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THE IMPORTANCE OF TECHNOLOGICAL INNOVATION IN THE LOGISTICS OF ETHANOL EXPORTS

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ABSTRACT

This paper analyzes the technological status of the bulk liquids logistical process at the port of Santos. The main objective is to identify problems encountered in port logistics for the export of ethanol and evaluate their respective technological innovation perspectives. Ethanol exports have increased given international environmental appeals. Within the complex and uncertain environments that contemporary corporations are experiencing, environmental issues have captured global attention. There is an awareness as to the relevance of reducing pollutant emissions to the atmosphere and one of the manners of so doing is by utilising ethanol as a source of propulsion energy fuelling automobile engines. Brazil is one of largest, high quality, ethanol producers in the world and a strong competitor to serve the global market given that the quality of the port logistic infrastructure poses significant impact on exports. Thus, this article proposes to further deepen the theory fundamentals alongside research conducted at companies of South-central Brazil´s sugar alcohol supply chain sector. The study´s analytical model is based on bibliographical research, monitoring and descriptive field surveys at companies within the segment. The article demonstrates that although the logistical process is evolving technologically, further investments in logistic infrastructure is required so as to obtain a sustainable competitive advantage and ensure the feasibility of exports of the Brazilian product.

Key-words: logistic process, technological innovation and ethanol.

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A RELEVÂNCIA DA INOVAÇÃO TECNOLÓGICA NO PROCESSO LOGÍSTICO DE EXPORTAÇÃO DE ETANOL

RESUMO

O presente artigo analisa o estágio tecnológico que se encontra o processo logístico de granéis líquidos do porto de Santos. O objetivo principal é identificar os problemas encontrados na logística portuária para exportação de etanol e avaliar suas perspectivas de inovações tecnológicas. As exportações de etanol aumentaram devido aos apelos ambientais internacionais. Num ambiente de complexidade e incertezas que vivem as empresas contemporâneas, as questões ambientais têm obtido atenção global. Há consciência da importância de reduzir as emissões de poluentes à atmosfera, e uma das formas de redução é a utilização do etanol como fonte de energia de propulsão nos motores dos automóveis. O Brasil é um dos maiores produtores de etanol de alta qualidade do mundo sendo um forte concorrente para atender o mercado global já que a qualidade da infraestrutura logística portuária tem impacto significativo nas exportações. Assim, o presente artigo procura aprofundar a fundamentação teórica, associada a pesquisas em empresas da cadeia de suprimentos do setor sucroalcooleiro da região centro-sul brasileira. O modelo analítico do estudo é baseado em pesquisas bibliográficas, monitoramento e pesquisas descritivas de campo junto às empresas do setor. O estudo mostra que, embora o processo logístico esteja evoluindo tecnologicamente, mais investimentos tecnológicos em infraestrutura logística são necessários para que se obtenha a vantagem competitiva sustentável e viabilize as exportações do produto brasileiro.

Palavras-chave: processo logístico, inovação tecnológica e etanol.

INTRODUCTION

Bibliographical revision of articles related to the Brazilian sugar alcohol market discloses the lack of studies related to logistics within the sector. Most publications explore technical themes concerning production and corporate market techniques.

Considering this gap, the study hereunder poses to address the current technological status of the logistics process for the export of ethanol, to identify and analyse the issues encountered in the logistics components and to evaluate the sector´s technological innovation perspectives.

In the highly competitive contemporary market, efficient logistics has a fundamental role in determining which companies and countries will succeed in the supply of ethanol, which has experienced increasing demand ever since the signing of the Kyoto Protocol established in 1997. This protocol, signed off by 84 countries seeks to reduce global green house effect gases.

The exports of Brazilian ethanol are increasing and one must revisit the processes entire logistics chain, particularly the port logistics so that by means of integrated logistics sustainable competitive advantage might be obtained and exports of the Brazilian products become feasible.

The problem that calls for investigation is the current technological stage of the logistical process involving bulk liquids. The general objective is to identify problems encountered in the logistics for the export of ethanol and discuss the possible technological innovations directed towards efficient and effective logistics. In terms of a specific objective, the intent is to verify: if the transportation modes, port infrastructure and storage capacities are adequate to meet the current and future demand and, if there are upcoming technological innovations in the logistics components. The research is limited to the Central Southern region of Brazil which is the largest ethanol producing area.

2 BIBLIOGRAPHICAL REVISION

2.1 LOGISTICS PROCESS COMPONENTS

At the on site of the XXI$^{th.}$ Century, administering the logistics process became one of the most predominant industry management drivers, comprising almost all functions within the corporation, also posing significant impact on customer satisfaction further to presenting major potential towards the obtaining of competitive advantage. Logistics adds value when stocks are correctly positioned to facilitate sales.

The creation of logistics value involves high costs however, the real interest that logistics arouses is not solely as to the high costs involved but rather, as to the comprehension of how certain companies utilize their competency in logistics to obtain competitive advantages. Leading companies usually present information systems that are capable of monitoring their logistics performance in real time, and this enables them to identify possible operational failures and adopt corrective actions before failures occur in the provisioning of services to clients.

According to Bowersox and Closs (2001), the logistics of a company is an integrated effort that seeks to create value to the customer at the lowest possible cost. It exists to satisfy the needs of clients, facilitating relevant production and marketing operations. From a strategic point of view, executives in this field try to meet a predefined customer service quality level by means of an operational competency that represents the current state of the art. The challenge is to balance services expectations and expenditures so as to meet the final objectives of the business.

Allocating value to logistics in corporate strategy generates, as a consequence, a series of queries related to the way companies of the same supply chain organize themselves to face new challenges (Silva, 2000).

Therefore, the integrated management of the many components of the logistics system is a necessary condition for companies to attain operational excellence at low costs whilst external integration with the supply chain enables the mitigation of leakages, further reducing costs. The concept of integrated logistics is firmly implemented at companies in more developed countries. It also comprises the flow of information between companies, clients and suppliers as well as the flow of materials, supporting the strategies of business units. (Bowersox & Closs, 2001).

Currently, logistics is perceived by many companies as a critical strategic tool given its impact on customer operations and for many managers logistics is core to obtain and maintain superior competitivity (Hutt & Speh, 2000).

According to M. Porter (1998), in the long term, companies obtain success in relation to competitors if they have sustainable competitive advantage. There are two basic types of competitive advantage: lower cost and differentiation. The lowest cost is the company´s capability to forecast, produce and market a comparable product in a more efficient manner than its competitors. At or close to competitor price, lower costs translate into greater profits. Differentiation is the capacity of providing the buyer with an exceptional and superior value in terms of product quality, special characteristics or services.

Certainly, integrated logistics in the organization´s systemic vision supports the obtaining of competitive advantage by demanding that the company´s value chain be managed as a system and not as a collection of separate parts. A company is more than the sum of its activities. It´s value chain is an interdependent system or a network of activities that are united by connections. The manner in which an activity is performed impacts the cost or the efficiency of other activities given that they frequently generate an interchange in what calls for optimization.

2.1.1 Basic elements of integrated logistics

A basic fundamental element in integrated logistics is transport management. Under any economic, political and military perspective, transport is unquestionably, the most important industry in the world that interacts with the US (Ballou, 2006). According to Hutt and Speh (2000), transport is often the highest logistics expense and with the impact of the continuous increase of fuel costs, most probably, its relevance will be further enhanced. One can basically classify transport into five modalities, namely: railway, highway, waterway, pipeline and airway. According to Chopra and Meindl (2006), the role of transport in corporate competitive strategy is predominantly represented when the company is evaluating the target needs of their clients. If the competitive strategy targets the customer that demands far too a high level of service and this client is willing to pay for this service, the company may then utilize transport as a key factor to promote greater supply chain efficiency.

In the logistics process, the selection of the best mode of transport (modality) significantly impacts costs. The definition of the transport mode occurs in function of the product to be transported and modality limitations.

In addition to transport, storage is also part of logistics integration. The storage site is critical in terms of impact on logistics costs as is the case of the speed of product delivery, to the client. Choice may fall upon concentrating products in a central warehouse or supplier – in this case there is an improved control over inventories – however, the distance to reach customers, increases. Alternatively, one might chose to, in addition to the central warehouse, set up an advanced distribution centre – in this case closer to customers – however, there is an increase in inventories and one must evaluate each decision´s costs benefits.

Most often decisions to establish warehouses are based on the expectation that proximity with the points of demand (clients) will ensure the required levels of availability and order fulfilment deadlines. According to Fleury (2000), it was verified that this does not always hold true and that there might also be alternative forms of obtaining the same results at lower costs. In effect, many companies have been revisiting their distribution systems and one might affirm that there is a trend towards centralization, whereby the number of

warehouses that are currently in operation, is inferior to a couple of years ago. There isn´t a single model. Solutions depend on the characteristics of each business and on the adopted integrated logistics strategy. It is perfectly possible to combine the consolidated advantages of scaled systems and the flexibility and response capacity of direct systems.

According to M. Porter (1998), another important factor in the efficiency of the process is the information system, whereby many are the factors that favour competitivity amongst which: the flow of information - a fundamental element in logistics operations; customer requests, stock requirements, movement at warehouses, transport documentation and invoices, are some of the most common logistics information. In the past, such information relied on paperwork whilst currently, with information technology, the transfer and electronic management of information provide excellent opportunities for the reduction of logistics costs and an improved coordination of operations.

The forecasting of sales and stock management also contributes with the efficiency of the process: it is of fundamental importance to establish a stock management policy, in such a manner that there is product availability at the lowest possible cost. One must define where stock is located, when to order and how much ought to be maintained in safety stocks.

2.2 TECHNOLOGICAL INNOVATION

Markets continue to expand globally as a result of internationalization of customer desires, advances in communication, decrease of transport costs and, growth of multinational companies. A. Porter (1991) emphasises the importance of products and services based on technology for the increase of value of international business.

Meyers and Tucker (1989) define innovation as being an idea, a practice or a tool perceived as new, given relevant enhancement. They emphasize that such innovations might differ into routine or radical, presenting possible dimensions: continuous, dynamically continuous or discontinuous. The authors

define radical innovation as a process of developing and introducing a product or new service which is based on new technology and directed towards a market that is not familiar with the product. On the other hand, in routine innovation, the market is familiar with the product, but the technology is novelty.

According to M. Porter (1990) mentioned by A. Porter (1991), a nation´s competitivity depends on the innovation capacity of its industries. Countries utilize several means to construct the capacity of creating new technologies, including the adaptation of technologies generated in other countries. Therefore, in international competitiveness, the company is the centre of action because in the capitalist economy, the firm is almost always the entrepreneur that must implement the technology.

Innovative companies seek to foment their competitiveness improving the quality of their products and services, reducing costs and meeting the expectations of their global clients. The globalization of markets, emerging technologies and the privatization of production are trends that explain the interest of governments and companies in the international competitiveness issue. However, technological innovation is poorly understood by politicians and by governmental economic planning and for sure, innovation planning and management is key to improve national development efforts (Johnson & Marcovitch, 1994).

Within the complexity of issues of public policies involving technology, many of the groups devoted to planning do not present the technical specialization and skill to comprehend the frequent technological complexity and analyse it´s impacts. In Brazil, much like several developing countries, these conditions do not differ and the contribution to technological evaluation is significantly reduced (Johnson & Marcovitch, 1994).

One notices the vast technological research literature concerning the product however, services are also candidates of technological innovation processes. According to A. Porter (1991), services are responsible for 70% of the US national gross product. The service sector is at least as intensive in capital as that of manufacturing and several industries are highly technological.

Information technology might significantly contribute with the service sector, particularly within that of supply chain.

Krishnan and Ulrich (2004) emphasize that minor attention is given to supply chain, an important segment of services which encompasses the logistics process. There are excellent opportunities for research in this field enabling development teams to decide on inventory policies and process flexibility that promote the best customer satisfaction and corporate profitability.

Meyer and Tucker (1989) affirm that the competitive advantage might result from a strategy that integrates logistics with the development activity of a new product during the initial phases of technological innovation. However, the logistics function and it´s relation with the development process of a product during technological innovation has not been thoroughly researched.

2.3 THE ETHANOL SECTOR IN BRAZIL

Ethyl alcohol or ethanol is produced in Brazil by mills and distilleries. According to data supplied by Ruling Nbr. 36 of the National Petroleum, Natural Gas and Biofuels Agency, ethanol is prepared in two manners as to the quantity of water in its composition: hydrated ethyl alcohol, containing approximately 6,2% to 7,4% of water and anhydrous ethyl alcohol, with only 0,7% of water.

According to data from the Ministry of Agriculture, Livestock and Supply (MAPA) and the Sugar Cane Industry Union (ÚNICA), Brazil presents two regions where there is a concentration of ethanol, whereby one centre is in the Northeast and the other in the Central South of the country, as per Figure 1 below:

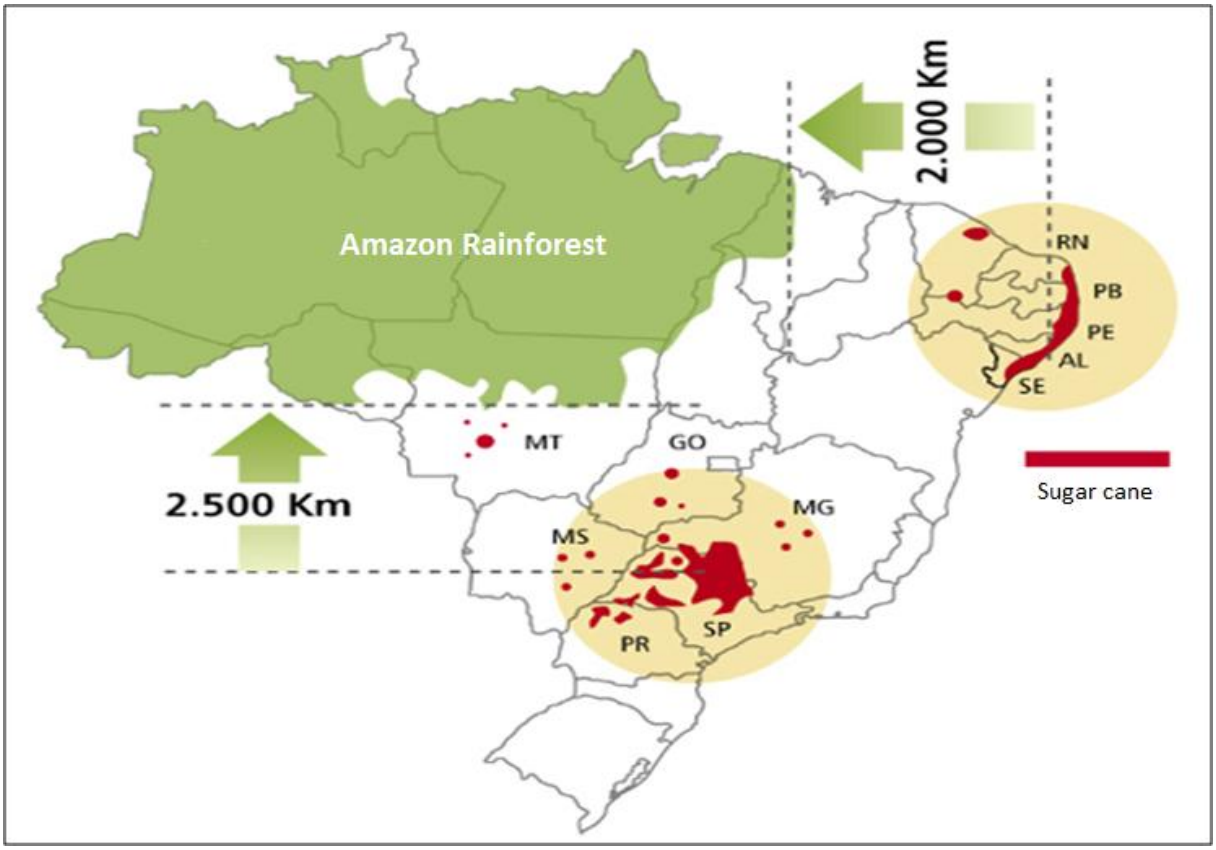

Figure 1: Ethanol production concentration regions in Brazil
Source: NIPE-Unicamp, IBGE e CTC

The distribution of ethanol occurs by means of a chain that begins at the alcohol industry, at the mills and distilleries, reaching the consumer market that might be at the fuel distributors, the food industry, the pharmaco-chemical industry and the alcohol-chemical industry.

The fuel distribution industry is the largest ethanol consumer market, followed by the food industry whereby, in this sector, the distilled beverage known as "cachaça" accounts for 10,5% of all the sugar cane processed during the 06/07 harvest period (CONAB, 2006). In third place, comes the pharmaceutical chemical industry, responsible for the ethyl alcohol utilized for cleaning purposes. The cosmetic industry also utilizes a sizeable portion of the alcohol for the manufacturing of perfumes. In last place, ethanol is also utilized by the alcohol-chemical segment, particularly in the industry of polymers.

Dolnikoff´s (2008) masters dissertation points out that there is a subsystem in the fuel distribution industry known as the carburizing ethanol

subsystem, indicating the use of ethanol fuel as a percent of gasoline utilized by automotive vehicles in Brazil. The described industry value chain is pictured in Figure 2, below:

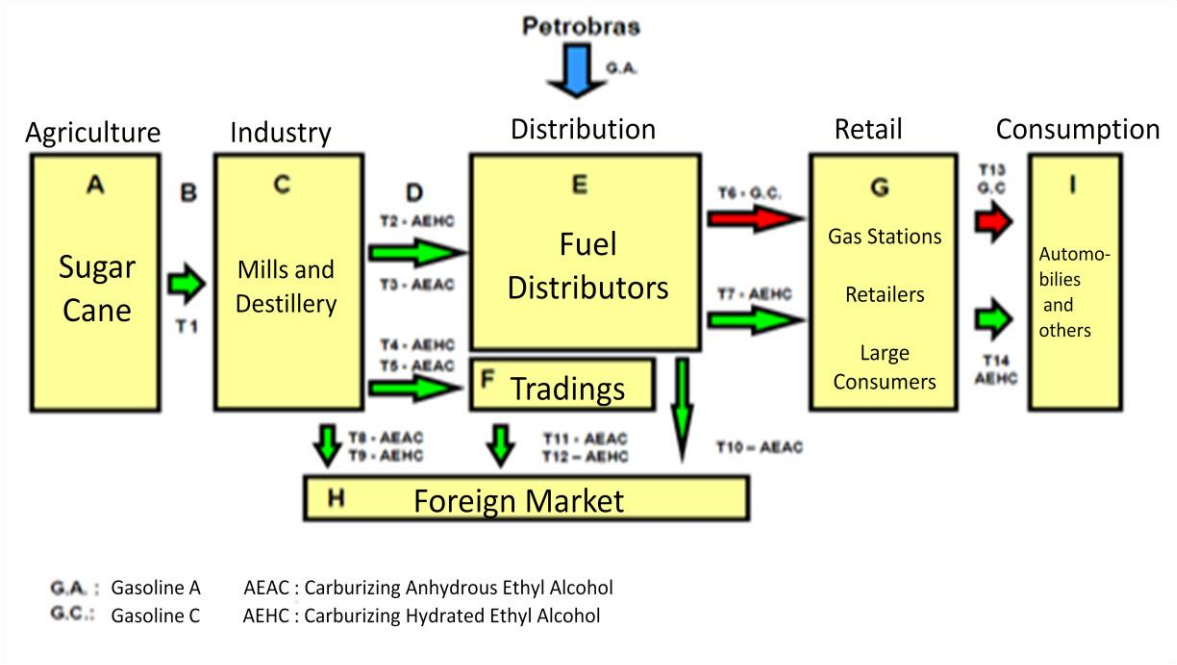

Figure 2: Carburizinf Ethanol Subsystem

Source: DOLNIKOFF (2008)

2.3.1 Agricultural and Industrial Production; Domestic and Foreign Markets

According to Mapa (2007) mentioned by Dolnikoff (2008), sugar cane and ethanol are usually produced at large rural properties, represented in the figure above by agent A, and the distillery is the specific site for the production of the bulk liquid ethanol, represented in the same figure by agent C. In Brazil, there are 240 mixed mills, producing alcohol and sugar, 106 specific producers of alcohol and only 14 producers of sugar. In terms of volume, the state of São Paulo is the largest producer. The major mode of ethanol transport is via fuel distributors, as indicated by agents T2 and T3 in the referred Figure. Exports of ethanol occur through so-called trading companies, represented by agent F in the same figure. It has an articulating role, performing the acquisition and sale of

products on the foreign market. Sample companies of this trade include Cargill, Coimex, Noble Group, Glencore and LDCommodities (Dreyfus) (Dolkinoff, 2008).

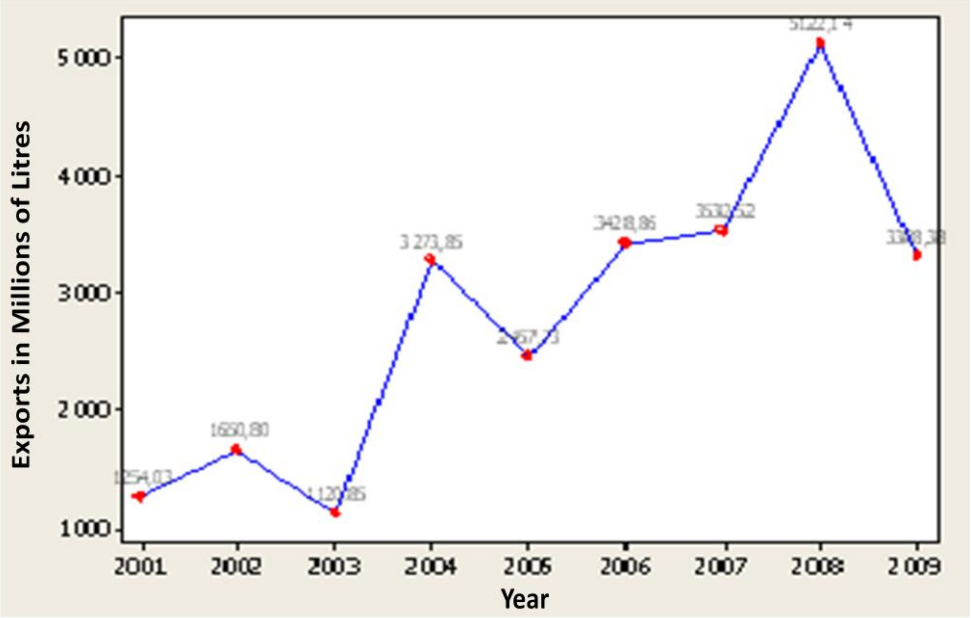

Figure 3: Ethanol Exports 2001-2009
Source: SECEX (2010)

3 METHODS AND RESEARCH TECHNIQUES

The study´s analytical model comprised the mapping of theoretical foundation by means of bibliographical research and monitoring techniques, integrating the results with descriptive field surveys at companies from the segment under analysis.

According to A. Porter (1991) monitoring is to look, observe, verify and update oneself with the development in a well defined field of interest. Monitoring is to survey the environment to obtain pertinent information. This information belongs to a particular technology – technological monitoring – where one might obtain historical information on technological development,

current information on the state of the art and information concerning future perspectives.

The descriptive research method, utilised to integrate monitoring results, was that of personal interviews with managers in the field of logistics of the sector under study. According to Mattar (2001), conclusive descriptive research is characterized by presenting well defined objectives and formal procedures and also for being well structured and directed towards the solution of problems or evaluation of alternative courses of action. For Yin (2001), one of the most important sources of information is the set of interviews. As an interviewee explains a fact, the good listener pays close attention to the exact words employed, captures the mood and emotional elements and understands the context as of which the interviewee is perceiving the world.

The sample of companies was prepared in a non probabilistic and intentional manner whereby eight were chosen. These present processes of relevance in the sugar alcohol sector with logistics interfaces. Thus, the sample provides a sound representation of the companies with the strongest participation. Triviños (1987) affirms that qualitative research, of theoretical foundation, may utilize random resources to determine a sample, that is, seek a certain type of representation of the largest group of subjects that shall participate in the study. However, most commonly, it does not take into account the quantification of the sample.

Although the structure of the interview supports the collection of information, in this study a semi structured survey was employed that usually enables the expansion of the field of questions in addition to the basic queries. However, Triviños (1987) points out that care must be taken during the semi structured interview process. It also obtains truly valuable results if the researcher has full grasp of the focus under study and of the theory that drives its steps.

Interviews are very helpful in investigation activities given that most of the experiences and of the knowledge acquired is not registered. One has access

to valuable information, sometimes acquired in consequence of a privileged position of interviewees, merely by means of conducting interviews.

Twelve interviews were conducted at eight companies and choice fell upon taking note of replies instead of recording the conversations, at the request of the interviewees, and given the confidential nature of some of the information. Much the same way, at the presentation of research results ,most of the company names are not mentioned.

4 PRESENTATION AND ANALYSIS OF DATA

By means of the information obtained in the monitoring process, integrated with field surveys, a significant increase in the global demand for ethanol was confirmed as was the expected increase in further growth, given the signing off of the Kyoto Protocol, the international agreement to reduce greenhouse effect gases in industrialized countries, and to ensure a clean development model at developing countries. The document foresees that, between 2008 and 2012, developed countries shall reduce emissions in 5,2% in relation to levels measured back in 1990.

The treaty was signed off in 1997 in Kyoto, Japan by 84 countries. Approximately 55 of these have already transformed it into law, therefore the pact is in effect. Amongst the alternatives to reduce the emission of greenhouse effect gases, there is the use of ethanol as a source of propulsion power for automobile engines.

The producers emphasize that there are basically two distinct ethanol markets: the industrial and the fuel markets, whereby in the industrial market, growth is minor, some 3 to 5% per annum. The largest expected growth resides in the fuel ethanol market. Following suit we find, in Figure 4, the behaviour of Brazilian ethanol exports of harvests from 2003/2004 to 2008/2009. In Figure 5, exports per countries between 1996 and 2005 are pictured.

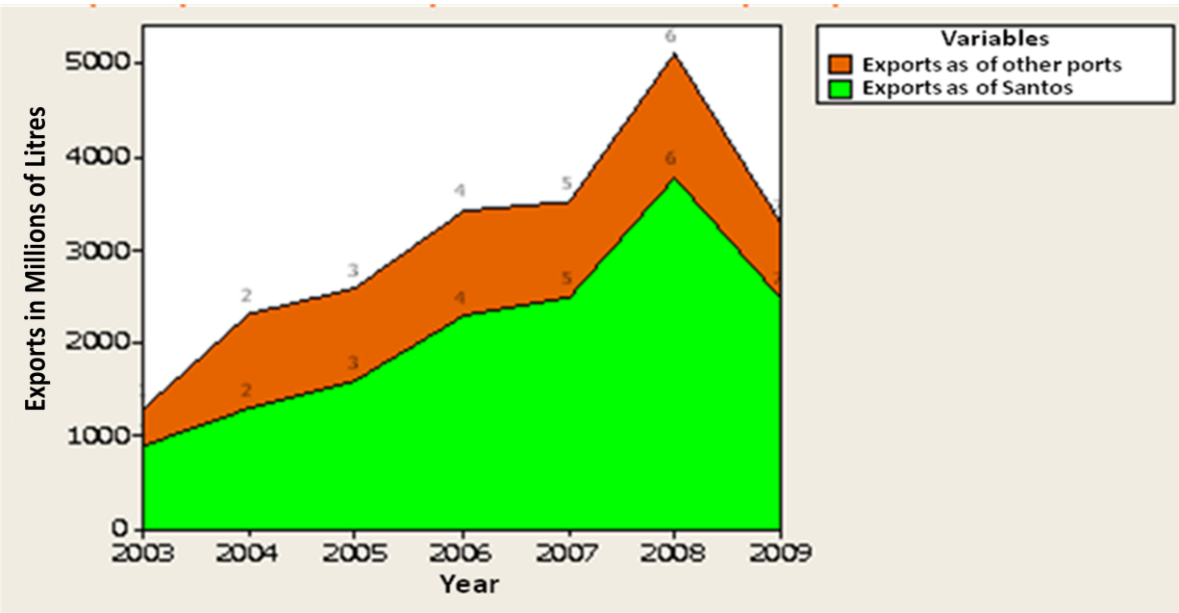

Figure 4: Brazil Exports x Port of Santos

Source: SECEX (2010)

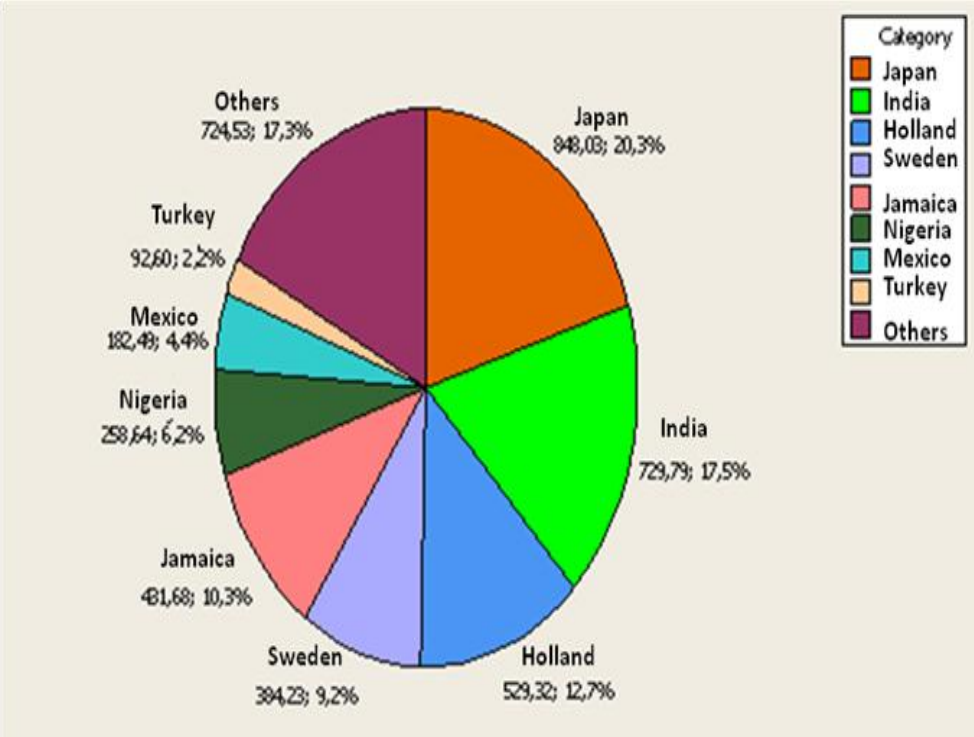

Figure 5: Ethanol exports per country 1996-2005

Source: SECEX (2010)

As indicated by producers, the quantity produced in the 2009/2010 harvest is approximately 28 billion litres and for the 2010/2011 the harvest is of approximately 31 billion litres. Increase in production occurs at the same pace as growth in demand, both to meet the local market and exports.

A. Porter (1991) emphasizes the importance of setting focus on the monitoring process. Thus, this research concentrated on exports and on the port of Santos, responsible for most of the exported ethanol, as can be seen from the graph above. The port of Santos contributed with 75% of the movement of Brazilian exports in 2009. According to research - prospection via monitoring integrated with field surveys – an optimistic export scenario for 2020 amounts to 25 billion litres for Brazil, of which approximately 19 billion exported as of the port of Santos, that is, five times the volume exported in 2008 (5.1 billion litres). Considering a conservative scenario, according to F.O Licht´s (2011), year 2020 exports ought to be 12 billion litres in terms of Brazil totals, of which 9 billion litres shall be shipped at the port of Santos. However, in addition to the need to increase the capacity of the mills – increasing the planted area of sugar cane – it is also mandatory to revise logistics, and in particular, the infrastructure of the port of Santos.

In the field survey, it was observed that although the exported volume of ethanol has decreased in 2009 and 2010, projections, under an optimistic scenario, indicate linear growth as of 2011, as illustrated in Figure 6:

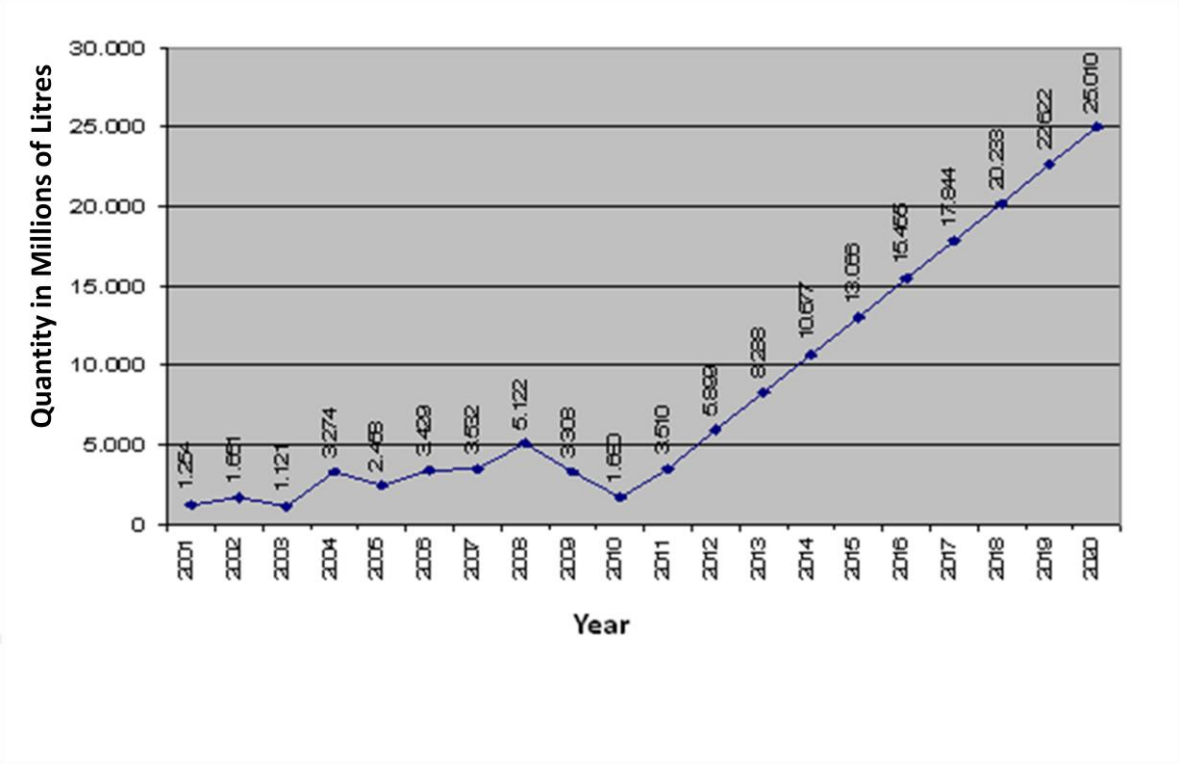

Figure 6: Brazil Ethanol Exports (millions of litres)

Source: AUTHOR (2010)

These values are related to the supply of Brazilian ethanol to partially meet the global demand that is expected to increase from 67 billion litres in 2008 to 209 billion litres in 2020 (F.O. LICHT´s, 2011).

However, some important aspects were identified in the research: the supply of Brazilian ethanol for export can be impacted by the domestic consumption of ethanol as a result of an increase in the fleet of flex fuel vehicles and by the utilization of ethanol as a raw material in the petrochemical industry. Analysing historical data from the graph above, between 2003 and 2008 where there was an impact caused by flex fuel automobiles - excluding 2009 when international sugar prices impacted the supply of ethanol - one can consider the following regression:

X=time, whereby 2003=0 and 2008=5, Y=exports in billions of litres. Y=a + bX

For X=0 we have Y=1,121, thus: 1,121=a + 0b, that is, a=1,121

For X=5 we have Y=5,122, thus: 5,122=1,121 +5b, that is, b=0,8

Therefore: Y=1,121 + 0,8X, projecting for the year 2020 (X=17) we have: y=1,121 + 0,8x17, thus Y= 14,721, that is, approximately 15 billion litres, total Brazil. This does not take into account the impact of the increase in the consumption of ethanol by the petrochemical industry.

As per F.O. LICHT´s (2011), recent analysis indicates a conservative scenario supplying 12 billion litres of ethanol for export, total Brazil, taking into account the increase in the fleet of flex fuel automobiles and the increase in the internal consumption at the petrochemical industry. Therefore, this scenario might be considered biased for exports.

4.1.1 Problems encountered and technological status of the logistics process of bulk liquids at the port of Santos

According to the managers of bulk liquid warehouses, the current storage capacity at the port of Santos is of 743 thousand cubic meters and of this total, 28% is devoted to the storage of ethanol, that is, 210 thousand cubic metres. The static volume is enough to meet the demand of up to 5 billion litres per annum. However, managers emphasize that this also depends on the efficiency of uploading and shipping cargo onto vessels. Thus, one might conclude that there is plenty of room for the improvement of strategic planning of integrated logistics.

In this aspect, there are two bottlenecks: the lack of diversity in transport modalities for the reception or pick up of ethanol, and of berths for the anchorage of vessels, given that there are only three at Alemoa and two at the Island of Barnabé. Meyers and Tucker (1989) emphasize that logistics, in radical innovation, falls behind in offering high level services because the needs of customers is not truly well known.

Berths are frequently overcrowded leading to delays in the uploading of ethanol and high costs on vessel per diems. Managers point out that all have

expansion plans at their storage terminals, totalling 131 thousand cubic metres exclusively for the storage of ethanol.

The bottleneck – anchorage berths for vessels – was mentioned by all as the greatest concern of the segment. The five berths utilized for the export of ethanol are not enough to meet the current demand. According to these same managers, there is a study at the port entity, CODESP, for the construction of another two berths at Alemoa with a three year forecast of project execution and building. This ensures that until 2014, ethanol exports as of the port of Santos, shall be impaired in time and costs given delays in vessel operations.

Another difficulty encountered is poor multimodality, that is, the availability of diverse modes of transport. A strong concentration in the road modality and no use whatsoever of railway or pipeline modalities, was verified. As to the railway modality, some tests were executed but there was no continuity. Most of the storage terminals at Alemoa have a railway terminal, but at the Island of Barnabé the terminals do not as yet have railway tracks. Managers indicate that at the port of Paranaguá, responsible for 16% of ethanol exports, the railway modality is frequently utilized.

As to the technological stage, companies have invested in technology for the automation of ethanol storage tanks, with automatic control of ethanol via a radar measurement system, automatic control of gas phase – addition of nitrogen and relief of pressure for the gas combustion system- thus avoiding emissions to the atmosphere.

Road transport, predominantly in the logistics modality, also received investments in technology, duplicating the sharing of cargo – the so called bi train trucks. The shape of tanks was modified, lowering the centre of gravity of the trucks and in consequence, greater performance was obtained, increasing the cargo capacity and reducing freight costs.

Another important aspect in logistics is that of information technology (IT). A. Porter (1991) emphasises that information might not appear in open literature, depending on who develops it. In this sense, the monitoring process

enabled the obtaining of important IT information as shall be seen following suit, in Figure 7, picturing the flow of information at ethanol´s integrated logistics.

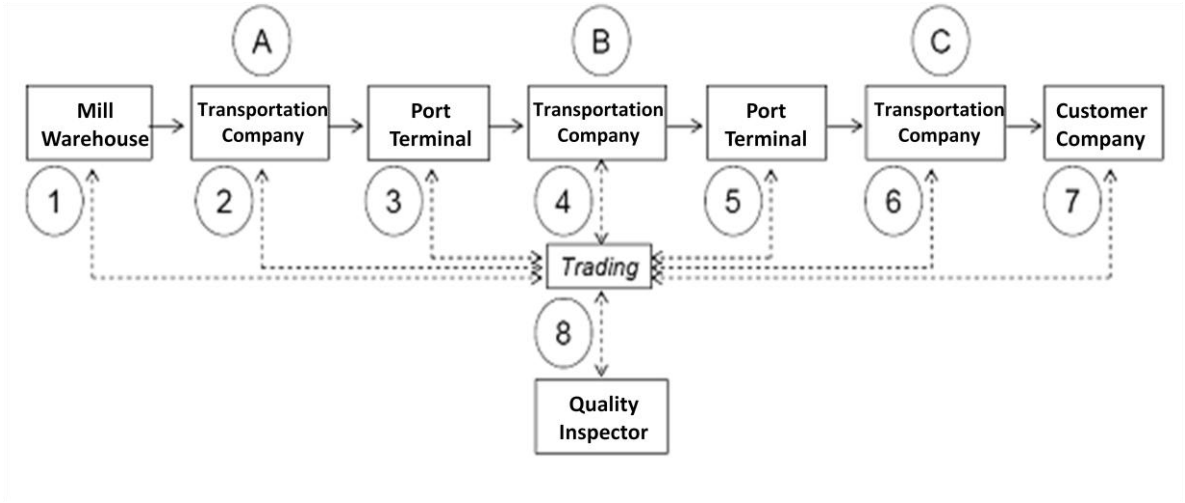

Figure 7: Flow of Information of the Ethanol Supply Chain
Source: AUTHOR (2010)

In the figure above, the dotted lines indicate the flow of information between the various players that comprise the integrated logistics chain for ethanol. Due to the existence of several and dispersed players in the referred chain, it was observed that there is a concentrator of information which takes place at a company known on the market as a trading firm.

From an IT perspective, information exchanged between the mill and the trading, indicated by number 1 on the figure, takes place via e-mail utilizing Excel spreadsheets. Information between transportation companies, whether those of terrestrial modality or using waterways, indicated by numbers 2, 4 and 6, and the trading, is also exchanged via e-mail. Simultaneously, information between the client company and the trading, indicated on the figure as number 7, is likewise exchanged over e-mail, as is the case with information exchanged between the trading and quality inspectors. Finally, the most interesting finding of the research was the verification that information between the port of origin (Santos) and the trading is exchanged via an intranet, whereby the trading company is able to access information displayed by the port terminal, containing information as to stocks and truck positions, at its entry and exit.

4.1.2 Technological innovation perspectives

Research demonstrates that the pipeline modality is not as yet utilized to transport ethanol from the mills to the port of Santos however, there are projects undergoing development. One of the projects mentioned, is that of Uniduto. Researching this company´s site the following information was collected: Uniduto was set up in 2008 by a group of ethanol producers concerned with the improvement of the logistics infrastructure of fuel produced in Brazil. The objective is the transport via pipelines, collection centres and port warehouses. Currently there are over 80 mills connected to 10 very large ethanol producers. With investments of more than 1 billion dollars, expectations are that the pipeline shall have been built by the end of 2011, whilst the start of activities is forecast for 2013, transporting most of the production of ethanol to the domestic and export markets.

Currently undergoing environmental certification, Uniduto foresees in its project a network with approximately 570 kilometres of pipelines, with four collectors located in the regions of Serrana (SP), Botucatu (SP), Anhembi (SP) and Santa Bárbara d'Oeste (SP), two distribution centres for the domestic market in Paulínia (SP) and an export terminal in Guarujá (SP), where a private off-shore port will operate. The total capacity of the pipeline system is of 17 billion litres of ethanol per annum.

Collector centres are strategically positioned to enable interaction with other modalities. The Botucatu terminal will enable interaction with road and railway transport, reaching production at the north of the state of Paraná; that of Anhembi will interact with the road and waterway transport that takes place along the Tietê-Paraná riverway which, with its 1.200 navigable kilometres, will help exit part of the production of ethanol from Mato-Grosso and Mato-Grosso do Sul states; the centre of Serrana will drain away production in the region and

part of the ethanol produced in the Triângulo Mineiro (MG) and Goiás state, via interaction with highways and railways.

The arrival of ethanol for export at the port of Guarujá will take place by means of pipelines and upload onto vessels will occur through single buoys.

It was verified that storage at the port of Santos, to meet ethanol exports, will increase until 2013, to approximately 341.000 cubic metres, a volume that is able to meet the intended demand of 9 billion litres by 2020 (total Brazil: 12 billion). For this optimistic demand, even with the reduction of the needs for storage after the start of the pipeline´s operation, there would be a need to increase the storage capacity according as illustrated in Figure 8:

Year	Volume (millions of litres) Brazil Exports	Volume (millions of litres) Santos Exports	Storage in m3 (required)
2011	3.510	2.632	98.600
2012	5.899	4.424	167.620
2013	8.288	6.216	235.517
2014	10.677	8.008	167.000
2015	13.066	9.799	204.000
2016	15.455	11.591	241.000
2017	17.844	13.383	278.000
2018	20.233	15.174	316.000
2019	22.622	16.966	353.000
2020	25.010	18.758	390.000

Figure 8: Ethanol Storage Requirements
Source: AUTHOR (2010)

The other transport modality is that of railways, that is not as yet utilized to transport ethanol to the port of Santos. Although some tests have already

been conducted, it was identified in the research as a future alternative. However, technological investment is required and this is mostly being evaluated in the modernization of railway terminals of ethanol stock warehouses.

In terms of information technology (TI), there are forecasts of major investments in softwares interconnecting the component companies of the logistics process. It is true that currently, IT has a support role but fact is that this role is being underutilized. There are integrations from the hardware perspective that have not materialized as yet and that are fundamental to the consolidation of information, in a cheap, fast and reliable manner (quality and safety) requiring integration.

5 FINAL CONSIDERATIONS

In general, the technological status of Brazil´s logistics lags behind in relation to other industrialized countries. Brazil needs more technological investment in infrastructure, primarily in the port sector and more options in terms of transportation modalities. Given that reduction in logistics costs and greater reliability in services rendered is sought, the use of more than one modality in Brazil arises as a great opportunity for ethanol exports to become more competitive. The highway modality predominates in Brazil´s transport matrix, even for products and routes where it is not the most competitive.

Most of the ethanol produced in the countries leaves the mill in trucks, an expensive means of transport that compromises profitability in areas of the interior of the country. The growing volume of fuel grade ethanol, justifies the construction of pipelines. The pipeline project that the company Uniduto intends to build, might be a good alternative for the transport of ethanol, but its forecast for pipeline operations is for the end of 2014. Nevertheless, some managers believe that delays may occur given the complexity of the project and most importantly, the uncertainty of scenarios.

The port structure also calls for improvements with views to the optimizing of integrated logistics. In the challenge of ethanol exports, logistics

operators are modernizing themselves, investing in technology so as to meet increasing demand. However, managers of companies in the segment emphasize the need for more technological investments in port infrastructure, mentioning, for instance, that the depth of waters at the channel of the port of Santos needs to be extended – currently at 11 metres – enabling the operation of larger vessels for the export of ethanol, thus reducing logistics costs.

They also point out the congestion of vessels at the bulk liquid terminals at the port of Santos given the increase in the number of ships. Furthermore, according to the researched companies, to meet the growing demand of ethanol there is the need to build more anchorage berths for vessels and with new technologies. Although CODESP has already announced the intent of building another two anchorage berths at the bulk liquid terminal of Alemoa, logistics managers do not expect expansions to be ready in less than three years, meaning that there will be at least three years of congestion and high over per diem vessels costs.

Managers of the researched companies emphasize the importance of further investments in the port of Santos so that the Brazilian ethanol may obtain competitive sustainable advantage. However, investments must occur in a systemic manner, considering the integrated logistics and analysing the entire supply chain, from mills in the interior of the country to product delivery on the consumer market.

It is of vital importance to emphasize that between the years 2003 and 2009, technological investments in storage at port terminals were sufficient to meet the current demand and up to 2012, despite having occurred with some delay. However, it calls for strategic planning, with views to meeting the increase in exports that will occur when Japan begins to increment the mixture, indirectly, of ethanol in its gasoline.

To meet the demand for ethanol exports through the port of Santos and, based on the optimistic scenario foreseen for 2020, (of 19 billion litres) a new technology will have to be developed in transport modalities, such as the pipeline. According to information obtained at Uniduto´s site, the pipeline when

in operation will be capable of transporting up to 16,6 billion litres of ethanol per annum.

According to Meyers and Tucker (1989), technological innovation is responsible for an important part in competitiveness and the logistic ability to contribute with technological innovation is an important complement to other areas of marketing that support technological innovation.

The technological evolution process of logistics is in course and as is the case in every organizational phenomenon, this takes place in a discontinued and non uniform manner, thus concurring that the same is important for the obtaining of competitive advantages in ethanol exports. On one hand, long is the course to follow so companies of the port sector may improve their logistics and on the other, this study enabled exposing that a very significant extension of this path has, to date, been paced towards completion.

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