reference	Problems Studied	Supply Chain Stages		
		Customers	Manufacturing or internal operation of the company as part of the supply chain	Suppliers
[1]	Markets, customers, delivery management.	**x**		
[2]	Customers, costs, volume or delivery flexibility.	**x**	**x**	
[10]	**Customers, costs, human resource management, internal business processes.**	**x**	**x**	**x**
[13]	**Customers, delivery management, costs, flexibility, internal business processes.**	**x**	**x**	
[14]	Customers, costs, internal business processes, product innovation.	**x**	**x**	
[15]	**Customers, markets, delivery management.**	**x**	**x**	1
[16]	Delivery management, costs.		**x**	
[17]	Costs, supplier flexibility, supplier efficiency.		**x**	**x**
[10]	Customers, delivery management, supplier efficiency.	**x**	**x**	**x**
[18]	Customers, costs, volume or delivery flexibility.	**x**	**x**	
[19]	**Customers, delivery management,**	**x**	**x**	

	product innovation, human resource management.			
[20]	Production, delivery		**x**	
[11]	**Production, customers, delivery**	**x**	**x**	**x**
[12]	**Customers, delivery management**	**x**	**x**	**x**
[21]	**Customers, delivery management.**	**x**	**x**	
[22, 23]	Communicati on with the customer and	**x**		**x**

Source: The authors

The work of [24] identifies a hierarchy of decisions within the SC and analyzes the relations between them, without specifying the associated problem. The said hierarchy, which is further developed throughout this paper through additional dimensions is comprised of: (i) necessary previous conditions for a given choice (upstream decisions); (ii) considerations on the impact of some decisions on others (downstream decisions); and (iii) an approach to the information required by the process. However, the fact it focuses on decisions and not on the challenges faced by the system certainly limits its scope. However, these authors' work constitutes part of the current development, which includes the focus of this paper.

The literature review revealed the lack of studies that seek to develop a broad and comprehensive perspective of the SC and cover a significant part of its components. Likewise, no works have been found that propose a formal structure capable of characterizing the SC's problems. Such a structure would be useful in those cases whose specificities call for a more detailed study; this is when more formal and technical decision-making proves to be useful.

3. Characterization of supply chain problems

The current SC problem is divided in two parts: the first one identifies a series of logistic units within the chain and proposes a corresponding notation system. The second one outlines troublesome instances and, from a SC standpoint, introduces the notation that situates a given problem within the chain.

3.1. Fundamental units

The fundamental units are the entities through which the SC actually performs, that is, the objects of their activity and decisions. In turn, these fundamental units address type, quantity and size specifications of the goods (or services) produced by the chain, as well as the location of the productive activities in question. The fundamental units identified by the current research are: the SC itself, companies, echelons, stages, links and facilities. Table 4 presents the notation system in question.

Table 4.
Notation of the supply chain's fundamental units.

Z|	**Chain**	**Company**	**Echelon**
Detail	Description: industrial sector to which it belongs, global or domestic character, countries or regions in which it performs, etc. a: constituent companies (1, 2,..) b: constituent echelons (1, 2,..) c: stages it comprises (procurement, production, distribution) d: constituent links (1, 2,..).	Description: corporate name, industrial sectors to which it belongs, global or domestic character, countries or regions in which it performs, etc. a1: chains to which it belongs a2: links to which it belongs a3: stage types to which it belongs. a4: echelon to which it belongs.	Description: associated companies; level or position within the chain, etc. b1: chain to which it belongs b2: companies belonging to this echelon (1, 2, …) b3: links of this echelon (1, 2, …) b4: stages associated with this echelon (procurement, production, distribution)
Notation	SC: (a, b, c, d)	O: (a1, a2, a3, a4)	E: (b1, b2, b3, b4)
Level	**Stage**	**Link**	**Facilities**
Detail	Description: type (procurement, production, distribution), associated companies; associated echelons, industrial sector to which it belongs; global or domestic character; countries or regions where it performs; etc. c1: chains to which it belongs c2: companies operating at this stage (1, 2, …) c3: links making up this stage (1, 2, …) c4: echelons making up this stage (1,2,)	Description: organization mode (vertical integration, strategic alliance, market), global or domestic character; countries or regions in which it exerts activity, etc. d1: chain to which it belongs d2: constituent companies (1,2,) d3: link organization (vertical integration, strategic alliance, market) d4: stage associated to with link (procurement, production, distribution)	Description: type of facility (factory, stock, distribution center, etc.), location. e1: chain to which it belongs e2: company to which it belongs e3: echelon to which it belongs e4: stage to which it belongs
Notation	S: (c1, c2, c3, c4)	L: (d1, d2, d3)	F: (e1, e2, e3, e4)

Source: The authors

3.2. Problem set featuring notation

Pursuing the social objective of the SC implies adequate management of its constitutive units and diverse functions, as well as the timely making of decisions in terms of problematic aspects. Many of these problems are associated with each SC unit – they are organizational and functional in nature. Two concepts have been coined to characterize them, namely level of decision [25,26] and characteristic matter: product flows (both, finished products and raw materials) and information flows [27]. The independent or coupled application of these concepts modulates the approach to the specific problems faced by the SC.

Decision-making within the SC is based on a clear notion of the specific nature of the problems that are to be solved. According to Decision Theory, this implies conceiving a structure made up of alternatives and associated criteria in which the latter intends to describe and even weigh up the former. A qualified decision making process must also include a mechanism to measure or estimate the criteria and look after the internal consistency of the information and the correct selection of the Decision Support System (DSS).

Although the logistic unit, the organizational function and the characterizing concepts are the main components used to define a problem, they are not the only ones. The full set of problem featuring components is the following: the elemental unit (U), the logistic functions (F), the characterizing concept defining a given set of problems (C), the levels of decision (N) and/or the characteristic flows (L), the decision (D), the previous conditions (B), the impact (I) and the descriptive alternatives, criteria and/or assumptions (J). Among these components, U and F are independent; C depends on the latter two and D depends on all the three of these, while B, I, and J depend on all of the above mentioned components.

This set of characterizing features intends to provide a comprehensive framework to fully characterize the SC problems in their own context, through the following detailed notation: $P^{i}_{(U, F, C, D, B, I, J)}$,

Where super index i is the label of a particular problem P. Although not all the different fields of a particular P label (U, F, C, D, B, I, J) are always active, the first four ones must be. Table 5 shows the Ps associated with the SC's logistic functions, as reported in the literature review.

As an example, we shall analyze P71: the scheduling problem, which has been an object of study for decades and remains a very active research field. Several reviews have contributed to this field [28-32], which include more than 200 papers that featuring this P:

U: Plant
F: Production
C: Operational (associated to N: the decision level)
D: Decision (scheduling)
B: Production planning, layout, routing of materials
I: Carrier type, handling of materials, determination of Stock Keep Units - SKUs)
J: Determined from notation by [33]:

The alternatives are: – work stations combinations (and associated machines) used to undertake the works (items) that could satisfy the problem's requirements.

Objective (makespan criteria to be optimized): total finishing time, total delay, total weighted delay (taking into account the relative importance of the client).

Parameters:

- Number of stations
- Number and homogeneity of parallel machines per station.
- Processing times

Assumptions and restrictions:

- Any work that can only be executed by one machine at a time.
- Any machine that can only execute one work at a time.
- Machines are constantly available.
- Any work that can and should only be processed once at any station.
- No work can be dismounted from the machine before it has been finished.
- Storage capacity among stations is unlimited.
- All works must follow the same route: from station 1 to station 2, and so on.
- The sequence in which works are processed must be the same at all stations.
- From time zero, all works are available to enter the sequence
- DSS has traditionally corresponded to heuristics and metaheuristics that have adequate CPU time solutions but only moderate acceptable optimality gaps.

The following section presents the decision framework in which each one of the problems is characterized. For practical purposes, Table 5 does not include elements B, I and J, which can be found in [24]. The table shows that the most frequent characterizing concept is "level", while "flow" is rarely taken into account. Through the literature review we detected 123 Ps that are associated with five fundamental units (that are in turn related to facilities), three decision levels, 12 logistic functions and the 48 decisions determined by [24]. Table 5 shows the problem featuring framework that was determined:

Table 5.
Characterization of SC problems.

Problem $P^{i}_{(u,n,f,d)}$	**Logistic unit (U)**	**Decision level (N)**	**Logistic function (F)**	**Decision (D) and description of the P**
$P^{1}_{(1,1,1,2)}$	1. Supply channel	1. Strategic	*1. Strategic planning*	2. Degree of vertical integration and outsourcing.
$P^{2}_{(1,1,3,7)}$			*3. Communication and information (C&I) network*	7. C&I network strategy
$P^{3}_{(1,2,3,6)}$		2. Tactical	*3. Communication and information network)*	6. C&I network design
$P^{4}_{(1,2,8,27)}$			*8. Procurement and supply management*	27. Procurement type
$P^{5}_{(1,2,8,24)}$				24. Specifications of goods

				procured
P6(1,2,8,26)				26. Selection of suppliers
P7(1,2,8,25)				25. Order intervals and quantities
P8(1,2,8,23)				23. Quality control
P9(1,2,11,39)			*11. Transportation*	39. Degree of consolidation
P10(1,2,11,41)				41. Transportation modes
P11(1,2,11,44)				44. Types of carriers
P12(1,2,11,43)				43. Carrier selection
P13(1,2,11,40)				40. Transportation fleet mix
P14(1,2,12,46)			*12. Order processing*	46. Order entry procedures
P15(1,2,12,45)				45. Order transmission means
P16(1,2,12,48)				48. Order follow-up procedures
P17(1,3,8,27)		3. Operational	*8. Procurement and supply management*	27. Procurement type
P18(1,3,8,24)				24. Specifications of goods procured
P19(1,3,8,26)				26. Selection of suppliers
P20(1,3,8,25)				25. Order intervals and quantities
P21(1,3,11,41)			*11. Transport*	41. Transportation modes
P22(1,3,11,44)				44. Types of carriers
P23(1,3,11,43)				43. Carrier selection
P24(1,3,11,40)				40. Transportation fleet mix
P25(2,1,1,2)	2. Warehouse	1. Strategic	*1. Strategic planning*	2. Degree of vertical integration and outsourcing
P26(2,1,2,5)			*2. Physical Facility network (PF)*	5. PF network strategy
P27(2,1,3,7)			*3. Communication and information network*	7. C&I network strategy
P28(2,1,5,9)			*5. Inventory management*	9. Inventory management strategy
P29(2,1,5,11)				11. Safety stock
P30(2,1,10,34)			*10. Warehousing*	34. Warehousing mission and functions
P31(2,2,2,4)		2. Tactical	*2. Physical Facility network*	4. PF network design
P32(2,2,3,6)			*3. Communication and information network*	6. C&I network design
P33(2,2,5,10)			*5. Inventory management*	10. Relative importance of inventory
P34(2,2,5,12)				12. Control methods
P35(2,2,5,13)				13. Desired inventory level
P36(2,2,6,15)			*6. Material handling*	15. Material handling fleet mix
P37(2,2,6,14)				14. Material handling fleet control
P38(2,2,10,33)			*10. Warehousing*	33. Warehouse layout
P39(2,2,10,36)				36. Stock location
P40(2,2,10,32)				32. Receiving/shipping dock design
P41(2,2,10,35)				35. Safety systems
P42(2,2,12,46)			*12. Order processing*	46. Order entry procedures
P43(2,2,12,45)				45. Order transmission means
P44(2,2,12,47)				47. Order picking procedures
P45(2,2,12,48)				48. Order follow-up procedures
P46(2,3,6,17)		3. Operational	*6. Material handling*	17. Unit loads
P47(2,3,6,16)				16. Types of material handling equipment
P48(3,1,1,1)	3.Plant	1. Strategic	*1. Strategic planning*	1. Definition of customer service
P49(3,1,1,3)				3. Customer service objectives
P50(3,1,1,2)				2. Degree of vertical integration and outsourcing
P51(3,1,2,5)			*2. Physical Facility network*	5. IF network strategy
P52(3,1,3,7)			*3. Communication and information network*	7. C&I network strategy
P53(3,2,2,4)		2. Tactical	*2. Physical Facility network*	4. IF network design
P54(3,2,3,6)			*3.*	6. C&I network

			Communication and information network	design
$P^{55}_{(3,2,6,15)}$			*6. Material handling*	15. Material handling fleet mix
$P^{56}_{(3,2,6,14)}$				14. Material handling fleet control
$P^{57}_{(3,2,7,20)}$			*7. Packaging*	20. Information media
$P^{58}_{(3,2,7,19)}$				19. Information to be provided with the product
$P^{59}_{(3,2,7,22)}$				22. Type of packaging
$P^{60}_{(3,2,7,18)}$				18. Packaging design
$P^{61}_{(3,2,7,21)}$				21. Level of protection needed
$P^{62}_{(3,2,9,29)}$			*9. Production*	29. Product routing
$P^{63}_{(3,2,9,28)}$				28. Facilities layout
$P^{64}_{(3,2,9,31)}$				31. Master production schedule
$P^{65}_{(3,2,12,46)}$			*12. Order processing*	46. Order entry procedures
$P^{66}_{(3,2,12,45)}$				45. Order transmission means
$P^{67}_{(3,2,12,47)}$				47. Order picking procedures
$P^{68}_{(3,2,12,48)}$				48. Order follow-up procedures
$P^{69}_{(3,3,6,17)}$		3.Operational	*6. Material handling*	17. Unit loads
$P^{70}_{(3,3,6,16)}$				16. Types of material handling equipment
$P^{71}_{(3,3,9,30)}$			*9. Production*	30. Production schedule
$P^{72}_{(4,1,1,1)}$	4.Distribution Center	1. Strategic	*1. Strategic planning*	1. Definition of customer service
$P^{73}_{(4,1,1,3)}$				3. Customer service objectives
$P^{74}_{(4,1,1,2)}$				2. Degree of vertical integration and outsourcing
$P^{75}_{(4,1,2,5)}$			*2. Physical Facility network*	5. IF network strategy
$P^{76}_{(4,1,3,7)}$			*3. Communication and information network*	7. C&I network strategy
$P^{77}_{(4,1,5,9)}$			*5. Inventory management*	9. Inventory management strategy
$P^{78}_{(4,1,5,11)}$				11. Safety stock
$P^{79}_{(4,1,10,34)}$			*10. Warehousing*	34. Warehousing mission and functions
$P^{80}_{(4,2,2,4)}$		2. Tactical	*2. Physical Facility network*	4. IF network design
$P^{81}_{(4,2,3,6)}$			*3. Communication and information network*	6. C&I network design
$P^{82}_{(4,2,4,8)}$			*4. Demand forecasting*	8. Forecasts of demand magnitude, timing and locations
$P^{83}_{(4,2,5,10)}$			*5. Inventory management*	10. Relative importance of inventories
$P^{84}_{(4,2,5,12)}$				12. Control methods
$P^{85}_{(4,2,5,13)}$				13. Desired inventory level
$P^{86}_{(4,2,6,15)}$			*6. Material handling*	15. Material handling, fleet mix
$P^{87}_{(4,2,6,14)}$				14. Material handling, fleet control
$P^{88}_{(4,2,10,33)}$			*10. Warehousing*	33. Warehouse layout
$P^{89}_{(4,2,10,36)}$				36. Stock location
$P^{90}_{(4,2,10,32)}$				32. Receiving/shipping dock design
$P^{91}_{(4,2,10,35)}$				35. Safety systems
$P^{92}_{(4,2,12,46)}$			*12. Order processing*	46. Order entry procedures
$P^{93}_{(4,2,12,45)}$				45. Order transmission means
$P^{94}_{(4,2,12,47)}$				47. Order picking procedures
$P^{95}_{(4,2,12,48)}$				48. Order follow-up procedures
$P^{96}_{(4,3,6,17)}$		3.Operational	*6. Material handling*	17. Unit loads
$P^{97}_{(4,3,6,16)}$				16. Types of material handling equipment
$P^{98}_{(5,1,1,2)}$	5. Distribution channel	1. Strategic	*1. Strategic planning*	2. Degree of vertical integration and outsourcing
$P^{99}_{(5,1,3,7)}$			*3. Communication and information network*	7. C&I network strategy
$P^{100}_{(5,2,3,6)}$		2. Tactical	*3. Communication and information network*	6. C&I network design
$P^{101}_{(5,2,6,15)}$			*6. Material handling*	15. Material handling fleet

			mix
P[102](5,2,6,14)			14. Material handling fleet control
P[103](5,2,7,22)		*7. Packaging*	22. Type of packaging
P[104](5,2,7,18)			18. Packaging design
P[105](5,2,7,21)			21. Level of protection needed
P[106](5,2,11,39)		*11. Transportation*	39. Degree of consolidation
P[107](5,2,11,41)			41. Transportation modes
P[108](5,2,11,44)			44. Types of carriers
P[109](5,2,11,43)			43. Carrier selection
P[110](5,2,11,40)			40. Transportation fleet mix
P[111](5,2,12,46)		*12. Order processing*	46. Order entry procedures
P[112](5,2,12,45)			45. Order transmission means
P[113](5,2,12,47)			47. Order picking procedures
P[114](5,2,12,48)			48. Order follow-up procedures
P[115](5,3,6,17)	3. Operational	*6. Material handling*	17. Unit loads
P[116](5,3,6,16)			16. Types of material handling equipment
P[117](5,3,11,41)		*11.Transportation*	41. Transportation modes
P[118](5,3,11,44)			44. Types of carriers
P[119](5,3,11,43)			43. Carrier selection
P[120](5,3,11,40)			40. Transportation fleet mix
P[121](5,3,11,37)			37. Assignment of customers to vehicles
P[122](5,3,11,38)			38. Vehicle routing and scheduling
P[123](5,3,11,42)			42. Load plans

Source: The authors

Table 5 also shows how any given decision is often associated with the same logistic function (column 4), but not always with the same decision level (column 3). Only 11 decisions (8, 19, 20, 23, 28, 29, 30, 31, 37, 38 and 42) hold univocal relations with Ps, whereas the rest are associated with more than one P, but never exceed five. Table 6 shows the relation between the Ps and their components. Columns 1 and 3 show the SC components, while columns 2 and 4 present the typologies of each component, their labels, and the number of related problems.

Table 6.
The relations between supply chain problems and their components.

Supply Chain component (id. Type of SC Component : # Ps)			
U	1. Supply channel level: 24	14. Fleet control: 4	
	2. Stock level: 23	15. Fleet mix: 4	
	3. Plant level: 24	16. Types of material handling equipment:4	
	4. Distribution center level: 26	17. Unit loads: 4	
	5. Distribution channel level 26	18. Packaging design: 2	
N	1. Strategic level: 23	19. Information to be provided with the product: 1	
	2. Tactical level: 76	20. Information media: 1	
	3. Operational level: 24	21. Level of protection needed: 2	
F	1. Related to warehousing	22. Type of packaging: 2	
	2. Related to packaging	23. Quality control: 1	
	3. Related to inventory management	24. Specifications of goods procured: 2	
	4. Related to material handling	25. Order intervals and quantities: 2	
	5. Related to strategic planning level	26. Selection of suppliers: 2	
	6. Related to order processing	27. Procurement type: 2	
	7. Related to production	**D**	28. Facilities layout: 1
	8. Related to demand projections	29. Product routing: 1	
	9. Related to the Communication and Information *(C&I)* network	30. Production program:1	
	10. Related to Physical Facility network (PF)	31. Master production schedule: 1	
	11. Related to transport	32. Receiving / shipping dock design: 2	
	12. Related to warehousing	33. Warehouse layout: 2	
	13. Related to packaging	34. Warehousing mission and functions: 2	
	14. Related to inventory management	35. Safety systems: 2	
D	1. Definition of customer service: 2	36. Stock location: 2	
	2. Degree of vertical integration and outsourcing: 5	37. Assignment of customers to vehicles: 1	
	3. Customer service objectives: 2	38. Vehicle routing and scheduling: 1	
	4. PF network design: 3	39. Degree of	

5. PF network strategy: 3	consolidation: 2 40. Transportation fleet mix: 4
6. C&I network design: 5	41. Transportation modes: 4
7. C&I network strategy: 5	42. Load plans: 1
8. Periodicity, magnitude and location projections: 1	43. Carrier selection: 4
9. Inventory management strategy: 2	44. Types of carriers : 4
10. Relative importance of inventory: 2	45. Order transmission means: 5
11. Safety stock: 2	46. Order entry procedures: 5
12. Control methods: 2	47. Order picking procedures: 4
13. Desired inventory level: 2	48. Order follow-up procedures: 5

Source: The authors

Finally, the concept of supply chain orientation (SCO) has been recently introduced as a philosophical approach to the implications of flow management in the supply chain [34]. However, flow management has been addressed independently of this philosophical approach, as can be observed in Arrupindi et al.'s work (1999). This can also be seen in Li et al.'s (2011) work on financial flow risk. SCO has been conceived as "the recognition, on the part of companies, of the systemic and strategic implications of the activities and processes involved in the management of the diverse flows of a supply chain". This concept has been slowly making its way in practical contexts, and has ended up becoming a significant SCM support. In this regard, one of the most relevant achievements has been the study of the implications of SCO on the procurement function through Key Supplier Relationship Management (KSRM). This approach has led to better Organizational Buying Effectiveness (OBE) as a way of measuring effective procurement behavior. SCO has also been incorporated to the supply chain structure through emphasizing the willingness of the companies to conceive the structure as an integrated entity [36]. Additionally, SCO has been used to manage uncertainty in business environments, in which it has been applied to the development of more efficient and flexible supply chains [37]; and to promoting a better willingness to "satisfy its needs by traveling along_a common path" [38] among the supply chain agents. The Supply Chain Orientation concept and its framework have been developed since twenty-first century [39]. To summarize, the study of supply chain flow issues identified in the current work corresponds to the SCO paradigm. Finally, the characterization of supply chains as a research tendency has only emerged in the last decade [40].

4. Conclusions

The current paper proposes a SC problem featuring a holistic framework that is intended as a SC management and organization support tool, in which each P conveys an issue to be dealt with in the SC. This particular notation system not only allows the P in question to be specified within the context it shares with other SC aspects, but it also synthesizes its most outstanding features and sets the foundations for future developments in technical decision-making. This implies that the development of information parameterization systems allow adequate links between the inputs and outputs that modulate the SC P featuring framework. Future research perspectives are the following: the characterization of the Ps that are studied here or that may be identified in the future; the introduction of new Ps and elements into previously defined Ps; the development of specialized DSSs for SC issues; and the development of methodologies to identify P featuring parameters.

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