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# Business process in supply chain integration in sugar and ethanol industry

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## Abstract

**Purpose** – Despite the increasing interests in supply chain management (SCM) within academy and industrial environment, there is still a lack of academic literature concerning topics such as methodologies to guide and support supply chain integration. The paper aims to discuss these issues.

**Design/methodology/approach** – This article presents the application of a diagnosis method in a Brazilian company from the sugar and ethanol industry to identify the level of supply chain integration. The diagnosis method is based on Cooper, Lambert and Pagh reference model for SCM. The method involves nine referential axes established from the eighth key business processes of the reference model.

**Findings** – It was pre-tested and supplemented with findings from interviews with academics and practitioners. Additionally, an illustration application was conducted in three relevant companies.

**Originality/value** – The application results were useful for refining the method that can be considered as a diagnosis instrument to permit companies to evaluate its supply chain integration.

**Keywords** Supply chain management, Business process, Supply chain integration, Supply chain management models

**Paper type** Research paper

## 1. Introduction

Business management has entered the era of inter-network competition where individual businesses no longer compete as solely autonomous entities, but rather as supply chains. Several authors have addressed how beyond firm's boundaries relationships could lead to superior value creation in order to achieve sustainable competitive advantage (Dyer and Singh, 1998; Dyer and Nobeoka, 2000; Krause *et al.*, 2007; Mesquita *et al.*, 2008; Flyn *et al.*, 2010). In today's competitive environment, the ultimate success of the single business will depend on management's ability to integrate the company's network of business relationships. Supply chain management (SCM) has emerged as an important strategy to develop relationships and improve firm's performance (for reviews, see Chen and Paulraj, 2004; Terpend *et al.*, 2008).

SCM is a very important area in the field of management research and it is considered one of the key activities that determine the successes of a company

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(Cambra and Polo, 2008). This success is mainly based on the capacity of integrating critical members of the chain what represents effectively the joint efforts of all the actors in the supply chain for a common goal (Flyn *et al.*, 2010). SCM goes in search of enhance competitiveness by integrating the company internal functions and linking them with the external operations that involves customers, suppliers, and other members (Kim, 2006).

Despite the increasing interest in SCM area, academics and practitioners still lack solids methodologies to guide and support SCM evaluation and implementation (Akkermans *et al.*, 2004; Croxton *et al.*, 2000; Lambert *et al.*, 1998). Methodologies related to SCM implementation have been provided by consulting companies and present a restrict publication and use.

Even though SCM has become subject of increasing interest in recent years, its concept is not yet effectively divulged and practiced in some industries. An important example is the sugar and ethanol industry that is rapidly evolving due principally to international agreements for exports. Many efforts have been done and technological innovations have been implemented in order to improve quality and reduce costs with significant gains in industrial efficiency and strong optimization of agricultural operations. On the contrary, this is not observed within the businesses process management area mainly in relationship improvement and supply chain integration where higher level of cooperation is required.

Sugar and ethanol industry has been emerging as one of the most important sector in the field of alternative energies in domestic and international markets. Brazil, for instance, is the second larger producer and the first larger exporter of the "green fuel" in the world. Nevertheless, it has not received the attention really required concerning operations management. So it is urgent and necessary to develop researches that permit to gather deeper knowledge of its supply chain and get its integration and optimization.

Considering limitations in current SCM literature and practical application in this specific field, the objective of this article is to evaluate how sugar and ethanol Brazilian industry is managing its supply chain. In other words it means to evaluate in what extent this industry adhere to SCM practice.

To accomplish this goal, in summary, the work focused on identifying and selecting a SCM conceptual framework as a reference, developing the evaluation method and the research instrument, selecting the company and conducting a case study.

The method is based on the Cooper, Lambert and Pagh original contribution (Cooper *et al.*, 1997) and it involves nine referential axes established from key business process.

The study was conducted in one of the leading groups within the sugar and ethanol industry in the world: the largest Brazilian sugar-ethanol company, the third world largest sugar producer and the fifth world largest producer of ethanol.

The structure, of this article consists of six major sections besides this introduction. In Section 2 is summarized the theoretical framework of SCM. In Section 3 is discussed the selection of the reference SCM conceptual model used to develop the method. In Section 4 is presented the research methodology. In Section 5 is presented the development of the method to identify the level of supply chain integration. Section 6 presents the case study description and Section 7 points out the main conclusions.

## 2. Supply chain management

Nowadays most individual business no longer compete simply as autonomous organizations but rather as supply chains. Supply chain is referred as a set of companies involved in the upstream and downstream flows of products, services, finances, and information from a source to a customer (Mentzer *et al.*, 2001). In brief, it can be understood that the supply chain constitutes a network of business relationships.

The success of a single business depends, primarily, on its ability to integrate the company's network of business relationships. Thus, what definitely matters is not the competitiveness of an individual company but that of the supply chain in which the company is inserted. Christhopher (1994) pointed that currently the real competition is not company against company, but rather supply chain against supply chain.

In this context, SCM has emerged as a form of achieving adequate integration of company's network of business relationships. SCM extends the idea of integrating internal business functions, departments, and processes beyond the company's frontier to all the companies in the supply chain (Cooper *et al.*, 1997; Fawcett *et al.*, 2008). Hammer (2002) suggest that will succeed companies that are able to work in close association with its partners for the development of projects and for the management of processes that involves all the supply chain.

There are many definitions for SCM. Taking into account all the above mentioned aspects and specific objectives and purposes, The Global Supply Chain Forum definition was adopted for the development of this article:

> Supply Chain Management is the integration of key business processes from end-user through original suppliers that provides products, services and information that add value for customers and other stakeholders (Lambert *et al.*, 1998; Croxton *et al.*, 2001).

## 3. Reference models for SCM integration

From a review of relevant literature, six SCM conceptual models that recognize the need of integrating business processes were identified (Cooper *et al.*, 1997; Supply-Chain Council (SCOR), 1996; Bowersox *et al.*, 1999; Melnyk *et al.*, 2004; Srivastava *et al.*, 1999; Vollman *et al.*, 2000; Mentzer *et al.*, 2001).

According to Lambert *et al.* (2005) and Pires (2009), only two of them provide enough information to support research development in this important area: Cooper *et al.* (1997) and the SCOR models.

In this context, Cooper, Lambert and Pagh SCM reference model (Cooper *et al.*, 1997) was selected to support the method for identifying supply chain integration used in this article. The reasons for this choice are:

- its high frequency of inclusion in existing research, much superior than the SCOR model;
- it is defined broadly and abstractly enough to facilitate its potential study (Lewis, 1998);
- it is of ample comprehensiveness, since encompasses eight main business processes involving at least six functional areas of the companies; and
- it has a more academic and didactic base since it presents clearly a conceptual structure and provides detailed information about the business processes what amplify the possibilities to theory development.

## 4. Research methodology

In summary, the methodology focuses on identifying a SCM reference model, identifying the adequate research methodology and developing the method for evaluating companies' level of supply chain integration.

The approach used in this work combines three different methodologies. First, a discovery oriented approach was used to create a preliminary diagnosis method based in a SCM reference model and to complement literature investigation with discussions in small groups of professionals from academy and industry, directly involved with the area (Kohli and Jaworski, 1990; Menon *et al.*, 1999). Second, the preliminary method was complemented with a step that involves pre-testing by submitting it to a group of potential respondents from different companies in order to evaluate applicability and integrating obtained knowledge. An illustration application was conducted in three relevant companies to accomplish Forza (2002) and Lewis (1998) recommendations, for refining the methodology and demonstrating its applicability.

For this purpose, an intentional sampling was established. It is a non probabilistic sampling in which the researcher utilizes his professional experience, rather than at random, to select, for instance, the companies that will participate of a defined research (Rea and Parker, 2000). Three companies, leaders in their supply chain, were selected. By one side a company with recognized competency in SCM practice, and by the other side two companies without recognized competency in the area. After the illustration application gained knowledge was analyzed and integrated to the method.

Finally, it was developed an iterative triangulation, employing systematic iterations between literature review, case evidence and intuition based on the researcher experience and judgment (Lewis, 1998).

A very important aspect of this development is that it should provide a framework for analysis, an efficient method for SCM field development and a clear explanation for practical applications, what can be considered of fundamental importance for researchers and practitioners (Chen and Paulraj, 2004; Wacker, 1998).

## 5. Method development

In this section are detailed all the necessary stages for constructing the method for identifying companies' supply chain integration level.

Based on The Global Supply Chain Forum SCM definition and on conceptual model of SCM proposed by Cooper, Lambert and Pagh reference model for supply chain integration, the method establishes nine referential axes related to key business processes and it should identify whether the company manages and integrates them within first tier key customers and first tier key suppliers. Key business processes proposed by Cooper *et al.* (1997), Lambert *et al.* (1998) and Croxton *et al.* (2001) are:

- customer relationship management;
- customer service management;
- demand management;
- order fulfillment;
- manufacturing flow management;
- supplier relationship management;

- product development and commercialization; and
- returns management.

These processes must be integrated through collaboration and relationship management along the supply chain, from initial suppliers to end consumers (Ballow, 2006).

In order to eliminate a possible source of confusion, returns management process was separated in returns management from customers and returns management to suppliers. A defined number of requirements were associated to each analysis referential axis. From the analysis of each requirement in each one of referential axes it is possible to identify company's supply chain integration level. The core of the method is related to the integration of key business processes.

*5.1 Requirements associated to key business processes*

Key business processes objectives and strategic and operational sub-processes stated in literature (Lambert *et al.*, 1998; Croxton *et al.*, 2001; Bowersox and Closs, 2001; Christopher, 2001; Lambert, 2004, 2008; Sols *et al.*, 2007; Forslund, 2009) were deployed, analyzed, and translated into evaluating parameters or requirements. These requirements were submitted to a selected group constituted of three professionals from industry, three academic and three professors/consultancy professionals. After a lot of discussions and many decisions meetings, it were defined which requirements should be considered for the method. The final requirements are presented on Tables I-IX.

*5.2 Categories and measurement scale*

A set of categories is associated to each requirement of each analysis referential axis. So, each requirement is classified in five categories, and each category reflects the situation of the company related to that specific requirement.

The categories combine amplitude and depth characteristics. Amplitude is related to the quantity of items to which the requirement is applied and is expressed in two levels:

**Table I.**
Requirements for referential axis related to customer relationship management business process

| Process E1: customer relationship management | |
|---|---|
| Requirements | Company differentiates customers identifying key customers |
| | Company has a cross-functional team for customer relationship management |
| | Company provides the framework for managing relationships with customers |
| | Develops and implements customized product/service agreement for key customers |
| | Develops and implements product/service agreement for customers segments |
| | Develops process improvement programs with customers |
| | Develops efforts to reduce demand variability with customers |
| | Develops programs with customers to eliminate non value added activities |
| | Identify opportunities with customers |
| | Develops guidelines for sharing process improvement benefits with customers |
| | There are procedures to periodically evaluate customer, based on bought products, sales and position on its market segment |
| | Designs performance reports to measure the firm's financial impact on those customers |
| | Designs performance reports to measure the customer's financial impact on the company |

| Process E2: customer service management | |
|---|---|
| Requirements | Company has a cross-functional team for customer service management |
| | Develops customer service strategy |
| | There is a communication channel to provide customers information about PSA |
| | There is an action plan to evaluate alternatives for manage events and its effects on the customer and on internal operations of the company |
| | The team determines a set of actions working jointly with the specialists in each of the functions affected by the event to evaluate the situation and define solutions |
| | The team coordinates the implementation of the selected alternatives |
| | The event is recorded in a database that can be used for future reference |
| | The evolution of the event is monitored in order to know to what extent the response has been implemented |
| | The team inform the customer about how the issue is being resolved |

**Table II.**
Requirements for referential axis related to customer service management business process

| Process E3: demand management | |
|---|---|
| Requirements | Company has a cross-functional team for demand management |
| | There are guidelines to collect data/information for forecast demand |
| | The team determines which forecasting approaches to use |
| | The forecasts are communicated to the other process teams that are affected by them including customer service management, order fulfillment, manufacturing flow, and product development and commercialization |
| | There are synchronization procedures to match the demand forecast to the company's production, sourcing and distribution capabilities |
| | There are contingency plans in the event of even internal or external events that disrupt the balance of supply and demand |
| | The team reviews and adjust the forecasts periodically |
| | The team works with the manufacturing flow team to gain flexibility |
| | The team works with customer relationship management team to reduce demand variability |
| | The team evaluates periodically differences between forecasts and actual demand |
| | The team evaluates periodically the level of production capacity utilization |

**Table III.**
Requirements for referential axis related to demand management business process

(1) for the majority of the items; and

(2) not for the majority of the items.

Depth is related to the way the requirement is applied: in a documented manner (formally) and in a non-documented manner (not formally).

Considering these situations, the following categories were established:

- *Category 5*. Company satisfies the requirement for the majority of items related to it and makes it formally.
  *Note*. The items related to the requirement refers, for example, to "customers", "orders", "events", "teams", "suppliers", "functional areas", "departments", and so on.
- *Category 4*. Company satisfies the requirement not for the majority of the items related to it but makes it formally.

| Process E4: order fulfillment | |
|---|---|
| Requirements | Company has a cross-functional team for order fulfillment management |
| | The team defines requirements for order fulfillment |
| | The team defines the specific steps from order entry to product delivery |
| | The team verifies customer credit |
| | The inventory is checked to verify if it is possible to fulfill the customer order |
| | The team communicates customer service management team when customer order is delivered |
| | The team communicates with the customer relationship management process team to make sure that all customer expectations are met |
| | Order cycle time is measured |
| | The team monitors quantity of complete orders delivered on time and compares to order fulfillment policy |
| | The team provides information about the order to customer service management, manufacturing flow management and demand management teams |

**Table IV.**
Requirements for referential axis related to order fulfillment business process

| Process E5: manufacturing flow management | |
|---|---|
| Requirements | Company has a cross-functional team for manufacturing flow management |
| | The team develops and implements a master production schedule |
| | The team produces a detailed capacity plan and a time-phased requirement plan |
| | The team identify manufacturing constraints and determines manufacturing capabilities |
| | The team synchronizes capacity and demand |
| | The team discusses the product and service agreement with customer relationship management team |
| | The team communicates manufacturing capabilities to the demand management, order fulfillment, and returns process teams |
| | The company has make or buy strategies clearly defined |
| | The company develops programs and implements actions to augment manufacturing flexibility |
| | The team measures manufacturing cycle time |
| | The team measures work in process level |
| | The team measures the quality levels |
| | There are procedures to identify non conformity causes |
| | There are procedures to define manufacturing priorities |

**Table V.**
Requirements for referential axis related to manufacturing flow management business process

- *Category 3*. Company satisfies the requirement for the majority of the items related to it but does not make it formally.
- *Category 2*. Company satisfies the requirement not for the majority of the items related to it and does not make it formally.
- *Category 1*. Company does not satisfy the requirement.

As result, Category 5 reflects the best situation concerning the parameters toward the high adherence degree of the company to the conceptual model of SCM. On the contrary, Category 1 reflects the worst situation.

Considering that it is not possible to measure the necessary effort to take one requirement from a defined category to a higher one, it is adopted an ordinal scale as

| Process E6: supplier relationship management | |
|---|---|
| Requirements | Company differentiates suppliers identifying key suppliers |
| | Company has a cross-functional team for supplier relationship management |
| | Company provides the framework for managing relationships with suppliers |
| | Develops and implements customized product/service agreement for key suppliers |
| | Develops and implements product/service agreement for suppliers segments |
| | Develops process improvement programs with suppliers |
| | There are procedures to quantify processes improvements benefits |
| | Identify opportunities with key suppliers |
| | Develops guidelines for sharing process improvement benefits with suppliers |
| | Designs performance reports to measure the costs/profitability of individual supply orders |
| | There are procedures for suppliers evaluation and development |
| | There are procedures to periodically evaluate supplier, based on bought products, relationship and position on its market segment |

**Table VI.** Requirements for referential axis related to supplier relationship management business process

| Process E7: product development and commercialization | |
|---|---|
| Requirements | Company has a cross-functional team for product development and commercialization process management |
| | The team includes customers and suppliers members |
| | Company has methodology to create new products and services |
| | There are defined guidelines for new product development |
| | Product development project determines product profitability levels |
| | Product development project determines time-to-market expectations |
| | Company designs and builds prototypes |
| | The team analyses make or buy decision |
| | The team determines marketing and distribution channels |
| | The team interacts with manufacturing flow management and supplier relationship management processes teams to product rollout |
| | The team works together marketing function for new products development |
| | The team evaluates new product sales performance |

**Table VII.** Requirements for referential axis related to product development and commercialization business process

| Process E8: returns management (from customers) | |
|---|---|
| Requirements | Company has a cross-functional team for returns (from customers) management process |
| | There are defined procedures for returns management process |
| | There are defined procedures for returns disposition |
| | There are defined plans for transporting and holding returned products until they reach their final disposition |
| | There is an analysis plan to identify returns causes |
| | There are rules for credit/debt customer/supplier |
| | There is a program for returnable packaging |
| | There are procedures for evaluating financial impact of the returns |
| | The returns are recorded |
| | The returns records are used for implement improvements in process and product |

**Table VIII.** Requirements for referential axis related to returns management business process (from customers)

the measurement scale. So it provides information about the ordination of categories, not about the magnitude of the differences among them (Rea and Parker, 2000).

*5.3 Analysis of the results*

Normally companies applies many of the requirements of the business processes what does not mean that they have a successful SCM. What really matters is the integration and management of all business processes, and to make this, companies must apply all the requirements of all processes, for the majority of the items related to each requirement and in a documented manner (i.e. formally). This is called the highest ordination and it is the situation that can lead companies to the highest level of supply chain integration.

So, the level of supply chain integration is obtained in dependence of the frequency of occurrence of requirements occurring in the highest ordination, taking into account all referential axes. Table X helps organize the data and Table XI provides the SC integration level.

Supply chain integration level is obtained from requirements frequency of occurrence in ordination 5 (RFO5), defined on Table XI.

Frequency of requirements occurring in ordinations 4-1 must be used as a reference to identify the status of the company related to supply chain integration. From them,

**Table IX.**
Requirements for referential axis related to returns management business process (to suppliers)

| | Process E9: returns management (to suppliers) |
|---|---|
| Requirements | Company has a cross-functional team for returns (to suppliers) management process |
| | There are defined procedures for returns management process |
| | There are defined plans for transporting and holding returned products until they reach their final disposition |
| | There are rules for credit/debt supplier |
| | There is a program for returnable packaging |
| | There is an analysis plan to identify returns causes |
| | There are procedures for evaluating financial impact of the returns |
| | The team informs supplier relationship management process team about the returns |
| | There are procedures to eliminate returns causes |

**Table X.**
Formulary for presenting results, and determining requirements frequency of occurrence (RFO) in each ordination

| Ordination | E1 | E2 | E3 | E4 | E5 | E6 | E7 | E8 | E9 | RFO | (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 1 | | | | | | | | | | | |
| Total | | | | | | | | | | | |

**Table XI.**
SC integration level in dependence of requirements frequency of occurrence in ordination 5 (RFO5)

| RFO5 (%) | SC integration level |
|---|---|
| $75 < A \leq 100$ | High |
| $50 < A \leq 75$ | Medium |
| $< A \leq 50$ | Low |

company should analyze involved requirements on each ordination; verify which are more distant from five ordination and which are the most critical. Company must establish priorities and actions plan toward higher SC integration level. Even though the ordinal scale adopted is not aimed to measure the effort to go from one level to a higher one, ordinations 4-1 help company to have, at least, an idea of the overall situation.

*5.4 Organization and application planning*

The requirements established for the referential axes form the questions that are put together in a questionnaire built in a structure aiming to facilitate its application and motivate the respondents. Data collection instrument should be applied by personal interviews when the researcher can get more detailed information, explain the questions, provide detailed instructions, and assure responses reliability by checking the evidences. Application should initiate with a detailed planning of the interviews, selecting previously the persons that will be interviewed in the company and make the arrangement for this interviews.

*5.5 Covering the complete supply chain*

The method considers that a supply chain is a group of basic chains, and each basic chain involves the company that will be evaluated and its first tier customers and suppliers. In this way each company must manage and integrate business process within key members of basic chain and then the total chain will be managed. The leader company of the supply chain is responsible for verifying or monitoring whether the other key members, both suppliers or customers, are managing their basic chains. Therefore, the evaluating methodology should be applied at the supply chain leader company.

## 6. Case study

In order to identify company's supply chain integration level a case study research has been designed. The study has been conducted in one of the leading groups within the sugar and ethanol industry in the world: the largest Brazilian sugar-ethanol company, the third world largest sugar producer and the fifth world largest producer of ethanol (Cosan, 2010). The sources of information are interviews with:

- the manager of supply department;
- the manager of sales department;
- the manager of production planning department;
- the manager of logistics department; and
- the manager of production department.

The interviews has been conducted with a set of questions in the form of a questionnaire combining the requirements of each referential axis (Tables I-IX) and categories and measurement scale.

The interviews were conducted in April-May 2012 in company's site localized in Piracicaba, Sao Paulo.

*Findings of the case study*

Data on Table XII indicates the company has low level of supply chain integration with only 50 percent of requirements on ordination 5.

*Referential axes analysis*

*E1: customer relationship management*. There are four requirements classified in Category 4 that need to be improved:

(1) programs with customer to eliminate non value added activities;

(2) identifying opportunities with customers;

(3) guidelines for sharing process improvement benefits with customers; and

(4) performance reports to measure customer's financial impact on the company.

For sugar and ethanol industry, this business process can be considered critical. Nevertheless, it is a process with almost none flexibility and has an apparent degree of simplification, mainly considering the fact that the company has not any option to identify and select key customers. Considering ethanol market, basically the company provides a single product to a single customer, Petrobras. Additionally, it facilitates the process of establishing product and service agreements.

However, the establishment of a relationship with a single customer can have drawbacks, and may rely on power relations, especially when it comes to a sizable company that has a strong influence on the market, such as Petrobras. It is worth reiterating that today is not given the option, the company focus, to choose between one or more client companies.

*E2: customer service management*. Only one requirement is classified in Category 4 and needs to be improved:

(1) inform the customer about how the issue (event) is being resolved.

Likewise business process customer relationship management, customer service management also presents an apparent simplification. This is due to the facility in managing the issues involved with the orders of only one product and only one customer, Petrobras again. However, Petrobras is an extremely demanding client in respect to the management of established products and service agreements and the flow of information related to order status.

*E3: demand management*. There is one requirement classified in Category 3: (1) communicating forecasts to process teams affected, and two requirements classified in Category 2: (1) involvement of manufacturing flow team, (2) involvement of customer relationship management team that need to be improved.

Demand management occurs by means of agreements between a single client, Petrobras, and plants, considering ethanol market. The reduction in variability can be achieved through actions such as increasing or reducing the alcohol content in gasoline, increase or reduction in product inventory levels in plants, or changing the

**Table XII.** Requirements frequency of occurrence (RFO) in each ordination

| Ordination | E1 | E2 | E3 | E4 | E5 | E6 | E7 | E8 | E9 | RFO | (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 9 | 8 | 7 | 10 | 3 | 2 | 6 | – | 0 | 50 | |
| 4 | 4 | 1 | 1 | 0 | 1 | 5 | 6 | – | 8 | 29 | |
| 3 | 0 | 0 | 1 | 0 | 3 | 0 | 0 | – | 0 | 4 | |
| 2 | 0 | 0 | 2 | 0 | 2 | 5 | 0 | – | 1 | 11 | |
| 1 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | – | 0 | 6 | |
| Total | 13 | 9 | 11 | 10 | 14 | 12 | 12 | – | 9 | 100% | |

mix of alcohol/sugar production. With the establishment of international agreements for the export of alcohol in a short future, however, demand management will certainly become a more complex business process and will require the vendor the use of more sophisticated forecasting tools and procedures to support the production process and avoid shortages or rising inventories. Thus, the reduction of variability and the balance between customer needs and the supply capacity of the company will require more precise forecasts and synchronization with production, purchasing and distribution.

*E4: order fulfillment*. This referential axis presents the best performance of the evaluation: all the requirements are classified in Category 5.

Also features a simplified. However, it will be extremely critical and complex with the increase of international agreements for the export of alcohol. In this situation the processes demand management, manufacturing flow management and logistics must align perfectly to support order fulfillment. The goal is to meet customer needs related to quality, quantity and on time. This certainly will require the development of partnerships with key members of the chain to meet real customer needs and reduce total cost of delivery.

*E5: manufacturing flow management*. Five requirements are classified in Category 1:

(1) cross-functional team;

(2) master production schedule;

(3) capacity and demand synchronization;

(4) analysis of PSA with customer relationship management team; and

(5) communicate manufacturing capabilities to demand management, order fulfillment and returns management processes teams.

Two requirements classified in Category 2:

(1) measurement of work in process level; and

(2) procedures to define manufacturing priorities.

There are three requirements classified in Category 3:

(1) detailed capacity plan and time-phased requirement;

(2) identify manufacturing constraints and determine manufacturing capabilities; and

(3) programs and actions to augment manufacturing flexibility.

One requirement classified in Category 4:

(1) make or buy strategies clearly defined.

Note that there are many requirements classified in low ordination which means the need for major efforts.

Manufacturing flow management is directly related to deliver the product when the customer wants and, therefore, the manufacturing processes must be flexible enough to allow rapid changes according to demand. Alcohol is produced by a continuous process which is characterized by a dedicated production line and generating basically a single end product or, depending on the product mix, two products: alcohol or sugar.

Thus, the need to implement and manage the flexibility in the production process is not mandatory, at least in terms of product mix. The same is not true with respect to volume flexibility. An increase in production capacity can only be achieved through investment in machinery and facilities for capacity expansion. Augmenting shift work or man power hours, for example, is not possible. An alternative could be the products outsourcing, a practice that is currently restricted to a few trading companies in the market.

*E6: supplier relationship management*. There are five requirements classified in Category 2:

(1) cross-functional team;
(2) procedures to quantify process improvements benefits;
(3) identify opportunities with key suppliers;
(4) guidelines for sharing process improvement benefits; and
(5) procedures to periodically evaluate supplier.

Also five requirements are classified in Category 4:

(1) identifying key suppliers;
(2) framework for managing relationships with suppliers;
(3) process improvements programs with suppliers;
(4) performance reports to measure costs/profitability of supply orders; and
(5) procedures for suppliers evaluation and development.

The most critical processes of SCM are the supplier relationship management and customer relationship management. Considering the apparent simplification of customer relationship management, supplier relationship management process effectively becomes the most critical process in the sugar and ethanol industry SCM. This business process determines who are the critical suppliers for the company, in technological or quantity aspects, and defines how the company should interact with its suppliers considering that there are certain key suppliers that are most important to the success of the company.

The need to have the raw material for alcohol production always available to keep the production process operating continuously makes relationships with the suppliers of sugar cane very important. Considering the sugar cane crop has a defined period, has a high production cycle, with planting planned in advance, and that the producing regions should be close to the industrial unit, exchange or replacement of a supplier in a season is practically impossible. Therefore, this business process needs to be treated very carefully. Thus, the appropriate choice of key suppliers with whom to establish and maintain partnership relations is of fundamental importance.

It is worth mentioning here, other examples, like the transport services providers, operating in the logistics of sugar cane delivery to the industrial unit, maintenance services providers that deals with operation availability and reliability of the production system, and so on.

*E7: product development and commercialization*. There are six requirements classified in Category 4:

(1) use of prototypes;
(2) make or buy decision analysis;

(3) definition of marketing and business channels;
(4) interaction with manufacturing flow management and supplier relationship management to product rollout;
(5) involvement of marketing function for new products development; and
(6) evaluation of new product sales performance.

Also, it is a relatively good classification since these requirements are not very distant from five ordination.

In the short-term, product development and commercialization process will assume an even more important role in the success of companies in the alcohol sector. The sugarcane alcohol on the market today, has already been impacted over the competition on price, quality, and sustainability in relation to social and environmental questions. It is therefore necessary that the business sector, research and development centers and suppliers of production technology, invest in product development activity, improving existing products and creating new products, such as the alcohol of high purity for specific applications, the co-generation of power from the primary product marc, among others. Commercialization also deserves more attention, since the increase in international export agreements, negotiations and delivery directly to the customer tend to grow rapidly.

*E8: returns management (from customers)*. This process is not applicable in sugar and alcohol sector considering the kind o supply and the product quality assurance.

*E9: returns management (to suppliers)*. There are eight requirements classified in Category 4:

(1) procedures for returns management process;
(2) plans for transporting and holding returned products until they reach their final disposition;
(3) rules for credit/debit supplier;
(4) program for returnable packaging;
(5) analysis plan to identify returns causes;
(6) procedure for evaluating financial impact of the return;
(7) inform supplier relationship management process team about the returns; and
(8) procedures to eliminate returns causes.

One requirement is classified in Category 2: cross-functional team, distant from ideal ordination.

Returns management business process assumes an increasingly importance in sugar and ethanol industry supply chain. It becomes critical, especially during the period plants cease its operation to perform equipment and facilities maintenance. During this period, items such as roller mills, gearboxes, steam turbines, pumps, among others, are transported to supplier facilities for maintenance, usually localized distant from the plant. After conclusion of maintenance services equipment must return to industrial unit and be ready for use when starting new harvest. Considering the long distances, the high volume of maintenance services and reduction of the non-operating period, returns management business process requires more attention from those involved.

## 7. Conclusions

SCM has assumed increasing importance in the competitive environment since competition has shifted from one firm competing with another to one supply chain competing with another. The success of a single business depends, primarily, on its ability to integrate the company's network of business relationships So is the supply chain that needs to be competitive, what makes its effective management essential for all participating firms.

Despite the recognition of its importance, the SCM has not been disseminated and applied in many industrial sectors, such as the sugar and ethanol industry where businesses process management area seems to be left to chance.

This paper analyzes sugar and ethanol supply chain integration from the perspective of a conceptual reference model that includes eight business processes used as benchmarks.

Results show there are many requirements classified in categories below ordination 5 in almost all referential axes. These requirements need to be improved so that the sector can achieve a superior level of supply chain integration (high level).

Business process returns management (to suppliers) shows the worst result in the assessment, since there is no one requirement in the ideal ordination. It is followed by supplier relationship management, with only two requirements in the ideal ordination, manufacturing flow management, with only three requirements in this ordination, and product development and commercialization processes with six requirements in the ideal ordination.

Considering the apparent simplification of customer relationship management process, supplier relationship management becomes the most critical process for this particular supply chain and therefore should receive greater attention from administrators.

However, this analysis also indicates that efforts should be dedicated in relationship improvement and supply chain integration mainly due to the establishment of international agreements for the export of ethanol and where higher level of cooperation is required. The new relationships that are being developed will require concentrate efforts on other business processes that currently have an apparent degree of simplification. Cite as an example the processes demand management, customer service management, manufacturing flow management and product development and commercialization that are becoming more complex and more critical to the success of companies that make up the supply chain.

The method developed for this research can be considered a diagnostic tool that enables companies to evaluate their position in terms of SCM. Based on this diagnosis, companies can identify and implement activities aimed at increasing their adherence to the reference model and augmenting the benefits gained through SCM. Deriving from a major research project, the method contributes to the theoretical development of structured models for implementing and supporting effective SCM.

The findings of the paper lead to following implications for further immediate research:

- identify potential SCM implementation barriers for sugar and alcohol industry and how should they be overcome; and
- establish a scale to measure the necessary efforts to bring requirements classification to the ideal ordination.

Is important to stress that technology, information and measurement systems strongly support the integration of business processes, however, the successful SCM depends also on the culture, confidence, and the collaborative environment.

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