Selecting Theoretical Models for IT and Supply Chain through a Bibliometric Research

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Abstract. The objective of this research is to identify the major works in IT and supply chain and selecting the main theoretical models for analysis. A literature search was performed on the major knowledge bases to determine and select the conceptual models being used. This resulted in the choice of Gunasekaran et al model. SCOR (https://supply-chain.org) and GSCF (http://www.gsb.stanford.edu/scforum). As a result, we analyze these three mentioned models. The research is important because it provided a bibliographical study on the use of information technology in managing supply chain by means of theoretical models.

Keywords: IT, SCM, SCOR, GSCF.

1   Introduction

Most companies are more and more applying IT (Information technology) systems, especially in Supply Chain Management (Supply Chain Management - SCM) to enhance their performance in competitive global markets [1].

According to Prajogo & Olhager [2], Information (and communication) technology plays a central role in supply chain management in the following aspects. First, IT allows firms to increase the volume and complexity of informations which needs to be communicated with their trading partners. Second, IT allows firms to provide real-time supply chain information, including inventory level, delivery status, and production planning and scheduling which enables firms to manage and control its supply chain activities. Third, IT also facilitates the alignment of forecasting and scheduling of operations between firms and suppliers, allowing better inter-firms coordination.

There are several conceptual models and many discussions on measures of supply chain performance in the literature, however, there is a lack of empirical analysis and case studies on performance metrics and measurements in an environment of supply chain [3], impacted by the use of information technology.

The objective of this research project is to identify the main works on IT and supply chain and selecting the main theoretical models for analysis. We performed a literature search in major knowledge bases to determine and select the conceptual models being used. This resulted in the choice of models Gunasekaran et al.[3], SCOR (https://supply-chain.org) and GSCF (http://www.gsb.stanford.edu/scforum). As a result we have the analysis of these three models mentioned. The research is important because it provided a detailed study on the use of information technology in managing supply chain by means of theoretical models.

2   Material and Methods

A broad survey of a relevant theoretical framework was done to investigate the IT applied to SCM from a literature survey conducted in major databases in the area of Information Technology, Logistics and Supply Chain Management. A bibliometric survey, or bibliometrics was performed for a quantitative analysis of the written communication of journal articles. Citations and cocitations were analyzed. The citation analysis is based on the premise that authors cite articles that are important in the development of their research.

Tarapanoff et al [4] defines bibliometrics as the study of quantitative aspects of production, distribution and use of recorded information from mathematical models for the process of decision making.

Some researchers observed that the frequency distribution of the data in a text or a set of references follows certain standards. These observations led to the bibliometric laws: Lotka's law that determines the contribution of each author to the advancement of science; Bradford's Law which is a method to select the most representative journals for an area of science; and Zipf's Law which found that words that occur in a text are counted and sorted in descending order of number of occurrences, the multiplication of the number of occurrences by the ranking position for each word is a constant [13].

Among the various bibliometric indicators formed from citation data, stands out even though the identification of the number of references to a specific set of work you want to qualify is possibly as important evaluation process of research activity, and operationally difficult to be applied to the funding agencies. These difficulties are mainly due to the large amount of documents involved in these situations and the known inconsistencies in the rates of citations and bibliographies.

Given these limitations, the data categorized quote by periodical and published in the form of indicators in the Journal Citation Reports (JCR) of the Institute for Scientific Information (ISI) began to be used as an evaluation parameter of researchers and institutions. Are published annually in the JCR three indicators, by journal title: the immediate index citation (immediacy index), the half-life of citations (cited HalfLife) and finally the bibliometric index most known and used, the impact factor (impact Factor) [14].

For international journals the research was conducted through the site ISI Web of Science (http://apps.webofknowledge.com), using the advanced search terms for IT or Information Technology and SCM or Supply Chain Management in the titles of articles . For Brazilian publications, we used the site SciELO (http://www.scielo.org) through the advanced search with the terms of Information Technology and Management of the supply chain. 36 articles, 27 of which were international and national 9 were found.

The publications are from the period 1999-2013, distributed according to Figure 1, and the relation of this periodic consulted in Table 1.
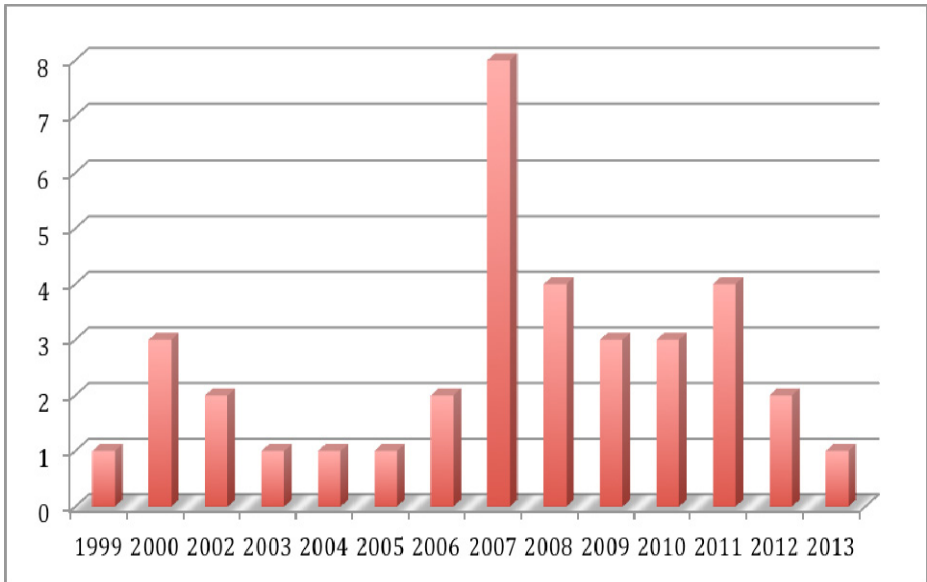
Fig. 1. Publications per year

Table 1. List of publications by periodicals

Periodic	Publications
AIRCRAFT ENGINEERING AND AEROSPACE TECHNOLOGY	1
COMPUTERS IN INDUSTRY	1
DYNA-COLOMBIA	1
Gest. Prod.	2
IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT	1
INDUSTRIAL MANAGEMENT & DATA SYSTEMS	1
Industrial Management	1
Interações (Campo Grande)	2
INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY	2
INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT	1
International Journal of Production Economics.	2
INTERNATIONAL JOURNAL OF PRODUCTION RESEARCH	1
INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT	2
JISTEM J.Inf.Syst. Technol. Manag. (Online)	1
JOURNAL OF BUSINESS-TO-BUSINESS MARKETING	1
JOURNAL OF OPERATIONS MANAGEMENT	1

Table 1. (*Continued.*)

JOURNAL OF STRATEGIC INFORMATION SYSTEMS	1
LOGISTIK IN DER AUTOMOBILINDUSTRIE: INNOVATIVES SUPPLY CHAIN MANAGEMENT FUR WETTBEWERBSFAHIGE ZULIEFERSTRUKTUREN	2
London: FT Prentice-Hall.	1
Production	2
PULP & PAPER-CANADA	1
Rev. Adm. Pública	2
SCIENTOMETRICS	1
Supply Chain Management: An International Journal	1
TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT	1
TECHNOVATION	1
TRANSPORTATION JOURNAL	1
TRENDS IN SUPPLY CHAIN DESIGN AND MANAGEMENT: TECHNOLOGIES AND METHODOLOGIES	1

Table 2. Periodics used in research

Títle	Author	Contribution to research
Information technology, operational, and management competencies for supply chain agility: Findings from case studies	Ngai, Eric W. T.; Chau, Dorothy C. K.; Chan, T. L. A.	Definitions of terms Competence of IT, IT Flexibility and Integration of IT.
A framework for analysing supply chain performance evaluation models.	ESTAMPE, D., LAMOURI, S.	Indicators Model SCM GSCF - Global Supply Chain Forum
A framework for supply chain performance measurement,	GUNASEKARAN, A.; PATEL, C.; MCGAUGHEY, R.E.	Model proposed by Gunasekaran et al. (2004) - strategic, operational and tactical levels are hierarchies in the function, where policies and compensation can be distinguished and proper control exercised (Ballou, 1992).
Better supply chains through information technology.	LEVARY, R.R.,	Proposes the benefits of the use of IT in supply chain
The performance prism: The scorecard for measuring and managing business success.	NEELY, A.; ADAMS, C.; KENNERLEY, M.	define performance appraisal
Use of information technology in managing supply chain in São Luís, Maranhão, and opportunities for the development of local suppliers	Morais, Káty Maria Nogueira; Tavares, Elaine.	Proposes the benefits of the use of IT in supply chain

There are several conceptual models and many discussions on measures of supply chain performance in the literature, however, there is a lack of empirical analysis and case studies on performance metrics and measurements in an environment of supply chain [3], impacted by the use of information technology.

The criteria used to select the models were originally cited in the articles studied. Thereafter, which related to IT and supply chain and covering at least the areas of customers, suppliers, delivery and production.

After reading the articles, the articles selected from table 2 and their major contributions to the research.

3 Analysis of Results

A) Model proposed by Gunasekaran et al. [3], a framework for performance measures and metrics is presented (see Table 3), considering the four major supply chain activities/ processes (plan, source, make/assemble, and deliver). These metrics were classified at strategic, tactical and operational to clarify the appropriate level of management authority and responsibility for performance.

According to Rushton & Oxley [10], this hierarchy is based on the time horizon for activities and the relevance of the decisions and the influence of different levels of management.

Table 3. Supply Chain Performance Metrics Framework

Supply chain activity/ process	Strategic	Tactical	Operational
Plan	Level of customer perceived value of product, Variances against budget, Order lead time, Information processing cost, Net profit Vs productivity ratio, Total cycle time, Total cash flow time, Product development cycle time	Customer query time, Product development cycle time, Accuracy of forecasting techniques, Planning process cycle time, Order entry methods, Human resource productivity	Order entry methods, Human resource productivity
Source		Supplier delivery performance, supplier leadtime against industry norm, supplier pricing against market, Efficiency of purchase order cycle time, Efficiency of cash flow method, Supplier booking in procedures	Efficiency of purchase order cycle time, Supplier pricing against market
Make/ Assemble	Range of products and services	Percentage of defects, Cost per operation hour, Capacity utilization, Utilization of economic order quantity	Percentage of Defects, Cost per operation hour, Human resource productivity index
Deliver	Flexibility of service system to meet customer needs, Effectiveness of enterprise distribution planning schedule	Flexibility of service system to meet customer needs, Effectiveness of enterprise distribution planning schedule, Effectiveness of delivery invoice methods, Percentage of finished goods in transit, Delivery reliability performance	Quality of delivered goods, On time delivery of goods, Effectiveness of delivery invoice methods, Number of faultless delivery notes invoiced, Percentage of urgent deliveries, Information richness in carrying out delivery, Delivery reliability performance

Measures to influence the strategic decisions manages high level, often reflecting the broad based policy research, corporate financial planning , competitiveness and the level of adherence to organizational goals.

The tactical level deals with the allocation of resources and measure performance against targets to be met in order to achieve specified outcomes at the strategic level. The measure of performance at this level provides valuable feedback on decisions mid-level management.

Measurements and metrics for operational level require accurate data and evaluate the results of management decisions at the operational level. Supervisors and workers must adjust the operational objectives that, if achieved , result in the achievement of tactical objectives [3].

B)   *SCOR® - Supply Chain Operations Reference Model*

It is a reference model of supply chain operations, coordinated by the Supply Chain Council - SCC (http://supply-chain.org/), analyzing their structure, composition and its performance indicators [11].

It was designed to assist in learning companies in relation to internal and external processes to their field of expertise [11].

The SCOR Framework is the basis for all supply chain management. It helps companies describe how a supply chain is organized, how well it performs and capabilities it possesses. The metrics in SCOR provide a solid foundation for measuring performance and identifying priorities, the processes are the common language in your supply chain operations..

The model allows companies the following advantages:

- Evaluation of effective processes themselves;
- Compare your performance with other companies;
- Looking specify the competitive advantage;
- Uses benchmarking information and best practices to improve their activities;
- Quantify the benefits in implementing change;
- Identifies the best software tools to meet their specific needs.

The SCOR ® is version 10.0, and is based on five core management processes - planning, supply, produce, deliver and return, as illustrated in Figure 2.
The description of the five processes:

a) Plan - the scope of the planning process and management of supply and demand as a reference model has been the definition of resources and demand planning inventory, distribution, production and capacity planning;

b) Supply - acquisition of raw materials, qualification and certification of suppliers, quality monitoring, negotiating contracts with vendors and receiving materials;

c) Manufacturing - manufacturing of the final product, testing, packing, process changes, product launch and ownership;

d) Deliver - order management and credit, warehouse management, transportation, shipping and customer service. Create database of consumers, products and prices;

e) Return - the raw material, finished product, maintenance, repairs and inspection. These processes extend to the supporting post sale to the consumer.
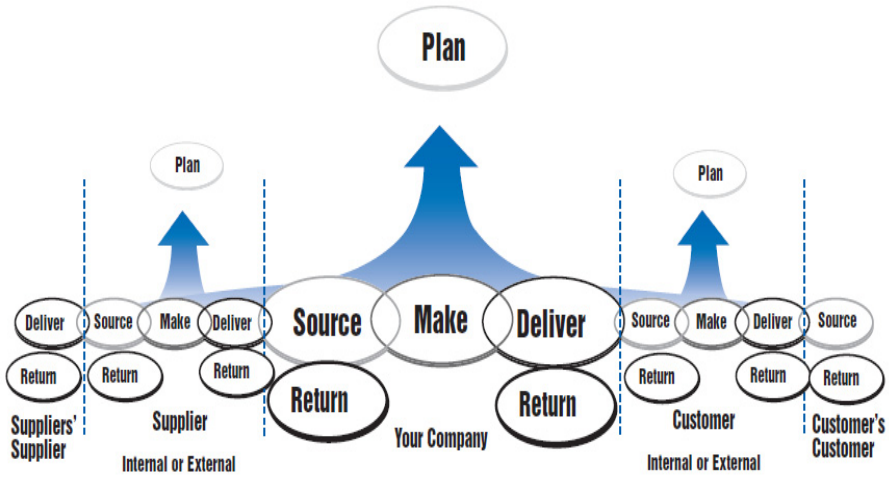
Fig. 2. – SCOR Model- version 10.0
Source: *Supply Chain Council*

C)   SCM Model - GSCF – *Global Supply Chain Forum*
This model GSCF was developed at Ohio State University in 1994 by Professor Douglas Lambert (http://fisher.osu.edu/research/faculty-expertise/marketing-logistics/lambert). He describes three levels (strategic, tactical and operational) and highlights the links between the process and structure of the supply chain. It focuses on eight processes: customer relationship management, customer service management, demand management, order fulfillment, manufacturing flow management, relationship management vendor, product development and marketing and management of return [6].

Figure 3 illustrates the eight business processes along the supply chain and presents the network structure of the supply chain, flow of products and materials, and key business processes interrelated, and borders intra-company involved in a chain supplies [12].

The GSCF suggests the classification of the processes of supply chain management for the four types of business, according to Santos [12]:

1. Managed processes: business processes conducted with a set of key companies along the supply chain will be treated and managed in an integrated manner.

2. Monitored processes: are not as critical to the company focus as managed processes, but it is important that they are integrated and constantly monitored.

3. Unmanaged processes: unmanaged processes are those that focus the company decides not to get involved in their management that considers not to be critical or monitored.

4. Processes of non-members: those involving members of the supply chain of the company focus and not members of the supply chain.

These metrics and models will be the basis for the development of performance indicators of the supply chain impacted by the use of IT.
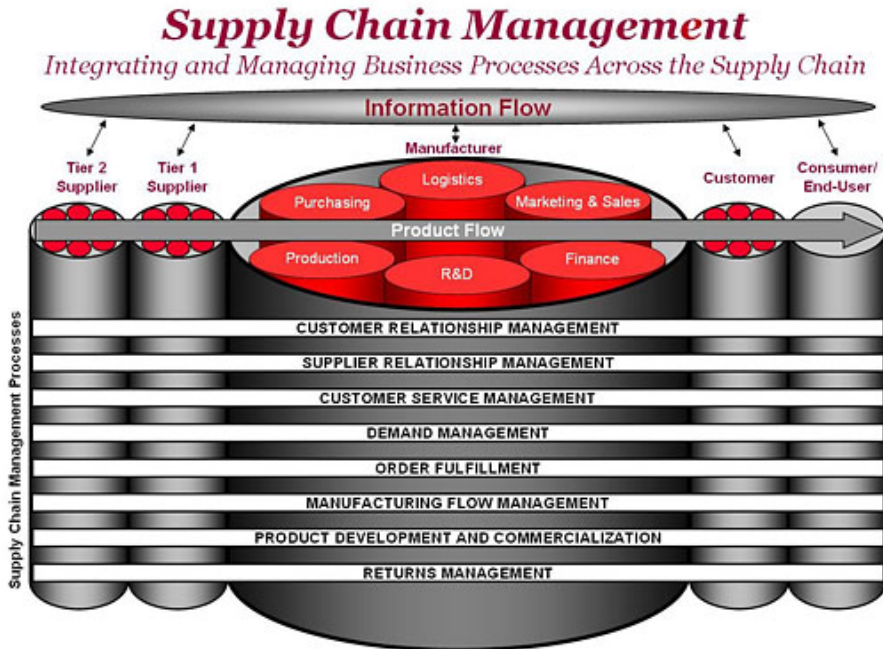
Fig. 3. Supply Chain Management: integration and management of business processes through the supply chain [12]

4   Final Considerations

The survey reached a view to identifying the main models for IT systems used in the supply chain.

The research objective was achieved because we can identify the major works in IT and Supply Chain using bibliometrics and selected the main theoretical models for analysis. As a result we get three Gunasekaran, Scor and GSCF models. Based on the conceptual framework in three related models verified that the six key areas are engineering, manufacturing, delivery, return, suppliers and customers.

Despite the lack of literature found in the survey, we perceive its importance for the occurrence of the continuity of the articles, which began early in this century and remain to the present day, presenting an increase in cocitações the last five years.

The literature is using bibliometrics is important to check what is being written on the subject in the major countries and academic centers tool.

One sees a lot of interest from various authors on the subject and the relevance of academic articles written on various research bases.

As a future project, is expected to use these this search to reassessment and development of indicators in order to measure the level of impact in different areas of the company, as well as contribute to improving the analysis of information technology systems in supply chain management supplies.

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