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The Evaluation of Information Technology: a Case Study in Brazilian Slaughter Houses

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ABSTRACT: This paper aims to show the evaluation of information technologies (ITs) that has been used to trace products in Brazilian cattle chain. The Radio Frequency Identification (RFID) is an identification technology that traces products from their origin to their destination. This work includes literature review on evaluation models in technology, information technology, information systems, and RFID. The field research described in this paper was carried out at four Brazilian slaughterhouses. Some methods used were qualitative approach, case study, and interviews to show results. Although RFID has some advantages in traceability systems, it has been used by these companies in other activities such as warehousing and stocking. Because of this, in the Brazilian cattle chain barcode has been used to trace products.

KEYWORDS: Evaluation, information technology, RFID, slaughterhouses.

1. INTRODUCTION

The Brazilian meat complex has been standing out in the market segmentation and differentiation since it has the most modern dynamics of technology and knowledge generation (MDIC, 2008).

Exports have risen steadily, so the beef cattle chain has been updated and professionalized favoring the legalization of this activity and the adoption of new technologies, such as traceability. Thus, in order to encourage the growth of exports, the country must have reliable traceability technologies, as demanded from some of the major meat importers, such as the European Union, that buy from Brazil (Sabadin, 2006).

According to Pineda (2008), eighteen Brazilian slaughterhouses account for 98% of the country's export – the five largest exporters control 65% of the market, and one of them is responsible for 40% of the total. In February 2007, the companies' overall profitability was $351 million, shipping 201,9 tons of carcass equivalent, which is 68,8% over profitability in February 2006. Also, exports increased 54,7% in the same period. According to Schiefer (2002), the meat sector is characterized by a number of specificities that demand the implementation of integrated managing concepts not only in the company, but also in the chain, which makes the implementation of these management concepts in a company difficult.

Ferreira and Vieira (2005) argue that traceability has taken on an essential role as a coordination tool in the beef cattle chain. The current traceability infor-

mation technology (IT) available for identifying beef cattle is: barcode rings, *bolus* (pierced microchip) and electronic identification (electronic ear tags). A traceability system that employs new identification technology, such as Radio Frequency Identification, RFID, is important in tracing the product from the place the animal was bred until it is sold to retailers for purchase by final consumers.

Although important to Kleiner (1997), the information technologies and identification technologies mentioned above have unjustifiably high costs since their benefits can sometimes be unpredictable. The lack of predictability is due to interface changes between software and hardware (technical issues) and also due to the lack of basis to compare the performance of information technologies according to the market expectation (strategy issues).

Taking this issue further, this article aims to show the evaluation about information technologies (ITs) that has been used to trace products in four Brazilian slaughterhouses.

The case studies were carried out in four slaughterhouses, and this work was divided into four steps. The first includes literature review for evaluating the identification technologies. The second includes research approaches, methods, and strategies used to gather the data. The third includes the case studies and a comparison between them. Lastly, the fourth includes conclusions and suggestions for further studies.

2. SUPPLY CHAIN MANAGEMENT, IT, AND RFID

Over the last decade, information technologies, specifically the Web, have revolutionized supply chain design, management, and control. They have enabled a paradigm shift from inventory to information; from competition to collaboration; and from cost to value (Boone and Ganeshan, 2007). These ITs are named by Devaraj, Krajewski, Wei (2007) as "e-business, and they need to be implemented after an evaluation of the needs of the supply chain. The next step occurs as the company has benefits of joining information technology and the supply chain. Then, companies use these technologies to enhance relationships between agents in a supply chain. These benefits are realized by companies when they engage in information sharing and other forms of collaboration between suppliers and customers that address the issues inherent in the production planning and scheduling of their products. Capturing and sharing

real-time information has become essential to improve supply chain performance. In addition, these technologies facilitate the collaboration of supply chain entities. These authors concluded that e-business technologies do impact production information integration in a supply chain. They add important information indicating that suppliers' integration affects the performance of the company.

According to Gunasekaran and Ngai (2005), the infusion of information technology into business operations drastically changes the way businesses operate. For managing relationships in SCM, IT is the foundation of a new paradigm that has been used to provide: centralized strategy, but decentralized operations; a synchronized supply chain management system; collaborative partnerships among select suppliers; a new interoperable and open information systems structure; brokers; and an intelligent, mobile, agent-based trading system.

Although information technologies such as Internet are important, Radio Frequency Identification (RFID) has been emerging as a technology that provides major improvements to efficiency and accuracy of materials handling systems. This technology enables the individual monitoring and tracking of items in transit through production systems, warehouses, and distribution systems (Gunasekaran and Ngai, 2005). According to these authors, open and shared information systems facilitate trust between buyer and seller, as well as timely availability of products and support services. Since suppliers or partnering firms are geographically dispersed, an effective communication system is necessary. The integration of the links between customers and suppliers is essential for supply chain.

RFID is an information technology that can improve the accuracy of information about products that agents are selling and buying and can promote an environment of trust in a supply chain. However, although it has many advantages, companies have to evaluate how important is the use and application of this technology in their operations and supply chain in order to avoid the mistakes that some companies have made in the past when they decided to implement ITs without any evaluation.

Regarding evaluation, Gunasekaran and Ngai (2005) affirm that while selecting and evaluating information systems for supply chain management, managers need to look at various performance indicators, including tangibles, intangibles, financial issues and

non-financial issues, measures of performance, and the overall strategic impact on the company.

In this paper the authors proposed a group of variables that can evaluate an information technology in a supply chain. According to Cannon et al (2008), as RFID use spreads across the global economy, firms will differ in when, how, and why they adopt this technology. Because of this, the evaluation of RFID must be done in companies that are in the same sector and in the same supply chain, such as the subjects cited in this paper.

3. EVALUATION OF IDENTIFICATION TECHNOLOGIES

Since the 1970's, researchers have been interested in IT evaluation resulting in a number of studies covering this issue because IT is considered an essential strategy development and competitive advantage method, and also because corporations invest heavily in IT.

The concern about the approaches used in the areas in which IT is applied is closely related to the technology evolution to present the results. Nevertheless, investing in IT is risky, so in order to reduce this risk, it is necessary to adopt an effective evaluation plan for this kind of investment.

Some authors have determined variables for evaluating IT considering a multi-level evaluation model starting with the most general one (information) and are moving up to the most specific one (identification technologies): information technology, IT, Information System, IS, and identification technologies. This article addresses the last three.

3.1. Information Technology Evaluation

In order to evaluate the financial gains from IT investment, the Activity-Based Costing system (ABC), the Return on Investment (ROI) system, and other financial and economical methods can be used. However, the use of these evaluation methods for evaluating the benefits derived from IT is questionable, especially regarding intangible benefits.

Considering technology as a company's subsystem, Sonnenwald, Maglaughlin and Whitton (2001) developed a multi-scale evaluation tool. The five attributes proposed by them are: relative advantage, compatibility, complexity, experimentation and observation skills.

To focus on evaluating IT safety, the Information Technology Security Evaluation Criteria – ITSEC UK- was created. In this work, this set of criteria is used to evaluate IT safety applied at the companies studied. According to these criteria, safety is one of the essential aspects of IT, and is defined as: **confidentiality:** avoiding prohibited information disclosure; integrity: avoiding prohibited information modification; availability: avoiding prohibited information or resources retention.

Porter (1996) argues that organizations have two key business objectives: operational effectiveness and strategic positioning. According to Tallon, Kraemer and Gurbaxani (2000), these are the same as the corresponding objectives for IT: efficiency, effectiveness, reach and structure.

3.2. Information Systems Evaluation

Miller's (2007) model is constructed according to literature references in IS failures. The model makes a distinction between the four kinds of IS evaluation procedures based on the IS lifespan. The first is strategic evaluation which is used sometimes for the pre-implementation stage evaluation. It also aids in IT/IS investments considering the comparison between potential and estimated costs. The second is the constructive evaluation that determines the IS importance and value during its development.

The third is the cumulative evaluation, which takes place after the implementation of IS, since it is used for post-implementation periods in test cases. This evaluation should include the investment and benefits return established by the strategic evaluation after the period of use of an IS. Finally, there is the *post-mortem* evaluation which is an analysis performed after the company discontinues a project totally or partially. This final type is actually a variation of the third (Miller, 2007).

3.3. Radio Frequency Identification (RFID) Evaluation

An important tool for this evaluation is the RFID Alliance Lab report. The basis for any RFID system is reading labels accurately. The RFID Alliance Lab's report examines the number of different performance aspects of the label including productivity (i.e., it establishes the number of labels that are actually working) and variation (i.e., the difference in performance between labels of the same model).

Miller (2007) compared twelve different categories

of labels including, among others, performance in noisy areas (as these may interfere with wireless or powerless technologies), reading rate, performance close to water or metal, technology maturity, operational quickness, and cost.

Based on the Miller (2007) study the RFID evaluation was divided into three different aspects: environmental, economical, and technical. Concerning the company environment, three aspects must be considered when evaluating whether a RFID should be implemented: control, noise, and disperse material. Economically, the cost-benefit relation is based on labor cost reduction and on data and error duplication. Considering technical aspects, the issue is evaluating technology often to ensure its conformity with the standards available.

4. METHOD

In this research a qualitative approach was adopted since the objective is to gather information through interviews, including the interviewees' opinions and views (Bryman, 1989). The case study method was chosen because the focus is on how much the companies nowadays use Information Technology to trace their products. The research was carried out using a small number of cases, but was thoroughly for all of the companies studied and does not allow for generalizations (Yin, 2001).

The research instrument was semi-structured interviews with closed and open answers (yes/no questions ranked on a 5-point scale, where 1 is "very low" and 5 is "very high"). The respondents are IT, traceability, and quality (including traceability) employees. These employees were interviewed, after which they responded to the entire questionnaire. The researcher went to all plants, interviewed all of these respondents *in loco*, and accompanied the traceability systems running in three of these plants (only in case study 1 the researcher did not visit the plant!). In case study 1, the respondent is an on-farm quality program manager of the slaughterhouse. In case study 2, the respondents were two members of the staff, one of whom works with traceability, and is in charge of cattle raiser support service. The other employee is the IT coordinator at the unit where the research was carried out. In the third slaughterhouse, designated case study 3, a quality warranty assistant and a systems analyst (who develops software) were interviewed. In case study 4 the respondents were a quality coordinator and an IT manager.

The evaluation variables were presented in Section 1 above, and are the basis of an IT evaluation method developed by the authors based on the review of the literature. The Cronbach's Alpha was used to test the reliability of the questionnaire, and the procedure output has an alpha of 0.81 to the first group of variables (organizational variables), an alpha is 0.85 for the second group (IT safety), and an alpha of 0,82 for the third group (technical variables). These results are good considering that 0.70 is the cutoff value for being acceptable. The attribute of relative advantage, which is related to the rate of technological innovation used by the company, was divided into three contributions provided by innovation (ranked according to the respondent's answers): company support in order to meet the goals, assurance that the company has quality results, and achievement and maintenance of high ranking in the market. For the attribute of compatibility, which is related to the company missions and objectives, IT was evaluated according to its contribution towards the following aspects: group communication, experience with communication technology, and reliability and response speed.

For the attribute of complexity, the evaluation items were: ease of system use and ease of learning the system. The company's ability to use IT was divided into ease of recovering data or inverting situations when using the system, effort required to use the system, risk involved, and costs. The company's observational ability is related to the last attribute which is innovation visibility in the market (technology used by the company in supply chains).

IT safety was evaluated using the same elements as before, mainly: confidentiality, data integrity, physical integrity, availability, and consistency. The business key objectives were translated by Tallon, Kraemer and Gurbaxani (2000) into IT and were ranked according to the same scale used before. Thus, IT was evaluated as a benefit for: efficiency, effectiveness, reach, and structure.

In the technical dynamic, IT was ranked according to the following variables: productivity, quickness of information delivery; conformity; equipment quality; hardware cost; profitability (time, labor, data duplication); company budgets; and proximity to water, which could interfere with physical integrity.

The case studies were carried out at four exporting Brazilian slaughterhouses. A table shows the similarities and differences between the companies' IT

evaluation, and the diagrams (spider web) will illustrate the comparison of the cases. The research was performed between October 2006 and May 2008.

5. CASE STUDIES

5.1. Case Study 1

In most of its operations, this company uses barcodes. The use of RFID is restricted to internal storage and inventory operations after the meat is boned and packed. RFID was implemented only on the pallets, not one very package. To the interviewee, the quickness of the shipping process is an advantage of using barcodes while one disadvantage is that there are different kinds of barcodes, which are sometimes useable only by some clients. The IT Evaluation based on changes in information and in the integration of the business organizational system was considered a significant contributor to accelerating the exchange of information. Besides this, it allows the administration to have an overall view of the company, optimizing decision making. The company has an IT sector, and this team coordinates all IT areas for every unit and is responsible for the clients (internal users) and suppliers (IT, software, and hardware companies). The IT tools the company has are (listed in chronological order of acquisition): Intranet, Internet, barcode, ERP (Enterprise Resources Planning), EDI (Electronic Data Interchange), RFID, and WMS (Warehouse Management System).

Evaluating the return on IT investments, it may be noted that the company has an annual planning session establishing goals to be met in various elements of IT, such as ease of system use, maintenance, and training.

The company complies with certain requirements and certificates of the IT provider., The presence of internal technicians and external auditors to evaluate the safety of the systems was evidenced. Since the company is undergoing an open-capital process, it will adopt new procedures to validate the information gathered. The respondent was not able to answer whether the company employs any methodology such as COBIT (Control Objectives for Information and Related Technology). Nevertheless, the company follows this methodology in its essentials when evaluating IT.

By evaluating IS in steps from the pre-implementation stage to the *post-mortem* stage, the company can evaluate each step. The inside team is responsible

for the strategic evaluation indicating what should to be changed   at the company. Based upon this evaluation, a product can be ordered from another company, or it can be implemented by the inside team if they already have that product. In the constructive evaluation, the company evaluates mainly the adequacy of its offering for the clients. In the cumulative evaluation, the focus is on the company's IT demand expectation. Discontinuing the use of the software was necessary because a more sophisticated one with more information and operations became available, which replaced the older one.

5.2. Case Study 2

In most of its operations, this company uses barcodes. RFID is used only in internal operations, in the overhead rail where the animals are hung before boning. That is when the barcode is first used. To transfer the information in the barcode boxes, the company uses wireless Internet in order to make these information boxes available in the company's system (physical and fiscal via WMS) for the clients. The company uses the Internet in order to keep a web system for the cattle   ranchers with information about the slaughter of animals they sold to the slaughterhouse. For the company, advantages of using the barcode are: cost, reliability, speed, and amount of information that can be stored on a computer. One disadvantage is the preventive maintenance needed to keep the system in working condition. The company intends to use the barcode system for two more years only.

The interviewers considered that the greatest information change resulting from the use of IT is increased safety for the company and dissemination of information, which provides more speed for information exchange and establishes a closer relationship among the various departments of the company. Regarding organizational integration of the business, the respondents think that the company has developed better communication between administration and operations.

In the company, the IT manager of a processing unit is responsible for IT within that unit. Staff members of the IT units work on implementing new technologies. The IT tools the company has are (listed chronologically in order of acquisition): Intranet, Internet, barcode, ERP, WMS, and RFID. In terms of evaluating the return on IT investments, it may be noted that the company has an IT department responsible for approving the implantation of new technology. The

evaluations are carried out via available software, visits to producers, and by soliciting the input of producers as they visit the slaughterhouse facilities.

According to the interviewee, the company meets some international standards. In evaluating safety, it was evidenced that the IT department is evaluated through frequent audits done by KPMG Company. The audit evaluates mainly the management of IT and the safety of the technology. The evaluation is made using tools, not technology (CRM – Customer Relationship Management, WMS, etc). In spite of this, ERP is audited more frequently, particularly its accounting, availability, and information quality modules.

Although the respondent also stated that the company does not employ any specific methodology for evaluating its IT, this individual showed a level of knowledge and usage of COBIT practices. In fact, the company adheres to essentials of COBIT methodology, such as Best Production Practices, in its evaluations of IT.

To evaluate IS the company carries out an evaluation of new tools by using them before their acquisition. In this pre-implementation stage (strategic evaluation), the company evaluates whether IT is aligned with the group strategy, but does not make the comparison suggested by the authors: the company fails to compare the estimated cost and potential of new IT. According to the interviewee, there is not any kind of evaluation at the implementation (constructive evaluation) and post-implementation (cumulative evaluation) stages. The interviewee also stated that the IT project was never discontinued. However, the respondent said that the company had initially used an ERP developed in-house, but that as the company grew this was replaced with another donated by an IT company.

5.3. Case Study 3

The IT used by the company is the barcode. Nevertheless, the company begins using it only after several steps in the slaughter room. According to the systems analyst, the company faced some difficulties in finding a barcode collector that could accurately read the information in the animals' barcode apparati.

Hence, the company chose to continue reading the animals' tags manually at the start of the processing phase following the slaughter. One respondent observed that using the barcodes offered the advantage of increased information reliability, but that the difficulty of operating the technology represented a significant disadvantage. Neither respondent was able to indicate the kind of analysis that is done in order to evaluate the return on investments in IT. The respondent stated that IT does not alter the information itself, but the channels through which it is disseminated and the speed and way in which it is presented (changes on the data display on a label, for example). Furthermore, it enables integration since all data are integrated with the company's headquarters. IT management is present in every unit (slaughterhouse) of the company and the manager is the responsible for all contact with the suppliers. According to the interviewee, an auditing firm provides audits for the evaluation of safety. Although the slaughterhouse follows certain steps from the solution identification phase to the IT evaluation phase, its methodology was to carry out the latter.

Regarding IS evaluation, the company evaluates every IS stage. In the pre-implementation stage (strategic evaluation), the slaughterhouse follows a number of theoretically established steps from solutions identification (finding adequate software) prior to acquisition of the systems. The company does not make the comparison suggested by the failing to compare the estimated cost and potential to new IT. The interviewee stated that the IT project was discontinued because, when some software was purchased or developed and it presented problems or did not work properly, this prompted the company to discontinue its use.

5.4. Case Study 4

The only IT technology that this company uses is barcode per lot. This brings the advantage of quick access to information as the database code can access all information from initial inspection to product expedition; and there are no disadvantages. There is a pilot project in progress for DNA identification that was developed by a team of researchers and is being tested in the slaughterhouse. In this kind of identification, the animal's blood is drawn, and it is matched to its traceing number. Should the company's customers find any problem with meat from the slaughterhouse, , that piece of meat (whether raw or treated) is sent back to the company which then forwards it to the analysis laboratory to detect the problem and identify the animal supplier from which it was purchased.

In the slaughterhouse, IT has allowed better business integration and information changes. Having adopted new information technologies, the company culture became more active and staff members benefited greatly, gaining more knowledge with the application of production control and administrative process software. The interviewee, the company's IT manager, is responsible for coordinating IT; and there is also a management and a technical support team.

The analysis of IT investments is performed by ROI - Return on Investment - and includes training and maintenance services offered by the supplier.

In order to evaluate safety, this slaughterhouse opts to outsource the responsibility to another party. Nevertheless, the quality of this outsourced service is, in turn, evaluated by the slaughterhouse itself (IT department). According to the IT manager, established theoretical methodologies are not used to evaluate IT in the company.

Regarding IS evaluation, the company evaluates certain stages. In the pre-implementation stage (strategic evaluation), the slaughterhouse follows some steps: identifies solutions (finding adequate software), selects suppliers (according to maintenance, modernization, and customization), and buys the system. Lastly, the company checks the alignment between IT and its strategy, but it does not make the comparison suggested by the authors failing to compare the estimated cost and potential of new IT that relates IT potential and estimated costs. There is no evaluation in the implementation (constructive evaluation) stage, although evaluation occurs at the post-implementation (cumulative evaluation) stage. According to the interviewee, the IT project was not discontinued.

5.5. Case Comparison for IT Evaluation

Table 1 shows the comparison of the cases according to the variables obtained from the literature review. The sub-variables and rakings were defined by using a scale designed by the authors and are ranked relative to each company. The other variables, mentioned earlier, are ranked and interrelated with each other according to each company reality. The items that were not ranked or not answered by the respondents are marked NR. Only the questions with closed answers and truly related to the evaluation of identification ITs were ranked.

Table 1: Cases Comparison.

Variables		Case 1	Case 2	Case 3	Case 4
Organizational Variables					
Relative Advantage	Goals support	4	4	4	3
	Quality of results	4	4	5	4
	High Rank Achievement and Maintenance	4	2	5	4
Compatibility	Group Communication	4	4	5	4
	ITC Experiences	4	4	5	4
Observation	Visibility	2	4	1	3
Business Key Objectives	Efficiency	4	5	4	4
	Effectiveness	4	5	5	3
	Reach	3	5	5	4
	Structure	2	5	5	3
IT Safety Variables					
Safety	Confidentiality	3	NR	NR	4
	Data Integrity	4	3	4	3
	Physical Integrity	3	3	4	3
	Availability	4	5	5	4
	Consistency	4	4	5	4
Technical Variables					
Technical Aspects	Productivity	4	4	4	5
	Variation	4	1	1	1
	Quickness	4	5	5	5
	Conformity	4	5	5	5
	Equipment Quality	3	5	5	4
Reliability	Reliability and response speed	5	4	5	4
Complexity	Easiness of the system use	5	4	5	4
	Easiness of learning the system	4	4	5	4
Experimentation	Easiness of recovering data	4	4	5	4
	Efforts to use the system	2	4	2	3
	Risk	2	4	0	3
	Costs	3	4	2	3
Environmental Aspects	Closeness to water	3	4	2	2
Economical Aspects	Hardware Cost / label	3	4	4	4
	Profitability	4	5	5	3
	Company Budget	3	4	2	3

Source: Done by the authors

Figure 1 shows that for the sub-variable – goals support – the average ranking was 3,75 and three slaughterhouses rankings were close to this average, case 4 was an exception . This is due to the fact that this company has been trying to adopt new technologies such as the DNA pilot project, ergo barcode does not fit the company IT goals anymore. It can be seen by for the sub-variable – Quality of the Results – the average was 4,25 and case 3 rankings were far above it (5,0). This can be observed by other sub-variables for which the respondents were less critical, or in the cases in which the slaughter houses do not intend to invest on more advanced identification ITs. For the sub-variable – High Rank Achievement and Maintenance – the average was 3,75 and the rankings of cases 2 and 3 were below and above average (2 and 5, respectively). One reason for this is that in case 2 barcode was considered an old-fashioned IT by one of the interviewees who work in an IT area; in case 3, the respondents considered the use of barcodes extremely useful. For the variable of compatibility, although the difference was not big, the companies in cases 1 and 3 considered that IT has more reliability and response speed than did those in cases 2 and 4. The same small difference can be seen for the sub-variable, data integrity, which can have influence on reliability. Nevertheless, for the sub-variable, response speed, which is ranked together with reliability, it is also related to the sub-variable quickness (included in the technical aspects) and for which the opposite response occurs: cases 2, 3, and 4 have higher rankings that case 1. This may explain the reason for low ranking differences for the two sub-variables. These rankings agree with the ones obtained for the sub-variable of Efficiency, which includes a higher rate of information exchange. All cases' rankings were close to the average (4,25) for the sub-variable Experiences with communication technologies, since all companies have been using information technology and communication (ITC) (barcodes and Internet were the first ITCs used by some of them—cases 3 and 4 for example). Those remarks are illustrated in figures 1, 2, and 3.
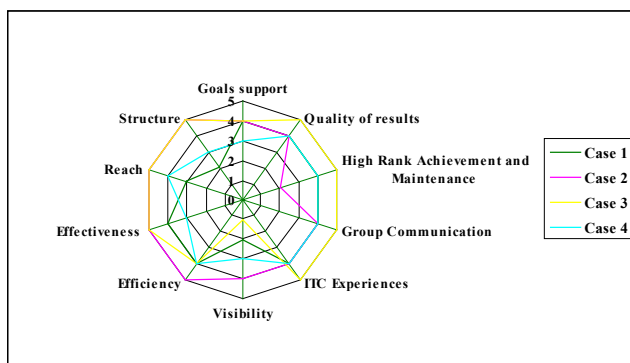

Figure 1: Comparison between the Organizational Variables.

For the variable of complexity, cases 1 and 3 considered that at, the offset, ease of implementation was higher than in cases 2 and 4. The ranking averages were 4 and 5, across all cases. For the sub-variable effort required to use the system, there is a bigger ranking difference between the cases, and the companies in cases 1 and 3, again, consider IT less difficult to use than the companies in cases 2 and 4. The average was 2,25, but case 2 ranking was far higher, 4. Case 2 shows a result somewhat contradictory to this sub-variable if compared to the sub-variable of "ease of system use", since these variables should have been expected to receive opposite rankings as occurred in the other cases. As for the sub-variable easiness of learning the system – the cases were ranked like the later (ease of system use), with the exception of case 1. This is due to the fact that during barcode implantation there was some resistance to changing operations from manual to computerized ones.

For the variable experimentation skill, case 3 opined that it was easier to recover data using IT; the other cases did not produce the same result, particularly case 2, in which the ranking was 3, below average (4). Those opinions bear a similarity to the sub-variable confidentiality, and the opposite of the sub-variable risk, which was consistent for all cases. There is no ranking for the sub-variable confidentiality for case 2 since that company did not consider IT to provide a significant level of safety, such that the sub-variable of Risk was ranked 4—a little above the average value (2,25). Case 3 also did not rank this sub-variable, in this case because the IT department had recently implemented a tool in the code to avoid interference from staff members in any departments other than IT in the code data. Therefore, the average for the sub-variable confidentiality was not calculated because it has only 50% of the rankings.

The sub-variable costs was ranked higher for case 2 (at a value of 4, the same as the average), which can be argued if compared to the sub-variable – Equipment Quality – for which there is a wider difference and opposite rankings (case 2 considers that the equipment has more quality). However, when discussing equipment quality, the case 2 respondents referenced problems with use of the equipment. Since the company did not analyze such failures, these can be considered either user or transport problems, and not equipment problems. Nonetheless, regardless of the origin of the problem, the company should change said equipment more often as this would result in higher IT costs, there by making the rankings for – Costs – more consistent.

Case 3 also presents lower – Cost – ranking (2, whereas the average was 4). The reason could be the lack of investment in data collection, for example, since, according to one of the interviewees, the company lacks a high quality data collection system. Therefore, costs related to both barcodes and equipment quality are inordinately low. Yet, the case 3 ranking for this sub-variable was higher than average (5, as compared with 4,25), which raises questions as this equipment was referred as part of that same collection system during the interview. The sub-variable – Visibility – presented higher ranking for case 2 and lower for case 3; the average was 2,5 and the rankings were 4 and 1, respectively. Although case 2 respondents considered their IT efficient, cases 1, 3, and 4 respondents considered their IT old-fashioned and unable to provide the respective companies with adequate visibility. Illustrating the above remarks on the average rankings are Figures 1 and 4.
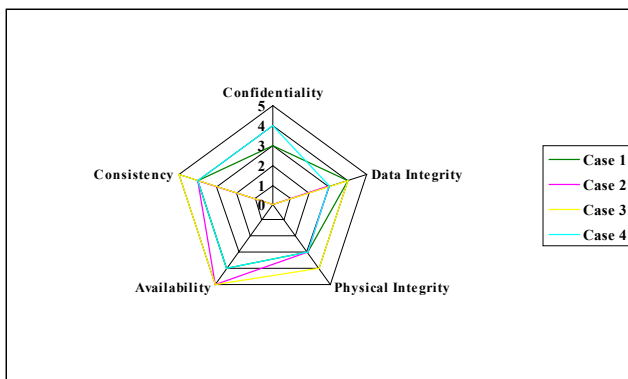

Figure 2: Comparison of the IT safety variables.

The sub-variable –Physical Integrity– was ranked very close to the average (3,25) for cases 1, 2 and 4. Case 3 presented an above-average ranking because the company outsources part of its freezing process, subcontracting this process to a third-party supplier that stores the product and delivers it to the market. The other companies' respondents universally mentioned experiencing some code label damages during the production process. The sub variable –Availability – was ranked higher for case 2 and is related to IT conformity-with-use standards. Since this company considers that IT provides more safety and conformity than the company in case 1, the case 2 company consequently was ranked higher for the sub-variable – Conformity – than was case 1. The average for the sub-variable – Consistency – was 4,25 and the rankings of all companies were very close to the average, case 3 excepted. These comparisons are illustrated in Figure 2.
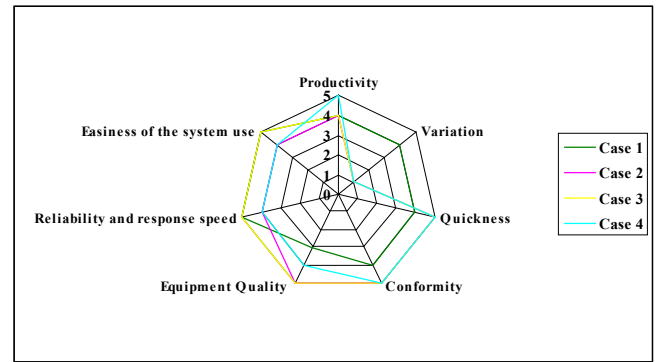

Figure 3: Comparison of some Technical variables.

The same phenomenon observed in the sub-variable – Visibility – can likewise be seen in the sub-variable – Reach – since the rankings were proportional. Case 3 is the only exception, being ranked below average for the sub-variable–Visibility – and above average (4,25) for the sub-variable – Reach – (5). This is due to the fact that both cases 2 and 3 perceived IT as enabling access to the clients, despite the fact that it offered less visibility. For the sub-variable – Effectiveness – cases 2 and 3 were ranked highest and above average (4,25). Case 1 ranking was average due to the company's flexibility when operating with its clients. Case 4 was ranked below average (3).

Flexibility should be a particularly important item (and thus carry more weight) for these companies since responsiveness, analyzed earlier with the sub-variables reliability and response speed, and flexibility had similar results. For the sub-variable – Structure – case 1 was ranked much lower than the others (2) and below average (3,75) because, as mentioned earlier, it considered that being on the market for such a long time, IT does not change its configuration anymore. On the other hand, case 2 states that IT will be still used for a period of two more years, at least, in companies and industries. Those comparisons are illustrated in Figure 1.
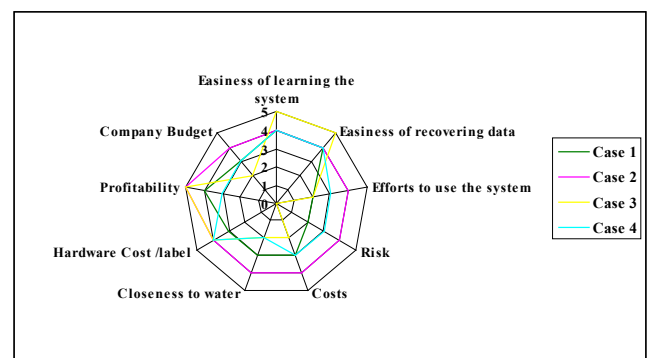

Figure 4: Comparison of some Technical variables.

The sub-variable – Productivity – was ranked average for almost all cases which stated that the barcode rings do not depend on them, but on the cattle breeders, so they evaluated the barcode used from the bleeding. All cases respondents stated that there might be problems printing the labels, except case 4 respondents who mentioned having no printing problems at all. There are differences when comparing it with the sub-variable – Physical Integrity – because for this variable the code label during and after use is considered, but for the sub-variable – Productivity – label quality, when it is printed, is considered. For the sub-variable – Variation – case 1 was the only one discrepancy in the rankings (4) if compared to the average (1,75). Variation was high because this company considers that there is a difference in the labels performance. For the sub-variable – Conformity – all rankings were close to the average (4,75), except case 1 which was below average.

Considering the company environment was based on its proximity to the water, only case 1 was ranked close to the average (3,75), which was consistent with the sub-variable – Physical Integrity. Cases 3 and 4 were also ranked consistent considering physical integrity higher and company environment problems lower. Case 2 was ranked consistent too, but unlike the others, proximity to the water was ranked high, thus, IT physical integrity was considered average.

For the variable – Economical Aspects – all cases, except case 1, were ranked close to the average (3,75) since the costs were already paid over the years since the company had started using IT and its hardware (data collectors and printers). All others still consider the costs high, especially when comparing quality and collector prices. For the sub-variable –Profitability– only case 1 (4) was ranked close to the average (4,25). Case 4 (3) was ranked way lower because it does not consider an average cost reduction.

Cases 2 and 3 considered that, because of the reduction of labor and errors, due to data duplication reduction that was caused by the manual process, they were ranked above average. Besides, case respondents considered that the barcode allows information accuracy, different from manual readings of the animal rings. Processing time reduction was considered Profitability by case 3 due to the easy and fast access to the company's products information within its units provided by the barcode. Figure 2, 3 and 4 show those comparisons.

6. Conclusion

The research shows conclusions that are in the literature about cattle chain. This chain has some particularities such as different sizes of farms, low level of integration between agents, mainly farmers and slaughter houses. These characteristics lead this chain to a difficult way to control the agent's activities, flow of products and the quality of them.

Because of this, traceability systems are necessary to support the control of the products such as fresh meat. This control allows that traceability system can create a closer relationship between farmers and slaughter houses. In day-to-day activities, these agents of the cattle chain change some information about animals that went from the farmers to slaughter houses. After this, slaughter houses send information about the delivery of these animals and their weight to give to farmer a confirmation that the lot of animals that were sold arrived to their clients.

The traceability system produces integration in the first part of the cattle chain although its intention is to control the animals and their information to clients. This integration is important and some methods of identification are used such as earrings with printed numbers, barcode and RFID. In Brazil, the earring with printed number is demanded by government but, if the company wants to use another kind of method, it will be possible, too. The four slaughter houses that were visited do not have RFID in traceability system but two of them have it in logistics operations.

In the sample of this paper, the respondents have some different opinions about implanting RFID but all of them have the same idea: this is a good IT but its cost is much too high. In addition, some of them say that they are not motivated to implant this system because other agents do not have the RFID. As a consequence, if other agents have printed number or barcode and if the company has RFID, this last company will have higher costs and will not get the integration with its suppliers and customers.

The Brazilian government in the beginning of this year had some problems to sell fresh meat to European Union. At that time the agents were waiting for the decision of the government to know what they had to do. When the interviews were being done some agents wanted to change their identification method but were waiting. After this, Brazilian meat was sold and the agents continued with their activi-

ties and their identification methods. The problem is that they could be more integrated if they had the same identification method. When they trace their products, chose the supplier of the technology, manage the identification in their company, they can create a collaborative environment inside the cattle chain. Their logistics activities can be more integrated, quicker, reliable, with the right IT.

These consequences exist when a company has an evaluation before it implants an IT. The results clearly indicate the lack of IT evaluation during its use, when it should be constantly evaluated to point out the interaction between technology and user and other ITs (such as data analysis software). If there is any problem with this interface, the investment in technology can be lost since it might be replaced or misused producing worse-than-expected results. The lack of methodology to evaluate this technology during all implementation stages can also pose a problem. This causes difficulty in defining which items should be observed for the company to decide whether it should adopt an IT solution.

The companies should provide better training for its employees providing them with more knowledge about new technologies, the company's technologies, and the integration between them. Yet, it could be noted that, especially for case 1, the barcodes do not have an aggregated value with the traceability system as it had in the beginning, when it was implemented. In case 2, this was not so clear, but, during the interviews, it could be noted that the company intends to adopt RFID due to the reliability it could bring to its operations. Furthermore, together with other ITs, it could also provide quick information exchange with the clients about products expedition. On the other hand, costs and operation changes are still the major obstacles to more modern ITs implementation, such as RFID. In case 3 there are also the manual readings of barcode animal rings and, in addition, the respondents showed satisfaction with the barcode labels. In Case 4, the IT manager showed no knowledge about RFID, making the barcode a viable option to be used for a longer period than necessary.

RFID resistance can be justified by some aspects: no knowledge about this technology and its use; as mentioned earlier, label and equipment cost (it is a common sense, so it is difficult to know whether the interviewee analyzed the costs or if it was just a repetition of spread information); low quality of the label accessories; change in the employees routine

due to possible changes to be implemented in the productive and managerial process, and other chain links processes; lack of government definition about traceability demands for the external market (what makes companies delay their decision about investing on RFID).

This paper was limited in some themes as Information Technology, traceability systems and cattle chain. Some subjects (government of IT, Quality, Logistics, and agribusiness) were not discussed by authors because the paper could lose its focus or be too large for publication in a journal. In the future, more research needs to be done on the subject.

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