Application of RFID in Brazilian harvest facilities: Two case studies

Priscilla Cristina Cabral Ribeiro
Production Engineering, Business, and Economy Department, Mines School, Ouro Preto Federal University
Campus Morro do Cruzeiro, Bauxita, s/n. Ouro Preto, Minas Gerais CEP 35400-00, Brazil

Mário Otávio Batalha
Production Engineering Department, São Carlos Federal University
Rod. Washington Luís - Km 235, São Carlos, São Paulo CEP: 13565-905, Brazil

Annibal José Scavarda
School of Business and Management, American University of Sharjah
Sharjah, PO Box 26666, United Arab Emirates

ABSTRACT
The aim of this paper is to evaluate the identification technology used in the two case studies presented in this work. One of the Brazilian industries studied is the largest exporter of meat in the world. Although Brazil has large companies in this sector, some of them do not use information technology (IT) to identify cattle. The Radio Frequency Identification is an IT that identifies cattle using electronic ear tags. This paper has a qualitative approach, two case studies, which were carried out with the application of a questionnaire (open and close questions). The companies studied use RFID only for their internal control, but they use barcode to trace and identify cattle and to send this information to their partners in their supply chain.

Keywords: RFID, Evaluation, Beef chain, harvest facility.

1. INTRODUCTION
According to [29], in 2007, Brazil exported 195,240 tons of meat in natura to the EU. In the following year, the amount exported was reduced to 36,218 tons. Such reduction can be explained by the trade embargo imposed at the end of January, 2008 which caused a bovine meat export loss of US$86 million. At that time, the EU detected some flaws in the Brazilian cattle tracking system, and so it reduced the number of meat supplier ranches. The Brazilian cattle tracking system includes producers, inspectors and certifiers, the Ministry of Agriculture, feedlots, harvest facility, retailers, research supporting foundations, and research institutions. The use of technology information, IT, is limited among the agents. Nevertheless, some ranches, harvest facilities, and retail companies have been re-evaluating their choice of identification methods. This control is important, but choosing the best identification method requires an analysis and evaluation of the method to be used by the agent. To do so, a set of variables will be ranked by the agents in order to choose the most adequate method.

This article aims to present a method which evaluates an identification technology used in the Brazilian beef chain, specifically in two harvest facilities (industries) through two case studies. This article is divided into six sections. The first is the Introduction, this item. The second one presents the Brazilian beef chain; the third presents the tracking system and RFID use; the fourth presents a literature review on TI, SI, and RFID evaluation; the fifth presents the method; the sixth presents the results and discussions including the case studies with rankings and comparisons; the seventh section presents the conclusions; and the last section presents the references.

2. BRAZILIAN BEEF CHAIN
The Brazilian beef chain can be divided into stages: the first one refers to animal production on ranches (Beef cattle ranching and farming). A rancher can control the whole process or parts of it. In addition, the rancher maintains a commercial relationship with the input industry, which will be the mineral salt, medicine, vaccine, and cattle food supplier. The slaughter industry is responsible for buying the ox, slaughtering, cleaning, deboning, packaging, and for the meat sales. The industry trade the animals directly with the ranchers through its purchase or sales sector or through intermediary agents (independent or representing the harvest facility) who conduct the transaction [37]. There is a lack of integration and the tracking system in this productive chain is flawed, which can result in disorganized regulatory documentation required to prove the control demanded by the final clients. Thus, this poor coordination could create a technical and/or sanitary barrier involuntarily. According to [37], food safety is a decisive factor when conducting agricultural activities, especially in Brazil. Technical barriers to the international trade related to food safety must be truly justified and must be in accordance with the Principles for Risk Analysis established during international agreements.

Regarding legislation, there have been discussions about ways to protect consumers from unauthorized disclosure of personal information that could harm them in the future in countries where the RFID tracking system has been already used. Those issues have delayed the implementation of technology in some sectors.

3. TRACKING SYSTEMS AND RFID USE
Tracking systems are control methods since they can identify operations and the ranches in which the animals have passed through. In addition, they can identify the responsible party in the event of an animal sanity problem. Ear tags and rumen bolus (chip inserted into the animal), are two different ways to monitor animals in order to track their path through the production chain. The ear tag is the lowest cost and the most frequently device used in the country for identifying cattle. An RFID module can also be used by inserting a chip into the ear tag. It is used to monitor the supply chain tracking goods throughout the world and to control inventory.

In Brazil, most of the cattle raisers and feedlots buy ear tags containing the corresponding animal tracking number and barcode. The RFID use is more limited due to its costs (tags, antennas, readers) and to the operation changes that would be required in the companies.

4. EVALUATION MODELS
The measurement processes used in the IT area have been updated to keep up with the technological development in order to produce results. Nevertheless, investing in IT involves risks, ergo, in order to avoid them an effective evaluation policy or a set of guidance policies are necessary. Those risks indicate the IT investments do not stimulate significantly the businesses strategies. Furthermore, other variables can increase the risks associated with IT investments. Some authors have grouped such IT evaluation variables according to a hierarchy of models of evaluation of information, technology, IT, SI, and information technology, which is concisely described in the following paragraphs.
[33] introduced an evaluation system in which they proposed five attributes to evaluate how much the adoption of an innovation (for the purposes of this study, it means technology or an identification method) influences a company. Those attributes are relative advantage, compatibility, complexity, and experimentation and observation ability. The Information Technology Security Evaluation Criteria (ITSEC UK), created to deal with IT security, includes the following variables: confidentiality, integrity (divided by the authors into physical and data integrity), availability, and consistency [12]. [35] established the key objectives to be accomplished by a company with the help of an IT as efficiency, effectiveness, reach, and structure. Evaluating RFID, [11] investigates the number of performance indicators of a tag including productivity (the number of tags that are effectively working), and variation/uniformity (performance differences found in tags of the same model). [20] compared 12 different tag categories including the performance in noisy environments (which interfere in wireless technologies), read rate, performance close to water or metal, technology maturity, quickness, and cost. The author divided the RFID performance evaluation into three aspects: environmental, economical, and technical. Regarding the environment, the author highlighted control, noise, and disperse material. Concerning the economical aspect, the cost-benefit relation was considered including reducing labor costs, and reducing data duplication (and errors) when necessary. The technical aspect includes tag features such as their accordance with the standards available. The original method was applied to the beef chain identification technologies, such as RFID and barcode. This application will be demonstrated in the case studies below. Table 1 presents these variables, divided into groups of variables with all consulted authors. The table includes brief descriptions about the variables. Table 1: Author’s contribution.

<table>
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<tr>
<th>Variables</th>
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<tr>
<td>Organizational Variables</td>
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<tr>
<td>Relative Advantage [30]</td>
<td>benefits from the technology to the company which adopted it</td>
</tr>
<tr>
<td>Quality of Results</td>
<td>High Rank Achievement and Maintenance</td>
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<tr>
<td>Compatibility [30]</td>
<td>the consistency among the innovation (IT) and the company targets, demands, and characteristics</td>
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<td>Observability [30]</td>
<td>- the visibility of issues</td>
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<td>Business Key Objectives</td>
<td>Efficiency</td>
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<th>Security Variables</th>
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<tr>
<td>Security</td>
<td>Confidentiality</td>
</tr>
<tr>
<td>Data Integrity</td>
<td>How much the tag and its structure provides data integrity</td>
</tr>
<tr>
<td>Physical Integrity</td>
<td>How much the tag and its structure provides physical integrity</td>
</tr>
<tr>
<td>Availability</td>
<td>The availability of data</td>
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<tr>
<td>Consistency</td>
<td>data accuracy and data currency</td>
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<th>Technical Variables</th>
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<tr>
<td>Technical Aspects</td>
<td>Productivity</td>
</tr>
<tr>
<td>Variation/Uniformity</td>
<td>performance differences found in tags of the same model</td>
</tr>
<tr>
<td>Quickness</td>
<td>How is the speed of the information interchanged by the tag</td>
</tr>
<tr>
<td>Conformity</td>
<td>The tags have conformity comparing with the standards?</td>
</tr>
<tr>
<td>Equipment Quality</td>
<td>The quality of readers, antennas, tags, and software</td>
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<tr>
<td>Compatibility [30]</td>
<td>the consistency among the innovation (IT) and the company targets, demands, and characteristics</td>
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<tr>
<td>Reliability and Response Speed</td>
<td></td>
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<tr>
<td>Complexity [30]</td>
<td>Easiness of System Use</td>
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The case study was the method used in two harvest facilities by the editors. The study was carried out in the period between October 2006 and March 2008. The total annual investments in IT in the harvest facility was not precisely informed by the respondent, but it is likely to be over US $10,000.00. The company IT tools are (in order of implementation): Intranet, Internet, barcode, ERP, EDI, RFID, and WMS.

Regarding the IT use, the company uses the barcode in the majority of its operations. The RFID is used in internal operations of stock and storage, and in pallets in which the meat cuts are placed. The company uses a sensor to read the final product tag (after the deboning process) for internal control. The material used for making tags is similar to the one used for making CDs, but it is more resistant due to the operations and handling of the pallets.

**Case Study 2**

The interviewees were 2 employees of the harvest facility denominated “Case 2”. The company partnerships with its suppliers, cattle raisers for example, are focused on the improvement of the quality of the raw material. Concerning industrial automation, the company forms partnerships to develop scales and harvest facility equipment. Regarding aggregate value, in accordance with the EUREPGAP, the cattle are now offered with a higher aggregated value than it used to be.

Changes in information due to IT include more security for the company and dissemination of information establishing a closer relationship between the company sectors which increases the information exchange rate. According to the interviewees, the company has achieved better organizational integration with improved communication between the administration and operations.

In the company, the IT manager of one data processing plants is the one responsible for IT. The IT team is responsible for implementing new technology. The company total investments in IT have recently been, and will be within three years, over US$220,000.00. The company IT tools are (in order of implementation): Intranet, Internet, barcode, ERP, WMS, and RFID.

Regarding the tracking system, the company uses the barcode reader, antennas and RFID tags, computers, and software such as the ERP for data processing. The company does not make use of transmission technology, but it does make use of identification technology such as barcode, mainly. RFID is used only in internal operations such as the deboning conveyer, where the cattle are kept before deboning, and which is where the barcode use begins. The information in the barcode labels applied to the boxes of meat is shared through wireless Internet in order to keep record in the company systems (physical and fiscal status via WMS) of the boxes being delivered to the clients. The raisers can use the Internet to keep track of the slaughter of the animals they sold to the harvest facility.

**5. METHOD**

In order to describe the method, we chose a qualitative research approach. The case study was the method used in two harvest facilities from which detailed information was gathered without generalizations ([39] and [7]). Semi-structured personal interviews were conducted with the harvest facility managers using an open and close questions questionnaire (yes-no questions ranked on a scale of 1=very low to 5=very high). The case 1 respondent was the Quality Farm manager. The case 2 respondents were two employees (one was responsible for the customer service for cattle raisers, and the other was the IT coordinator in the plant studied). In this case, 2 employees were interviewed because they both could contribute to different parts of the questionnaire. The evaluation variables were described in section 3, and they are the basis of the IT evaluation method developed by the authors using a more extensive review of the literature than the one presented in such section. Some of the responses were omitted from the results obtained to fit within the allowed number of pages per paper established by the editors. The study was carried out in the period between October 2006 and March 2008.

**6. RESULTS AND DISCUSSION**

**Case Study 1**

This first case study was carried out in a large sized harvest facility which conducts business abroad and has a total of 73 thousand employees (including the industry, feedlot, and headquarters). It was denominated “Case 1”. The company works on several partnership businesses, among which is a partnership with suppliers (raisers) that are paid extra money for taking part in a company partnership program and are given technical assistance and information related to the partnership. Organic products for example are responsible for the aggregate value, and according to the respondent, it aggregates value not only to the harvest facility product, but also to final product for the clients. According to the interviewee, IT provided more availability of information with the Internet’s implementation in ranches despite infrastructure difficulties. This implementation increased the integrity between ranchers and industries and the cattle’s data interchanging in this supply chain.

The company has an IT sector with a corporate team that coordinates all IT areas and units, and which is responsible for the clients (internal users) and suppliers (IT, software, and hardware companies). The total annual investments in IT in the harvest facility was not precisely informed by the respondent, but it is likely to be over US $10,000.00. The company IT tools are (in order of implementation): Intranet, Internet, barcode, ERP, EDI, RFID, and WMS.

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**Case Studies comparison**

In this section, the most discrepancies from average rankings will be compared. Since the questionnaire had open questions, some rankings will be commented according to the open responses.

There is a discrepancy between the sub-variable “High rank achievement and maintenance” rankings. The Case 2 ranking was
“low”. The respondents considered that the tracking technology used, barcode, does not help the company to earn market distinction. Notwithstanding, the rankings of the sub-variable “visibility” were consistent with those of the variable “reach” since case 2 respondents consider that the IT has still provided access to the clients although visibility has been declining. The respondents of Case 1 believe that the technology used does not provide visibility, but since it complies with sanitary requirements it helps market reach and stability. Case 2 respondents ranked the variables “equipment quality” (barcode data reader) and “variability” (barcode labels) “very high” and “very low”, respectively.

The variation was considered high for Case 1 since the responses show a difference in the tags' performance, which does not occur in Case 2. The two case 2 respondents pointed out some problems with the equipment, but since the company has not investigated these problems, they can be considered either user problems or transport problems.

Evaluating the results for the variable “Effort to use the system”, Case 1 respondents considered it is easier to use the barcode than the respondents of Case 2 since more time and training were necessary to use the system in this case.

The sub-variable “confidentiality” was not ranked by the respondents of Case 2 because they believe the IT used does not provide security. Hence, the ranking of the sub-variable “risk” was higher than in Case 1, in which the use of barcode was not considered risky since the company keeps its information confidential.

Case 1 and Case 2 were using RFID but in different parts of their facilities. The Case 1 was using in warehousing operations and Case 2 was using during the process. Even though they were in the same level of the IT implementation, they showed different reasons to avoid invest in RFID. Case 1 did not show the interest in this implementation in it process for the future because it had problems with the RFID costs and lack of information about the system from the RFID suppliers. Case 2 was not intending to implement RFID for the short term. The company had problems with barcode reader, which had technical problems while the employees were collecting data from the cattle. Because of this, they were waiting for new technologies and financial resources to invest in the long term.

Case 1 is one of the largest companies in Brazil and has more resources (financial, human, technical) than Case 2, and its managerial structure is more advanced either. The harvest facility has a group of managers, which all of them have to present, at least, Master Degree to be a candidate for this function. Case 2 is a large company, but it had some financial problems during 2009, so it was hard to invest more in IT.

In addition, both cases did not know how to evaluate the IT according to technical and financial variables. They have interest to evaluate in a different way, spending some time in technical aspects and not just financial ones.

### 7. CONCLUSION

The use of IT has become widespread in Brazilian companies since the second half of the 90’s. Nevertheless, in the companies studied, the decision on using information technologies such as RFID has yet to be evaluated; the technology must be evaluated. The Brazilian beef chain has a heterogeneous structure with small and big companies in the same market. There are differences in the management of harvest facilities and in the use of the IT regardless of size or market participation. Thus, achieving integration between the agents becomes more difficult making it hard to make a joint decision, which could otherwise optimize some operations in the productive chain.

On account of the world financial crises, debt interests have become higher and the companies studied have been facing losses and cash flow problems. Moreover, due to the lack of integration and culture in the sector, companies have not shown interest in using new ITS such as RFID due to higher costs, lack of information, benefits analysis, and evaluation.

### 8. REFERENCES


