Risk and agri-food supply chain performance: perceptions from initial analysis

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Abstract
There are little researches related to the risks assessment in models of performance of agri-food supply chains. Thus, this research aims to identify key performance/risk indicators to agri-food supply chains and propose a framework of analysis. The method used was the case study with in-depth interviews in order to demonstrate the concepts and presuppositions of the literature with support the technique of analytical progression for data treatment. Our results suggest that the performance indicators and risks to the agri-food supply chains can be classified into five categories, namely, financial, responsiveness, food quality, flexibility, and technology/innovation.

Keywords: Performance, Risk, Agri-food supply chain

Introduction
According Mentzer et al., (2001, p. 4) a supply chain is "a set of three or more entities directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to customer". In this context, a agri-food supply chain can be seen as the link several companies from agricultural production to de end

consumer in which the products can be marketed fresh or processed (Matopoulos et al., 2007; Van der Vorst, 2007). Under this perspective, Aramyan et al. (2007) claim that to improve performance of the supply chains as a whole it is necessary transcend the limits of an enterprise incorporating the entire chain.

The models for evaluating the performance of supply chains have been highlighted as a tool of great importance in supply chain management (Beamon, 1998; Beamon, 1999; Guanasekaran *et. al*., 2001; Chan, 2003; Claro *et. al*., 2003; Guanasekaran *et. al*., 2004; Aramyan *et. al*., 2006; Aramyan *et. al*., 2007; Chia *et. al*., 2009). However, there are little researches related to the impact of risks assessment in models of performance of SC, especially in Agri-food Supply Chain.

In Brazil, the creating water buffalo has grown considerably in recent years, reaching 1.18 million of heads in 2011. São Paulo State stands out as the main producer of buffalo milk and its derivatives, in 2006 accounted for 24.5 % of buffalo milk in Brazil, which generated a revenue around of US$ 423.78 million, 26% of the sum national (IBGE, 2011). However, this chain has a lack of research on performance indicators.

All things considered, the focus of this research was to answer the question: *What are the risks and performance indicators that can be used to structure a performance measurement system (PMS) with a focus on Agri-food Supply Chain?* Thus, this paper aims to identify key performance indicators of an agri-food supply chain and the risks that affect the chain and to propose a theoretical-empirical model of analysis.

This article is organized into five sections. Besides the introduction presented in this section, the literature review is presented in the following section. The methodology is presented in the third section. Finally we present the results and final considerations.

Theoretical background

Van der Vorst (2005) defines supply chain performance as the degree to which a chain meets the expectations of the consumer and the parties involved. A performance measurement system (PMS) is an important tool for managing a supply chain and can facilitate the understanding and integration among its members, to compare competing systems or provide insights for better decisions that bring competitive advantages to chain (Beamon, 1998; Chan and Qi, 2003). However, as shown in Table 1, the great difficulty in establishing what, how and when to measure and the difficulty of alignment of goals among members of the SC has led to the creation of several models with different indicators (Beamon, 1999; Aramyan et al., 2007).

Shepherd and Günter (2006) point out that much attention has been given to the indicators related to costs to the detriment of others, especially innovation, quality and flexibility. However there are other quantitative variables that directly interfere in the performance of the chain and thus is recommended the use of indicators that combine costs with other qualitative variables according to the competitive priorities of companies and chain (Chan, 2003; Chia et al., 2009).

In an agri-food supply chain there are some specific characteristics that differentiate it from other chains and directly interfere with the performance (Table 2). Aramyan et al. (2006, 2007) stressed the importance of food quality and safety to propose and test a PMS to assess agri-food chains.

Table 1 - Different indicators of competitiveness in the literature

Author	Financial	Responsiveness	Quality	Flexbility	Innovativeness	Others
Beamon (1998)	X	X		X		
Beamon (1999)	X	X		X		
Guanasekaran et al. (2001)	X	X		X		
Chan (2003)	X	X		X	X	X
Claro et al (2003)	X			X		
Guanasekaran et al. (2004)	X	X		X		X
Aramyan et al (2006)	X	X	X	X		
Aramyan et al (2007)	X	X	X	X		
Chia et al (2009)	X	X	X	X	X	X

Source: review of literature

Table 2 - Specific characteristics of a agri-food supply chain

Características	Autores
Seasonality in availability of raw materials, consumption and production	Zuin e Queiroz (2006); Aramyan *et al*. (2007); Batalha e Silva (2011)
Perishability and variability of quality of raw material	Zuin e Queiroz (2006); Batalha e Silva (2011)
Perishability of the final product	Ziggers and Trienekens (1999); Zuin e Queiroz (2006); Aramyan *et al.* (2007); Batalha e Silva (2011)
Behavior and preferences of consumer	Zuin e Queiroz (2006); Batalha e Silva (2011)
Sensory properties of product	Ziggers and Trienekens (1999); Aramyan *et al.* (2007)
Necessity for transport and storage conditional	Aramyan *et al.* (2007)
Quality and safety food	Zuin e Queiroz (2006); Aramyan *et al.* (2007);
Dependence on natural conditions of farm products	Ziggers and Trienekens (1999); Aramyan *et al.* (2007); Zuin e Queiroz (2006)
Consumer preoccupation concerning method of production	Ziggers and Trienekens (1999)

Source: review of literature

Supply Chain Risk Management (SCRM) involves the identification and control of internal and external risks that may affect the performance of a chain, through a coordinated approach among the members in order to prevent or mitigate the vulnerability of the chain as a whole (Jüttner et al., 2003).

With the recent attention by researchers all over the world as regards the need for providing coordination between production and distribution, so that the products are available on time and place right (Mentzer et al., 2001), the prioritization of supply chain before formed by the triad "reduction of production costs - higher value products customer satisfaction," has been added in recent years by the need for mapping their risks and vulnerabilities.

Thus, the risks approach involving the supply chain has been studied by several researchers in recent years (Zsidisin, 2003; Chopra and Sodhi, 2004; Christopher and Peck, 2004; Finch, 2004; Jüttner et al, 2003; Jüttner, 2005; Peck, 2005; Sheffi and Rice, 2005; Wagner and Bode, 2006; Tang, 2006; Wagner and Bode, 2007; Manuj and Mentzer,

2008; Rao and Goldsby, 2009; Jun Lin and Hayes, 2010; Tummala and Schoenherr, 2011) among which some indicating that risks may affect the performance of SC (Zsidisin et al., 2004; Zeng et al., 2005; Elkins et al., 2005; Ritchie and Brindley, 2007; Faisal, 2009).

From this perspective, it is important that organizations choose to address the risks most relevant that impact about the performance of the chains to which they belong. However, when choosing which risks are most relevant, it is important to know the consequences that the risks bring to the business (Hallikas et al., 2002; Sheffi, 2005; Kouvellis et al., 2006, Ritchie and Brindley, 2007). Table 3 synthesizes the aspects of risk trigger and consequences in literature.

Table 3 – Link between performance and risk in agri-food supply chain

	Performance measures [(1)]	**Risk trigger** [(2)]	**Risk consequences**	**Authors**
FINANCIAL	• Cost: Production/distribution Transaction • Profit • Return on investment • Inventory and sales	• Transportation breakdowns • Inaccurate forecast • Longer lead times • Lack of planning • Swing demands	• Low customer service level • Less consistent financial return • Damages for shareholders	• Towill (2005) • Jun Lin e Hayes (2010) • Peck (2006) • Blos et al. (2009)
RESPONSIVENESS	• Fill rate • Product lateness • Customer response time • Lead time • Shipping errors • Customer complains • On-time delivery	• Loss of control (of the process) • Depends transport mode chosen • Lack of effective system integration • Increase in costs	• Downtime and failure to satisfy the customer´s requirements on time • Loss of opportunity and market share	• Zsidisin e Ritchie (2009) • Ellegaard (2008): • Aguiar (2010) • Sheffi e Rice (2005) • Peck (2006)
QUALITY	• Sensory properties • Shelf life • Product safety and health • Product reliability and convenience • Production system • Environmental aspects • Marketing	• Lack of standards • Short life cycles • Poor quality of supply • Market with low competitiveness • Process errors • Delay response	• Consequences for financial viability • Close relationships and low trust on the partners • Damage for brands, reputations and businesses	• Kleindorfer e Saad (2005) • Faisal e Shankar (2006) • Peck (2006) • Zsidisin e Ritchie (2009)
FLEXIBILITY	• Information and material flow integration • Supplier performance • Stockout • Customer satisfaction • Volume • Delivery • Backorders • Lost sales and late orders	• Supplier fulfillment errors • Selection of wrong partners • Poor quality of process • Low quality of service • Rate of exchange	• Operational inefficiency • Negative impact on revenue targets • Flexibility heavily restricted • Consequences for financial viability of the company	• Sheffi e Rice (2005) • Jüttner e Maklan (2011) • Svensson (2002) • Asbjornslett (2008) • Tang e Tomlin (2008) • Zsidisin e Ritchie (2009)

INNOVATIVENESS	• New launch products • New use of technology • Money invested (employee training) • New services implemented per year • Number of suggestions implemented per employee year	• Higher Cost: • Lack of supply chain visibility • Lack of network • Cost capacity • High design changes • Lack of suggestion of innovations	• Loss of opportunity and market share; • Operational inefficiency • Consequences for financial viability of the company	• Chan (2003) • Chia et al. (2009)

Source: review of literature

(1) Indicators from Table 1

(2) Adapted of Tummala and Shoenherr (2011).

Methodology

This research was conducted in accordance with the form proposed by Collis and Hussey (2005), namely: a) about the objective consisted in an exploratory study, b) about the process, is a qualitative study.

The method used was the case study with: i) literature review to identify performance indicators and risks, ii) in-depth interviews in order to demonstrate the concepts and presuppositions of the literature with support the technique called analytical progression (Miles and Huberman, 1994) for data treatment, and iii) a four-points Likert scale, with a begin of 1 "irrelevant", and 4 to "fundamental" used for selection of indicators.

The case study was used because it is recommended for studies of contemporary phenomena in your contexts (Yin, 2003), and in particular for exploratory research into industrial networks (Easton, 1995).

Regarding the method, the case study proved to be the most appropriate to the needs of the present research. In this direction, Voss (2009) presents three main points that must be evaluated in selecting the case study method to conduct research, and this research is framed in all, namely: a) the phenomenon can be studied in their environment natural b) responds questions about "why, what, what, how" with understanding the nature and complexity of the phenomenon as a whole, and c) when little is known about the research topic.

The chain studied was the water buffalo milk chain of Sao Paulo State, Brazil. The interviews were conducted in September – December 2011 with 3 rural breeders, 4 processors, 1 wholesale.

For the data analysis we used as support the progression analytical. According Miles and Huberman (1994) is the progression of the description for the explanation. In this sense, the authors suggest that the analytical progression begins telling a story in order to build a "map" in the intention to formalize the elements of the story and finding the key variables. Then proceed with the construction of a theory or model, or connection between the variable and how they affect each other.

From this perspective, the first step in data analysis proceeded with the creation of a text. A method data coding was established to create this first text. The coding is an iterative process that allows researchers to compare the similarities and differences between the data, preparing to axial coding (Ellram, 1996).

The second stage was carried out to interpret the data. At this stage it was established the coding interpretation, which is basically the stage where connections are made between the coding categories developed in open coding (Ellram, 1996). In the third and

last step was performed selective coding, in which, alternative patterns are sought and analyzed to explain the phenomenon of interest.

Findings of the case study

The tables 4 e 5 show, respectively, the evaluation of the performance indicator and of the risks by the different players of the chain water buffalo.

Table 4– Evaluation of the performance indicators by the players of the chain of water buffalo

Categories	Indicators	Rural Breeders	Processors	Wholesale	Mean
Financial	Production costs	4,0	3,5	3,0	3,5[a]
	Distribution cost	2,0	3,3	1,0	2,1
	Transaction cost	2,0	2,3	3,0	2,4
	Profit	4,0	4,0	4,0	4,0 [a]
	Return on investment	3,0	3,8	3,0	3,3 [a]
	Sales	3,7	4,0	4,0	3,9 [a]
Responsiveness	Order fulfillment	1,7	4,0	4,0	3,2 [a]
	On-time delivery	1,3	4,0	4,0	3,1 [a]
	Customer response time	0,7	3,5	4,0	2,7
	Lead time	0,3	2,5	0,0	0,9
	Shipping errors	0,3	3,8	3,0	2,4
	Customer complains	1,0	3,8	4,0	2,9
Quality	Appearance of product	4,0	3,8	4,0	3,9 [a]
	Color	2,7	3,8	4,0	3,5 [a]
	Texture	0,3	3,8	4,0	2,7
	Shape and size	0,3	3,5	4,0	2,6
	Taste	0,3	3,5	4,0	2,6
	Shelf life	0,3	3,8	4,0	2,7
	Health	3,3	4,0	4,0	3,8 [a]
	Food safety	4,0	4,0	3,0	3,7 [a]
	Certification	1,7	3,8	4,0	3,1[a]
	Confidence in the product	2,7	4,0	3,0	3,2 [a]
	Traceability	1,7	3,0	3,0	2,6
	Storage and transport	4,0	3,8	4,0	3,9 [a]
	Working conditions	3,0	3,8	0,0	2,3
	Customer service	0,7	3,5	4,0	2,7
	Disposition of the product at retail	0,3	3,5	3,0	2,3
Flexibility	Customer satisfaction (pre-transaction, transaction after transaction)	4,0	3,8	3,0	3,6 [a]
	Delivery	1,3	2,8	0,0	1,4
	Volume	1,3	2,8	3,0	2,4
	Lost sales	1,7	3,0	4,0	2,9
	Late orders	1,7	3,3	1,0	2,0
	Integration of the information flow	3,0	3,3	4,0	3,4 [a]
	Supplier performance	4,0	4,0	4,0	4,0 [a]
	Stockout	1,3	4,0	3,0	2,8
Technology and innovation	New launch products	1,7	4,0	4,0	3,2 [a]
	Use of new technology	4,0	3,5	4,0	3,8 [a]
	Investment in employee training	4,0	3,3	3,0	3,4 [a]
	New services implemented	1,7	2,3	4,0	2,6

[a] *Performance indicators selected (mean equal or greater than 3)*

Table 5– Evaluation of the risks by the players of the chain of water buffalo

Categories	Risks	Rural Breeders	Processors	Wholesale	Mean
Financial	Problems in storage or transport	2,7	3,3	4,0	3,3 [b]
	Constant failure or inaccurate forecast of demand	1,0	3,0	4,0	2,7
	Long lead time	0,3	2,3	3,0	1,9
	Lack of planning	2,7	2,5	1,0	2,1
	Fluctuation in demand during the year	2,3	2,3	4,0	2,9
Responsiveness	Problems in process control	*	3,3	0,0	1,7
	Inadequate distribution	*	3,5	3,0	3,3 [b]
	Delivery system computerized	*	3,0	3,0	3,0 [b]
	Low use of information technology	*	1,5	4,0	2,8
	Lack of monitoring of distribution costs	*	3,0	3,0	3,0 [b]
Quality	Lack of standardization	3,3	3,7	4,0	3,7 [b]
	Short shelf life	2,0	3,7	3,0	2,9
	Poor quality of the raw material	2,3	3,0	*	2,6
	Lack of competition	2,3	1,0	1,0	1,4
	Uncontrolled of process	2,3	1,3	*	1,8
Flexibility	Supply failures	3,0	4,0	4,0	3,7 [b]
	Lack of integration between suppliers and customers	3,7	3,0	3,0	3,2 [b]
	Quality problems in production	4,0	2,3	4,0	3,4 [b]
	Low level of customer service	0,7	1,7	3,0	1,8
	Rate devolution high	0,3	1,7	1,0	1,0
Technology and innovation	High cost of technology	3,3	3,5	*	3,4 [b]
	High cost of launching new products	0,7	2,5	*	1,6
	Lack of cooperation network	2,0	1,0	*	1,5
	Shortly financial resources for innovation	3,7	2,0	*	2,8
	Lack of suggestions for innovation	2,0	1,0	*	1,5

[b] *Risks selected (mean equal or greater than 3)*

* *Does not apply to player in question*

As shown in the Tables 4 e 5, the findings of this research suggest that the performance indicators and risks to the chain in question can be classified into five categories, namely, financial indicators, responsiveness indicators, food quality indicators, flexibility indicators, and, technology and innovation.

In the category of financial indicators, were selected production costs, profit, return on investment and sales. In addition, the perceived risk is related to problems of storage or to transport the finished product. It is understood that because it is a perishable product (water buffalo milk and its derivatives) the improper storage or fail on transport directly impact the quality of the final product, (Batalha and Silva, 2001; van der Vorst *et. al.*, 2005), affecting the financial indicators.

Regarding the responsiveness indicators noted as important elements, the order fulfillment and on-time delivery. In face of it, the perceived risks are related to problems in process control, inadequate distribution of the product and the lack of a computerized system to do so. Thus, it is understood that the risks mentioned can affect the supply of

raw materials and products between the links in the chain affecting the supply of product to the final consumer (Peck, 2006).

Concerning the category food quality the indicators identified as important are related to appearance of product, color, health, food safety, certification, product confidence and storage and transport. While the perceived risks in this category involves the lack of standardization. In this context, note that the lack of standardization negatively impacts the maintenance of a constant quality, seen as a barrier, too, in other agri-food supply chain (Fearne *et. al*., 2001; Ziggers and Trienekens, 1999).

In another category, flexibility indicators, selected indicators are customer satisfaction (pre-transaction, transaction after transaction), supplier performance, and integration of information and material flow within the chain. In this respect, the risks involved are lack of integration between suppliers and customers and quality problems in production. This perspective, note that is highlighted the need for coordination between suppliers and customers to ensure that products be available at the time and place right (Mentzer *et. al*., 2001). In addition, it is essential equilibrate the customer satisfaction and efficiency along the supply chain (Lambert, 2008).

In the category of technology and innovation, the selected indicators have been launching new products, use of new technology and investment in employee training, and the perceived risk for this category refers to the high cost of technology. After all we understand that technology and innovation are sources of competitive advantage (Chan, 2003), however, requires, among other factors, as investment capacity of enterprises.

Conclusion

The importance of this research can be seen through its: i) contribution to the managers in order to enable a better understanding about the risks and performance indicators that can compound an PMS in Agri-food Supply Chain, and ii) contribution to the theory by proposing a framework that can serve as a benchmark for future studies. Thus, we can hypothesized that the variables highlighted from Tables 4 and 5 must compose a PMS to evaluate the performance of a Agri-food Supply Chain.

However, due to the small number of cases studied, more research needs to be held. Studies in other chains with different dynamics are fundamental to developing a more accurate model, so there must be careful with the generalization of this result.

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