Gest. Prod., São Carlos, v. 25, n. 2, p. 304-318, 2018
http://dx.doi.org/10.1590/0104-530X2844-18

ISSN 0104-530X (Print)
ISSN 1806-9649 (Online)

Impact of product certification in the Brazilian automotive batteries industry: a case study

Impacto da certificação de produto na indústria brasileira de baterias automotivas: um estudo de caso

Juliano Giovanetti[1]
Marcelo Gechele Cleto[1]

Abstract: Product certification, when compulsory, is the adoption by an industrial segment of a set of procedures required by a sector regulatory body, proving that the product that is the object of regulation meets the minimum quality requirements. The objective of this research was to study the impact of product certification in a medium-sized industry of automotive batteries manufacturer. which has recently been subjected to compulsory certification. We aimed to study the impacts on the organization internal value chain, as well as its interaction with its competitive environment, from qualitative variables taken from two models in the literature. We performed a case study and identified impacts in productivity, marketing strategies, relationship with its supply chain and in the labor force qualification requirements, among other factors of the studied company.

Keywords: Product certification; Standardization; Automotive batteries; Technical regulations.

Resumo: *A certificação de produto, quando compulsória, é a adoção, por um segmento industrial, de um conjunto de procedimentos exigidos por um órgão de regulação de um setor, que atesta que o produto, objeto da regulamentação, atende aos requisitos mínimos de qualidade. O objetivo desta pesquisa foi estudar o impacto da certificação de produto em uma indústria de médio porte, fabricante de baterias automotivas, cujo segmento foi recentemente submetido a certificação compulsória. Pretendeu-se estudar esses impactos na cadeia interna de valor da organização, bem como na sua interação com o seu ambiente competitivo, a partir de variáveis qualitativas retiradas de dois modelos encontrados na literatura para avaliação dos impactos da certificação. O método de pesquisa adotado foi o estudo de caso. Como contribuições do trabalho foram identificados impactos significativos na produtividade, nas estratégias mercadológicas, no relacionamento com a sua cadeia de suprimentos e nas exigências de qualificação da mão de obra, entre outros aspectos, da empresa pesquisada.*

Palavras-chave: *Certificação de produto; Normalização; Baterias automotivas; Regulamentação técnica.*

1 Introduction

Brazil has seen in the last two decades greater State intervention in matters relating to health and safety, the environment, with consumer protection and fair competition reflecting the increased awareness of society to these issues (Martins & Silva, 2011). Unfair trade practices that deceive and harm the consumer by offering low quality products and make him difficult to discern about that become increasingly intolerable, because they affect market efficiency and harm companies that respect the consumer, discouraging them to remain in the market, or in some cases urging them to adopt the same practice. In this context, the State legitimately, provide effective mechanisms for consumer protection abridging these practices, ensuring minimum quality standards for traded products (Machado, 2000). One of these mechanisms is the product certification, which can be compulsory or voluntary. When compulsory, the State regulates the product specifications for quality and safety and may even cover its manufacturing and marketing process.

From 1999 to 2013 it was included more than 250 families of products and services within the Brazilian System of Conformity Assessment, 161 of them through compulsory certification. Lead-acid batteries for automotive vehicles were included in the program by Administrative Order 299, of June 12, 2012, in order to establish minimum performance

[1] Setor de Tecnologia, Centro Politécnico, Programa de Pós-graduação em Engenharia de Produção – PPGEP, Universidade Federal do Paraná – UFPR, CP 19011, Jardim das Américas, CEP 81531-990, Curitiba, PR, Brasil, e-mail: juliano.giovaneti29@gmail.com; mgcleto@ufpr.br

Received Dec. 20, 2016 - Accepted June 26, 2017

Financial support: None.

requirements and security through the compulsory certification mechanism, meeting the requirements specified in the standards: NBR 15914 (ABNT, 2013a), NBR 15940 (ABNT, 2013b), CONAMA 401:2008 (Brasil, 2008) and Normative Instruction IBAMA n ° 3 of March 30th, 2010 (Brasil, 2010b). In July 2013, the deadline expired, to complete the certification process for manufacturers and importers, as for retail this deadline was extended to June 2014. From these dates all automotive batteries can only be imported, manufactured or marketed serving regulation of INMETRO-National Institute of Metrology, Quality and Technology.

As raised in this research, the inclusion of automotive batteries in the compulsory certification program of INMETRO was timely for the following reasons: large number of manufacturers were active in the informal sector, in a situation of unfair competition with those who were legalized; many batteries were being sold without complying with the specifications mention of their labels. And the battery is a product whose quality characteristics are difficult to assess during the purchase, many consumers were being injured and, finally, the fact that it is a product of high risk to the environment and the health and safety of those who handle it.

Considering the above context, it is noted that this market presents problems of asymmetric information, when one of the parties involved in a particular transaction has information that the other party does not, and can therefore take advantage to themselves, to the detriment of the other party (Guasch et al., 2007). One example of this asymmetry in the case of batteries is customer difficulty knowing what is its rated capacity, fundamental information to assess your application. One of the main conditions for the intervention of the State in the relations between economic agents is the presence of market imperfections, and the asymmetry of information is identified as one of the most important motivations for State regulatory action (Swann, 2010).

Once established by the regulatory body, product certification impacts can be significant for a determined industrial segment. Despite its obligation to extend to all manufacturers, this strikes them differently, depending on their characteristics such as size, technology, infrastructure and human resources, etc. (INMETRO, 2007). Often involves performing laboratory tests, definition of methods for tracking products, replacement of equipment to ensure process control, hiring of skilled workers or specialists, and other items that may require significant investments (Butter et al., 2007).

Through the above, this work aims to investigate which product compulsory certification perceived impacts on a battery company during the adaptation process to regulation. As main objective deployment, we intend to know the perception of its managers on the impacts of certification in internal chain of enterprise value as well as their relationship with the competitive environment as two approaches in the literature to assess these impacts: Swann Model and ISO Methodology.

The research starts from the premise that the product compulsory certification is a process of normalization imposed by the State and supported by a social interest. Thus, the research is justified in view of the relevance of the use of standards and patterns to organizations and governments, it fits in the research line "standards economy", which has aroused the interest of several authors of the academy (Blind, 2013; Egyedi, 2012; Foukaki & Kärreman, 2013; Khudina, 2012; Swann, 2010). Also is justified by the economic impact that product certification can represent in the production chain of automotive batteries, affecting the patterns of competition between competitors with the potential risk of eliminating those that do not adapt themselves to this new context.

To achieve the goal a case study in a mid-sized battery manufacturer from Londrina, Northern Paraná, was performed, from January to July 2014. This article is divided into five sections. Section 1 provides the introduction and work context. In Section 2 the theoretical references, related to the effects of standardization in organizations are presented. Section 3 provides a breakdown of the methodological approach used in the research. The survey results and discussion are presented in Section 4 and in Section 5, the article presents the main conclusions.

2 Literature review

According IAPMEI (2015), certification is to demonstrate the conformity of the characteristics of a product, service or system compared to a precise reference document that establishes and quantifies the parameters that should be checked. As a rule this procedure is performed by an independent entity. Already standardization, according to Abreu (2005), is a way to organize activities by creation and use of common rules to contribute to economic and social development. According to Barzel (2003) certification comes as a result of a previous standardization process, and its objective is to prove the compliance of its implementation. It is understood, therefore, for purposes of this research that certification is a part of the wide field of normalization knowledge.

The study of the effects of standardization in organizations and the economy as a whole has intensified in the last decade. Haimowitz & Warren (2007) point to two factors: the first is associated with globalization and the increasing need to develop compatible standards, and the second relates to the higher volume of current available statistical data on

usage patterns, making it possible to measure their effects on the economy.

Some of the positive effects of standardization most cited in the literature review are related to: reduction of information asymmetry, reducing transaction costs, economies of scale and spread of technical knowledge. Egyedi (2012), Goedhuys & Sleuwaegen (2013) comment on the effects of standardization in reducing information asymmetry. According to these authors, standards can improve the flow of information between suppliers and consumers about the inherent characteristics of the products, thus facilitating market transactions. In general, standardization can reduce uncertainty costs that consumers face to evaluate the quality of the product. These costs include the time and effort that consumers dedicate to research before making the purchase. Also, by restricting the range of product or processes features, rules and regulations can promote economies of scale (Blind, 2004).

Some authors point ambivalent effects, Khudina (2012) for example, says that the effects, positive and negative of patterns use can be generated at the same time, and in such circumstances, there is no single answer to the question the norms facilitate or hinder market competition. In this sense, Blind (2013) also mentions that depending on the content of the standards applied, negative economic effects can occur as constraints to innovation and market competitiveness. In light of this context, in which there are positive aspects and concomitant negative, empirical studies have attempted to isolate the net economic effect of standardization. The results of these studies point to the fact that, under the right conditions, standards have a beneficial effect on the growth of the economy (Swann, 2010).

Swann (2010) provides an overview of the evolution of this issue in the last 10 years. According to him, there are four particular areas where there has been significant progress: (i) normalization, growth and productivity, (ii) standardization and innovation, (iii) standardization and trade, and the last (iv) called Standards' Black Box, analyzing the mechanisms by which these effects occur.

Swann (2010) points out that in the first three areas there is a predominance of studies using econometric models that despite being able to show the positive effects of standardization possible not show the intrinsic mechanisms that cause this effect. The fourth study area, the Standards' Black Box is the bringing together studies that attempt to fill this gap, to which Swann proposes a model that underlies part of this article and will be described in more detail in section 2.1.

Confirming the statement of Swann (2010), a study conducted in 2010 by International Organization for Standardization (ISO) showed a great diversity of approaches to the study of the effects of standardization, especially making use of macroeconomic evaluation, based on reviews of high complexity econometric models. Still, according to this study, methodologies have not been identified that would enable comparative studies and benchmarking the economic impact of standardization between companies (Gerundino & Hilb, 2010).

In order to address this lack, ISO proposed a methodology for measuring the impact of standards, based on the value chain concept of Porter (1985), as an alternative to econometric models (ISO, 2010). This methodology will be detailed in subsection 2.2.

2.1 Swann model

To understand what are the mechanisms of transformation in which the normalization results in the effects observed at the macroeconomic level, Swann (2010) developed the model of Black Box. This model, developed based on the theoretical and empirical knowledge of the author, aims to explain why the rules favor or hinder certain economic effects.

The proposed model has two groups of variables, here called intermediate and finals impact variables. Depending on the purpose of the standard and the business environment where it is being used, these variables assume different connections between themselves, what may result in different effects. The standard goal and the business environment characteristics define how these connections will happen and what the effects will be generated.

The following presents an overview of the economic effects of standardization, as proposed by Swann (2010). In Figure 1 is possible to see the representation of the effects in a map format, indicating the objectives of standardization, the intermediate and final impact variables, and the possible connections between them. The map is divided into three parts: (i) objectives of standardization; (Ii) intermediate economic impacts; and (iii) final economic impacts.

On the left of Figure 1 are shown eight purposes of standardization, considered by the author as relevant. The central part identifies eight intermediate economic impacts of standardization and the right side of the map highlights its main final economic impacts.

The author guides the reading of the map, starting with the goals of standardization, which are grouped into three categories, namely:

(I) reduction of variability; quality and performance; measurement standards; compatibility and interoperability;

(II) Health and safety; and environmental preservation; and

(III) Codification of knowledge; and future vision.

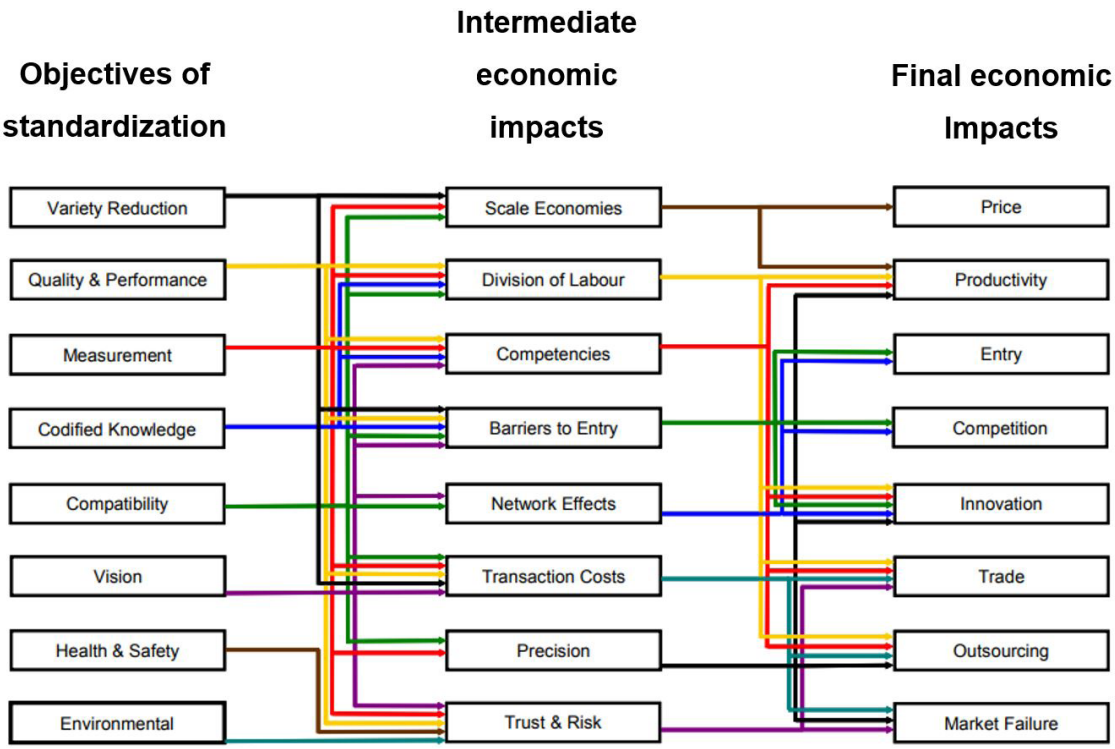

Figure 1. Overview of impacts of standardization. Source: Swann (2010).

Following the various map elements are connected through color lines representing its possible connection routes. For example: a standard classified for the purpose of "Quality and Performance", will be related by its nature, with the definition of quality requirements, in the case of a product. Then, a possible intermediate economic variable is "Trust and risk reduction", which may have, for the cause-effect relationship, a connection with the variable" market imperfections .

2.2 ISO Methodology

The ISO Methodology is designed to give support to organizations evaluate the economic benefit of using standards (Gerundino & Hilb, 2010) .The methodology has three objectives: to provide a set of methods for measuring the impact of standards on creating value with an emphasis on organization´s business; provide decision makers with clear and manageable criteria for assessing the value associated with the use of standards; provide a guide for the development of studies on the evaluation of the benefits of standards in organizations (ISO, 2010).

The ISO Methodology consists in four steps:

1- Understand the organization's value chain;

2- Identify the impacts of standards;

3- To analyze the value drivers and determine the operational indicators;

4- To evaluate and calculate the results.

The first step is to understand the industry value chain range in which the organization operates to then identify its internal value chain. A value chain comprises a sequence of activities that generates determined result that may be a product or service (ISO, 2010). In the methodology implementation, first identify in what activities the standards or rules are used and how they contribute to the creation of value for the company. The next step is to draw up a "map" to help determine the impacts resulting from the use of standards in each of the major business functions and, when possible, at the level of activity. On the map are related functions, their activities, the rules and impacts. Operational indicators related to the activities of the functions affected by the standards need then be defined so that can be quantified and converted into financial results. This can be done by direct measurement (eg, saved costs for purchasing raw materials and components) or indirectly using the existing database in the company (Gerundino & Hilb, 2010).

An overview of the steps of the methodology is presented in Figure 2.

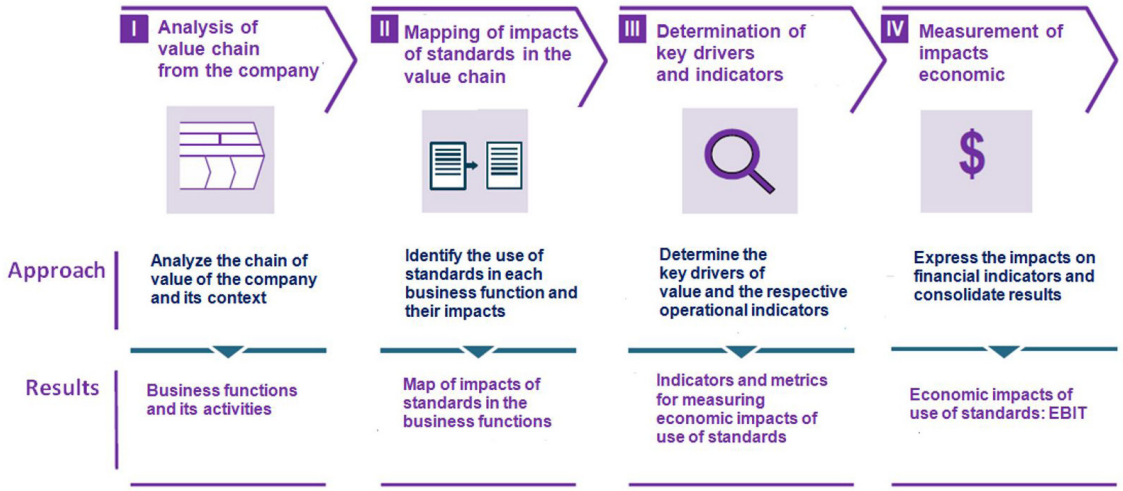

Figure 2. Overview of the methodology. Source: ISO (2010).

2.3 Characterisation of the market, product and production process

The market for automotive batteries consists of marketing original batteries, for newly manufactured vehicles and batteries for replacement. It was not found available official statistics related to the number of manufacturers that include micro and small firms acting in the aftermarket. However, considering also the medium and large firms, according to Castro et al. (2013), they are 52 in total, sized according to the classification established by SEBRAE (2014). Based on Machado (2002), approximately 61% of battery´s weigh is composed of lead that is mostly recycled. The remainder is distributed between acidic solution, plastics and polymers.

Briefly, the main stages of manufacture of batteries include the mass production of lead oxide and bars, that will make the positive and negative plates, your healing, mounting plates and other components in the box, fill with acidic solution, sealing, and finally the formation step consisting in applying electric charge. In the process a series of trials and tests are performed to ensure the quality of the final product (Salkind et al., 1994). The electrical performance parameters that must be met for its use, according to NBR 15940 (ABNT, 2013b), are: nominal capacity (C20) shows the amount of power that the battery can supply, capacity reserve (RC) indicates the length of time the battery still works after an alternator failure and finally the starting current (CCA), important for the activation of the vehicle's starter motor.

3 Methodological procedures

In general, present research can be characterized as qualitative, exploratory and descriptive, using case study as a method. We opted for the qualitative approach, considering it more appropriate to the reality of this research because the concern is with the understanding and interpretation of the phenomenon (effects of regulation) and not its measurement (Santos et al., 2000).

As this exploratory research there is not the purpose of developing hypotheses to be tested, but to become familiar with the phenomen trying to obtain a new perception of it through the use of models found in the literature (Cervo & Bervian, 2002). Also, takes themselves as descriptive as it seeks to describe the characteristics of this phenomenon, evaluating and describing the relationship between pre-existing variables (Gil, 2007).

The company was selected by location, easy access to information and permission to visit its plant. As data collection instrument were used semi-structured interviews with employees in management positions, and the application of questionnaires, as well as on-site observation and analysis of company documents.

As research strategy was decided to collect and grade the managers´ perception regarding the impact they observed. The qualitative variables were defined from Swann Model and ISO Methodology. The variables of Swann Model were used to evaluate the impacts relative to external environment and the variables of ISO Methodology to assess the impacts on the organization's internal environment. It is noteworthy that the ISO methodology was adapted, and instead of economic measurement of impacts was assessed the perception of impacts in each function of the value chain.

As data collection instrument were prepared two questionnaires, called A and B. The questionnaire A has two blocks. In the first there are closed questions about the company profile and in the second, issues related to Swann Model and theoretical content researched.

Questionnaire B was prepared on open issues related to the impacts observed in each function. They were entered for each function, examples of impacts identified in previous case studies conducted by ISO.

The choice of scale to evaluate the intensity of the perception of impact for each variable followed the recommendations of Viswanathan et al. (2004) which mention that people are easier to express opinions using symmetrical scales with up to 7 positions. Then, it was chosen to use a scale type Stapel, symmetrical with seven positions: -3: -2; -1; 0; 1; 2; 3, respectively, indicating "strongly negative", "moderately negative", "lightly negative", "impact missed", " lightly positive", "moderately positive", and "strongly positive." The interviews were carried out between June-August 2014, with the participation of six professionals, all in positions of supervision and management. The profile and code to identify the respondents are in Chart 1.

During the field research it was noted that from the six respondents only P1 was able to answer about all the variables because he have participated on the board level and have coordinated the certification process. This fact made it impossible to statistical analysis application for the answers. It was adopted alternatively as a method, first, to point out the value pointed by P1, and second, checking if the value of this impact was consistent with the perception of others enabled to answer about the variable in question. In case of divergence, a consensus value was sought among the respondents.

4 Presentation and discussion of results

4.1 Company characterization

The company began operations in 1984 as a maker of battery plates, and then, in 1988, bringing to market its first line of own batteries. It is located in the city of Londrina / PR, Brazil, occupying an area of 14,000 m2 and 8,000 m2 of covered area. Based on size classification criteria established by Sebrae (2014), it is a medium sized company with currently 234 employees, 50 in administration. Its main market involves the states of Paraná, São Paulo and Rio de Janeiro and the Northeast region. Your participation in the replacement market is estimated around 5% in volume in 2013. The average annual sales is 40 million of reais in the last three years, with an average production of 45,000 batteries per month in 75 models. On average, 60% of its batteries are produced with maintenance-free technology.

4.2 Classification of standards according to the typology of Swann

Normative documents that are related to product certification of automotive batteries were analyzed and classified according to the typology of Swann (2010), presented in Chart 2.

It is noted that the rules which are part of the regulations fall within the following goals: Quality and Performance, Measurement, Codification of knowledge and Environment. A rule may fall into more than one classification at the same time. The other objectives were not identified in the analysis of the set of rules. Important to emphasize that the purpose of the standard will have a direct relationship with the variables of impacts and their connections.

4.3 Presentation of results - Swann model

The results as impact intensity for Swann model variables are presented in Table 1.

From the results in Table 1 and other information obtained in the field research, it was designed a diagram with the identified connections between variables, adapted from Swann model shown in Figure 3.

Chart 1. Personnel interviewed.

Position of the interviewee	Identification of the interviewee	Profile of the interviewee
Product Development and Quality Manager	P1	Chemist, has a master's degree and has been with the company for 20 years. He participated in the meetings of the INMETRO committee to elaborate the RAC of batteries.
Quality Coordinator	P2	Graduated in management with a postgraduate degree in business management. He has been with the company for 10 years.
Commercial Manager	P3	Graduation in business administration and MBA in finance. He has been in the company for 1 year. He has 10 years' experience in the battery market.
Production manager	P4	Chemical Engineer with postgraduate degree in Industrial Administration. He has been with the company for 15 years.
Buyer	P5	Graduated in business management. He has been with the company for 10 years.
HR Coordinator	P6	Graduated in business management. He has been with the company for 1 year.

Chart 2. Classification of standards according to the typology of Swann.

Standards	Functions	VARIETY REDUCTION	QUALITY & PERFORMANCE	INFORMATION / ACCURACY	CODIFIED KNOWLEDGE	COMPATIBILITY / INTERFACE	VISION	HEALTH AND SAFETY	ENVIRONMENT
Ordinance no. 239, of May 9rd, 2012 (Brasil, 2012a)			x					x	x
Ordinance no. 299, of June 14th, 2012 (Brasil, 2012b)			**x**	**x**				x	x
NBR 15914 (ABNT, 2013a)				x					
NBR 15940 (ABNT, 2013b)			x	x	x				
ISO 9001:2008 (Partial requirements) (ABNT, 2009)			x	x	x				
Resolution Conama 401/2008 (Brasil, 2008)									x
Law nº 12.305 of August 2rd, 2010 (Brasil, 2010a)									x
Normative Instruction IBAMA n ° 3 of March 30th, 2010 (Brasil, 2012b)									x

Table 1. Score of perceptions by impact variable.

Intermediate effects			Final effects		
Variables	**Interviewed**	**Score**	**Variables**	**Interviewed**	**Score**
Economies of scale	P1, P4	-2	Price	P1, P3	-2
Competências	P1, P4	+3	Productivity	P1, P4	-3
Division of labor	P1, P4	+2	Entry into new markets	P1, P3	+2
Barriers to entry	P1, P3	+3	Competitiveness	P1, P3, P4	+3
Network Effects	P1	0	Innovation	P1, P4	+1
Transaction Costs	P1, P3, P5	-2	Foreign trade	P1	0
Accuracy	P1, P4	+3	Outsourcing	P1, P4	0
Trust and risk reduction	P1, P3, P4	+3	Market Failure	P1	+3

The bold lines represent the connections that was chosen to discussion. This came from the consistency of empirical evidence found.

4.4 Discussion of results – Swann Model

4.4.1 Standards "quality and performance" and the variables "economies of scale" and "productivity"

Ordinance INMETRO No. 299 in its Annex VIII (Brasil, 2012b), established on federal level, minimum quality requirements for batteries including electrical performance, vibration resistance and retention of electrolytes, which to be obtained by the manufacturer required changes not only the product but its manufacturing process, having negative impact on the variables "Economy of scale" and "Productivity", as mentioned by P1 and P4.

These adjustments primarily affected the mass production stages of lead oxide and formation of batteries. Other steps have also been affected, but with less intensity. The overall drop in business productivity was around 10% which is why the company opted for the hiring of additional work and the opening of the third shift in bottleneck activities. For P1 the realization of infrastructure investments much earlier could have avoided such impacts. Despite this result, several studies, such as those conducted by DTI (2005) and AFNOR (2009), from the econometric data analysis, associate macroeconomic level normalization with increased productivity.

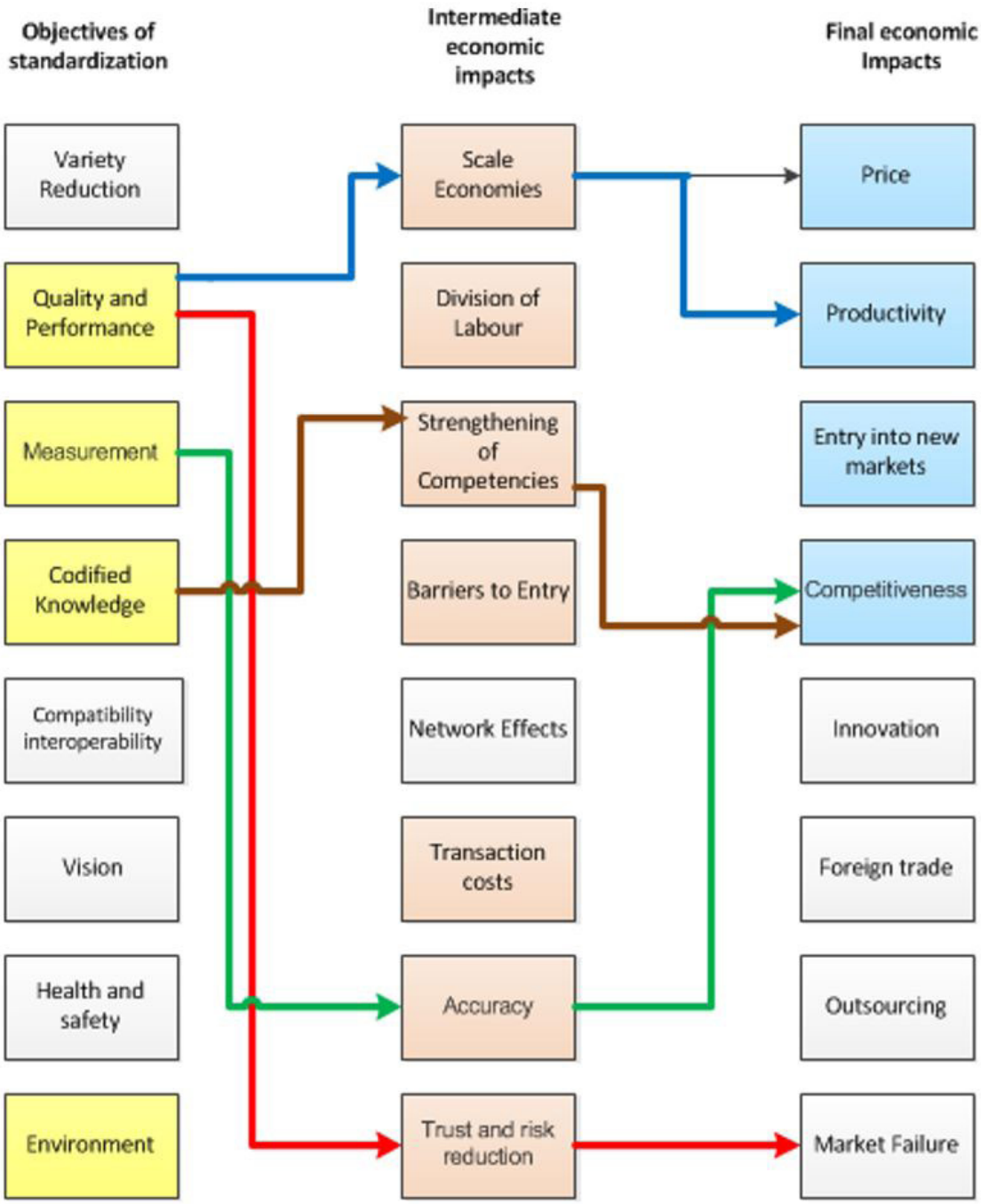

Figure 3. Diagram of impact variables for battery certification. Source: Adapted from Swann (2010).

4.4.2 Standard Measurement and variables "Accuracy" and "Competitiveness"

The NBR 15940 (ABNT, 2013b) establishes the test methods to verify compliance with the specifications set, and therefore it is a rule of "measuring" according to the typology of Swann (2010). As reported by P1, for this fullfilment the company revalued its measurement methods seeking greater metrological reliability which impacted positively on the "Accuracy" variable. For P1 and P3 this impact was observed in the better quality of the finished product by the drop in failure rates for quality problems in the final inspection, as well as losses at various stages of the manufacturing process.

According to Swann (2009) standards related to the measurement can contribute to a better process control,

reducing losses, as well as the quality of products making them more competitive. From the findings above it is possible to infer that the NBR 15940, had a positive impact on variable "Competitiveness" since they are in line with the perceptions expressed P1, P3 and P4.

4.4.3 Quality Standard and Performance and the variables "Trust and risk reduction" and "Market Failure"

Ordinance 299, in its Annex VIII, beyond minimum quality requirements establishes mandatory information on the label of the battery. These two requirements have significant positive impact on variable "Confidence and risk reduction" because they guarantee consumer access to essential information for choosing the best option for the intended application, eliminating the asymmetry of information as well as assuring that matches the label information, eliminating two of the main factors prevailed unfair competition practices in this market.

For P1, P2 and P3 such practices have decreased after certification, which led them to have a highly positive perception of impact for the variable "Market failure". According Egyedi (2012) standards can help overcome problems related to incomplete and asymmetric information about the quality of the products leading to market failures.

4.4.4 Coding standard of knowledge and the variables "Strengthening skills" and "Competitiveness"

Technical standards can be an important way to technical knowledge diffusion as mentioned by Henry (2010). In the case of batteries, the NBR 15940 contains technical information such as performance specifications, instructions for test, design characteristics and others that represent part of the state of art of this technology. Being compulsory, the diffusion occurs by the need for assimilation by the manufacturer without which will not be able to tailor the product and its manufacturing processes. In the perception of P1, this diffusion really happened spread, and he highlights the intense exchange of technical information during the certification period involving partners competitors, suppliers, accrediting, certification bodies and laboratories. Still, according to the respondent, there were more "leveling" of technical product knowledge, especially among small manufacturers, driven to understand the technical standards to apply them in their factories, confirming the relationship between normalization, encoding and technological diffusion as mentioned by Grimaldi & Torrisi (2001).

For the reasons mentioned above we can infer that technological diffusion associated with the care of NBR 15940 (ABNT, 2013b), had an impact on the variable "Competence" contributing to the improvement of product quality, and therefore also impacting positively on the variable "Competitiveness", shared perception by P1, P3 and P4.

4.4.5 Other connections

In conducting the case study we observed other connections, for example, the NBR 15914 standard and the variables "Competence" and "New Markets", or between the Ordinance 299 and the variables "Transaction costs" and "Price", but due limited space, its discussion was not did in this article. However, they are available in Giovanetti (2014).

4.5 Presentation of results - ISO Methodology Adapted

Chart 3 shows a comparison between the steps of the original and adapted ISO methodology, including the expected results at each stage.

Steps 1 and 2 of the methodology were made through visits before the questionnaires A and B application and they will be presented as follows:

Step 1. Analysis of the company's value chain

Step 1 was to identify the internal value chain including its main functions and activities according to the model of Porter (1985). This survey was conducted with P1 using the existing processes mapping in the company due to NBR ISO 9001 (ABNT, 2009) certification. The result of the mapping is presented in Chart 4.

Step 2. Identify the use of standards for function

At this stage the standards have been identified and the immediate consequence of its use for each value chain function is presented in Chart 5. It should be noted that as "standard" means, in addition to the ABNT rules, ordinances, resolutions or any other documents associated to them.

Steps 3 and 4. Identification and assessment of the intensity of impacts by function

These steps to identify the impact on the company in the view of respondents and the evaluation of their intensity was initially performed. The result is shown in Table 2. Recalling that the score of their intensity had intended only to assist in the analysis of data, with no claim to statistical validation.

The scores shown in Table 2 were obtained through interviews with managers from the application questionnaire 02. The next item will be discussed only functions with impact punctuated with "3".

Chart 3. Comparison of the original and adapted methodology.

Steps	ISO Methodology Original	ISO Methodology Adapted	Result
1	Analysis of the value chain of the company	Maintained	Identification of the functions and activity of the company.
2	Mapping the Impacts of Standards in the Value Chain	Identify the use of standards by function.	List of the use of norms by function.
3	Determination of key drivers and operational indicators.	Identify the use of standards by function.	List of impacts identified by function
4	Information gathering and measurement of economic impacts.	Impact assessment by function.	List of intensity of impact by function.

Chart 4. Business functions of the enterprise value chain.

Generic Functions of the Porter Model (1985)		Designation of the function in the organization	Activities
Primary Functions			
a	Sales and Marketing	Commercial	Marketing and sales management activities, relationship with clients and representatives.
b	Outbound logistics	Receipt of materials	Receiving and storing materials, internal movement of components and MP.
c	Operations	Production	Production Planning, battery manufacturing, machine maintenance, equipment and vehicles end quality control.
d	Inbound logistics	Distribution,	Packing, expedition, distribution, transportation and follow up of purchase order
e	Services	Post-sales	Customer service, technical assistance services and training of resellers.
Secondary Functions			
f	Technological development	Product development	Technical homologation of suppliers, development of battery models and product improvement.
g	Human resource Management	People management	Hiring and training employees.
h	Procurement	Purchases	Supplier approval and selection, order issuance and monitoring.
i	Infrastructure	Administrative	Accounts payable and receivable, accounting, tax, reporting, legal matters and information technology.
j	-------	Environment, health and safety.	Monitoring of legal requirements, document management, other environmental monitoring activities and health and safety at work

4.6 Discussion of results - adapted ISO Model

Regarding to "Commercial" function in the perception of respondents decreased unfair competitive practices, such as offering infeasible battery prices. On the other hand increased the competitiveness of micro and small manufacturers, who have to offer best quality products, representing now a threat before insignificant. It was noted that the certification encouraged a higher level on the quality of the products among competitors, impacting the competitive advantages of organizations (Brunsson et al., 2012; Eto, 2010). This framework has imposed the need for new marketing actions, such as training of retailers to improve the effectiveness in selling the product, strengthening and promotion of the brand, making gifts and promotional material.

For the "Production" impacts were also identified as significant, especially for the improvement of process capability to meet the specifications of product quality characteristics, resulting as reported by P1, P2 and P4 in more stable processes and less variability. This significant improvement in the process

Chart 5. General mapping of the use of standards by business function.

Generic Functions of the Porter Model (1985)		Identification of the Standard.	Mapping between functions and standards.
Primary Functions			
A	Commercial	ABNT NBR 15914 (ABNT, 2013a) and Ordinance no. 299 (Brasil, 2012b)	Determines the minimum information for the battery label
B	Receipt of materials	NBR ISO 9001 (Requirements 7.4, 7.5.3, 8.2.4) (ABNT, 2009)	Defines criteria for performing inspection, identification, traceability and storage
C	Production	ABNT NBR 15940 (ABNT, 2013b) and ISO 9001 (8.2.4, 8.3, 7.5.5, 7.6) (ABNT, 2009)	Defines requirements for test results and mandatory testing by the ordinance. Establishes calibration, identification, traceability, and nonconforming product requirements
D	Distribution	Ordinance n°299 (Brasil, 2012b), Law n°12.305 (Brasil, 2010a) and Conama 401 (Brasil, 2008)	Need for reverse logistics. Preservation of batteries in stock
E	Post-sales services	Ordinance n° 299 (Brasil, 2012b)	The ordinance establishes requirements for handling customer complaints
Secondary Functions			
F	Product development	ABNT NBR 15940 (ABNT, 2013b) and Ordinance n° 299 (Brasil, 2012b)	Need to homologate the product before the market launch including trials and descriptive memo
G	People management	-----	---------
H	Procurement	Ordinance n.º 299 (Brasil, 2012b and ISO 9001 (Requirement 7.4) (ABNT, 2009)	Need for approval and evaluation of suppliers
I	Administrative	------	---------
J	Environment, health and safety	Conama 401 (Brasil, 2008) and law n° 12.305 (Brasil, 2010a)	Need to maintain legal documentation in order including records generated related to reverse logistics and environmental certificates

was the result of the need to meet the NBR 15940 (ABNT, 2013b), which established a maximum variation of 5% compared to the nominal values of electrical performance parameters (C20, RC and CCA). Prior to certification only large manufacturers established a value maximum variation, but was much higher than the value established in the regulations. Initially, until the process stabilization, this requirements resulted on a rework and waste indicators increasing, as mentioned by P1 and P4.

One of the impacts mentioned to function "Product Development" was the new battery models costs for launching increasing because of the need to present laboratory tests and technical product memorial. However, these requirements have contributed to the prevention of possible failures in subsequent production steps and post-sales, where the failures´ costs could be higher as mentioned P1.

The "Human Resources" was noted as having significant negative impact due to increased costs arising from additional hiring of direct labor and the opening of new work shifts. These emerging actions were taken to mitigate the fall of productivity in sectors that have become bottlenecks after the adjustments made in the production processes.

The "Procurement" function was also scored as having highly positive impact due to new requirements regarding the quality have been passed on to suppliers, forcing them to improve the quality level of their products. P3 cites, as an example, boxes and labels suppliers, which at first had some supplies failed to adapt to the new required quality levels. It is observed so that the compulsory certification has also worked as a propagation mechanism of higher quality requirements to the supply chain.

Table 2. Identification and intensity of impacts by function. Primary Functions.

Function	Impacts observed	Intensity of impact	Interviewee
Primary Functions			
Commercial	- Lower price difference between competitors. - Price increase of the order of 10 to 15%. - Less possibility of product differentiation. - Decrease of unfair competition practices	3	P1, P3
Receipt of materials	- Increased accuracy in supplier quality inspection	2	P1, P2, P5
Production	- Production processes with less variability - Decrease in productivity - Reduction of losses in the process. - Formation of bottlenecks in the production line. - Increased production costs	3	P1, P2, P4
Distribution	- Increased distribution costs	-2	P1, P4
Technical assistance	- Expected fall in the number of warranty requests	2	P1, P2
Secondary Functions			
Product development	- Higher costs for development of new battery models. - More reliable projects reducing the risk of product failures in the field.	3	P1
Human resource Management	- Increase in direct labor. - Third shift implementation	3	P1, P6
Procurement	- Improvement of the quality of the products supplied.	3	P1, P5
Administration	It was not investigated.	N.A	
Environment, health and safety	Better control of legal documentation related to environmental management.	1	P1

4.7 Main results of the survey

In a results summary it is possible to highlight the following findings:

- The adjustments made in the production process necessary to meet certification resulted, at first, in the formation of bottlenecks and consequently in factory productivity drop;
- Certification decreased product differentiation capacity, both in terms of price and quality, favoring a greater increase in competition and defining new business strategies;
- The greater demand for quality ended up being passed on to the network providers also forcing these to improve the quality of their products;
- Certification increased direct and indirect production costs. The latter related to compliance costs (costs to ensure the conformity of the product), as provided in the literature;
- The increase in these costs was not passed on in full to the prices of products, following the rest of the market behavior, resulting in a possible decline in profitability of products;
- Certification promoted the increase of technological competence in that it led to the sharing of knowledge and experience among partners and other agents involved in the certification process;
- It is noted by the collected perceptions that the product certification contributed significantly to the reduction of unfair competition practices and increasing the overall quality of the batteries, which shows that possibly market failure no longer does so present.

5 Conclusions

This study sought to deepen research on the product certification impacts, adopting a non-econometric approach for which there is little research and

publications about. The purpose of this study was to investigate the effects of standardization as a result of product certification in a particular context in which its implementation was not deliberate, but required by a State regulation. To fulfill these objectives and answer the research question a bibliographic review related to the topic was held. In addition, a case study was conducted in a medium-sized company located in the north of Paraná.

It was found that the results of this study successfully met proposed objectives. The main scientific contribution of the research was to reveal the impacts of certification from an empirical perspective, comparing the theoretical basis adopted as a reference to the effects observed in the field. And many corroborated with the foreseen as reducing the asymmetry of information and technology dissemination and others presented distinctly the recommended as the initial drop in productivity. As applied contribution, we can highlight the confirmation, in this case study, the relevance of compulsory product certification as a tool for treatment of market failures.

It can be seen from the results presented that product certification can have a significant impact on both technological and organizational levels in an industrial company. In this sense, it is suggested as a theme for future research studies these impacts in a larger number of companies, segmenting them by size. Small, medium and large companies have different organizational and technological capabilities, which will influence their adaptation strategies to be able to certification. Understand which are these strategies and the impacts generated, considering its size, can make important contributions to the science of patterns and to the planning process of public policies geared to conformity assessment programs.

It also is intended that the theoretical framework adopted, which were merged, adapted and analyzed critically two approaches to evaluate the impacts of standardization, the Swann Model and ISO Methodology, will contribute to the state of the art research in standardization. Finally, it is believed that the results identified in this study may provide grants for the improvement of future product conformity assessment programs in different industrial sectors.

References

Abreu, J. A. P. (2005). *Tecnologia industrial básica: trajetória, desafios e tendências no Brasil*. Brasília: MCT.

Associação Brasileira de Normas Técnicas – ABNT. (2009). *NBR ISO 9001:2008: Sistemas de Gestão da Qualidade: requisitos* (2a ed.). Rio de Janeiro: ABNT.

Associação Brasileira de Normas Técnicas – ABNT. (2013a). *NBR 15914:2013: Baterias chumbo-ácido para uso em veículos automotores de quatro ou mais rodas: requisitos e simbologia*. Rio de Janeiro: ABNT.

Associação Brasileira de Normas Técnicas – ABNT. (2013b). *NBR 15940:2013: Baterias chumbo-ácido para uso em veículos rodoviários automotores de quatro ou mais rodas: especificação e métodos de ensaio*. Rio de Janeiro: ABNT.

Association Française de Normalisation – AFNOR. (2009). *The economic impact of standardization: technological change, standards and growth in France*. Paris: AFNOR.

Barzel, Y. (2003). Standards and the form of agreement. In *Proceedings of the Annual Conference of the International Society for the New Institutional Economics* (pp. 7). Budapeste, Hungria: ISNIE.

Blind, K. (2004). *The economics of standards: theory, evidence, policy*. Cheltenham: Edward Elgar Publishing.

Blind, K. (2013). *The impact of regulation on innovation: NESTA Compendium of Evidence on the Effectiveness of Innovation Policy Intervention.* London: NESTA.

Brasil. (2008, 5 de novembro). *Resolução Conama nº 401/2008, de 04 de novembro de 2008. Estabelece os limites máximos de chumbo, cádmio e mercúrio para pilhas e baterias comercializadas no território nacional e os critérios e padrões para o seu gerenciamento ambientalmente adequado, e dá outras providências* (seção 1, pp. 108-109). Brasília, DF: Diário Oficial da República Federativa do Brasil.

Brasil. (2010a, 3 de agosto). *Lei nº 12.305, de 2 de agosto de 2010. Institui a Política Nacional de Resíduos Sólidos; altera a Lei nº 9.605, de 12 de fevereiro de 1998; e dá outras providências* (seção 1, pp. 3). Brasília, DF: Diário Oficial da República Federativa do Brasil.

Brasil. (2010b, 5 de abril). *Instrução Normativa IBAMA nº 3, de 30 de março de 2010. Institui os procedimentos complementares relativos ao controle, fiscalização, laudos físico-químicos e análises, necessários ao cumprimento da Resolução CONAMA nº 401, de 4 de novembro de 2008*. Brasília, DF: Diário Oficial da República Federativa do Brasil.

Brasil. (2012a, 11 de maio). *Portaria Inmetro n. 239, de 09 de maio de 2012. Aprova o Regulamento Técnico da Qualidade para Baterias chumbo-ácido para veículos automotores* (seção 1, pp. 178). Brasília, DF: Diário Oficial da República Federativa do Brasil.

Brasil. (2012b, 18 de junho). *Portaria Inmetro n. 299, de 14 de junho de 2012. Institui no âmbito do Sistema Brasileiro de Avaliação da Conformidade a certificação compulsória de baterias chumbo-ácido, para veículos automotores* (seção 1, pp. 97). Brasília, DF: Diário Oficial da República Federativa do Brasil.

Brunsson, N., Rasche, A., & Seidl, D. (2012). The dynamics of standardisation: three perspectives on standards in organisation studies. *Organization Studies*, 33(5-6), 613-633. http://dx.doi.org/10.1177/0170840612450120.

Butter, F. A. G., Groot, S. P. T., & Lazrak, F. (2007). *The transaction costs perspective on standards as a source of trade and productivity growth*. Amsterdam: Tinbergen Institute.

Castro, B. H. R. D., Barros, D. C., & Veiga, S. G. D. (2013, março). Baterias automotivas: panorama da indústria no Brasil, as novas tecnologias e como os veículos elétricos podem transformar o mercado global. *BNDES Setorial*, 37, 443-496.

Cervo, A. L., & Bervian, P. A. (2002). *Metodologia científica* (5a ed.). São Paulo: Prentice Hall.

Department of Trade and Industry – DTI. (2005). *The empirical economics of standards* (DTI Economics Paper, No. 12, 135 p.). Londres: Department of Trade and Industry.

Egyedi, T. M. (2012). *To select or not? dealing with competing standards in public it procurement*. Delft, Netherlands: Delft University of Technology.

Eto, M. (2010). Definitions and functions. In D.-G. Choi (Org.). *Education guideline 3: textbook for higher education - standardization: fundamentals, impact, and business strategy* (pp. 3-36). Singapure: APEC.

Foukaki, A., & Kärreman, M. (2013). Untangling disarray – A meta-analysis of studies on standards and standardization from a two-dimensional framework. In *Paper presented at the International Conference on Information and Social Science (ISS2014)*. Nagoya, Japan: International Academy Institute. Recuperado em 27 junho de 2015, de http://ibac- conference.org/ISS%20&%20MLB%20 2013/Papers/ISS%202013/B2258..docx.pdf

Gerundino, D., & Hilb, M. (2010, June). The ISO methodology: assessing the economic benefits of standards. *ISO Focus*, 10-16. Recuperado em 23 abril de 2015, de http://www.iso.org/sites/TC_Chairs_2011/assets/Gerudino_Hilb_ISO%20Focus%2010-06-E.pdf

Gil, A. C. (2007). *Métodos e técnicas de pesquisa social*. (5a ed). São Paulo: Atlas.

Giovanetti, J. (2014). *Impactos da certificação de produto na indústria de baterias automotivas: um estudo multicaso* (Dissertação de mestrado). Universidade Federal do Paraná, Curitiba.

Goedhuys, M., & Sleuwaegen, L. (2013). The impact of international standards certificationon the performance of firms in less developed countries. *World Development*, 4, 87-101. http://dx.doi.org/10.1016/j.worlddev.2013.02.014.

Grimaldi, R., & Torrisi, S. (2001). Codified-tacit and general-specific knowledge in the division of labour among firms: a study of the software industry. *Research Policy*, 30(9), 1425-1442. http://dx.doi.org/10.1016/S0048-7333(01)00160-3.

Guasch, J. L., Racine, J. L., Sanchez, I., & Diop, M. (2007). *Quality systems and standards for a competitive edge*. Washington: World Bank Publications. http://dx.doi.org/10.1596/978-0-8213-6894-7.

Haimowitz, J., & Warren, J. (2007). *Economic value of standardization*. Otawa: Standards Council of Canada.

Henry, J. (2010). Economic impacts. In D.-G. Choi (Org.), *Education Guideline 3: textbook for higher education - standardization: fundamentals, impact, and business strategy* (pp. 91-113). Singapure: APEC.

Instituto de Apoio às Pequenas e Médias Empresas e à Inovação – IAPMEI. (2015). *Certificação de sistemas de gestão da qualidade nas organizações*. Recuperado em 29 outubro de 2015, de http://www.iapmei.pt/iapmei-art-03.php?id=338

Instituto Nacional de Metrologia, Qualidade e Tecnologia – INMETRO. Conselho Nacional de Metrologia, Normalização e Qualidade Industrial – CONMETRO. (2007). *Guia de boas práticas de regulamentação*. Brasília: CONMETRO.

International Organization for Standardization – ISO. (2010). *Assessing economic benefits of consensus-based standards: the ISO methodology*. Genebra: ISO.

Khudina, E. (2012). *Technical barriers to trade and standardization policy*. Europa-Kolleg Hamburg.

Machado, I. P. (2002). *Avaliação ambiental do processo de reciclagem de chumbo* (Dissertação de mestrado). Faculdade de Engenharia Mecânica, Universidade Estadual de Campinas, Campinas.

Machado, R. T. M. (2000). *Rastreabilidade, tecnologia da informação e coordenação de sistemas agroindustriais* (Tese de doutorado). Faculdade de Economia e Administração, Universidade de São Paulo, São Paulo. http://dx.doi.org/10.11606/T.12.2000.tde-27122002-151411.

Martins, J. C., & Silva, R. C. (2011). Da intervenção do estado na economia. *Revista do Curso de direito da Faculdade de Humanidades e Direito*, 8(8), 9-30. http://dx.doi.org/10.15603/2176-1094/rcd.v8n8p9-30.

Porter, M. (1985). *Vantagem competitiva: criando e sustentando um desempenho superior* (15a ed.). Rio de Janeiro: Campus.

Salkind, A. J., Kelley, J. J., & Cannone, A. G. (1994). Lead-acid batteries. In D. Linden. *Handbook of batteries* (2nd ed., Chap. 23). USA: MacGraw-Hill.

Santos, G. T., Rossi, G., & Jardilino, J. R. L. (2000). *Orientações metodológicas para elaboração de trabalhos acadêmicos* (2a ed.). São Paulo: Gion.

Serviço Brasileiro de Apoio às Micro e Pequenas Empresas – SEBRAE. (2014). *Critério de classificação de empresas*. Recuperado em 5 março de 2015, de http://www.sebrae-sc.com.br/leis/default.asp?vcdtexto=4154

Swann, G. M. P. (2009). *The economics of metrology and measurement* (Report for National Measurement Office,

116 p.). Londres: Department of Business, Innovation and Skills (BIS).

Swann, G. M. P. (2010). *The economics of standardization: an update* (Report). Londres: Department of Business, Innovation and Skills (BIS).

Viswanathan, M., Sudman, S., & Johnson, M. (2004). Maximum versus meaningful discrimination in scale response: implications for validity of measurement of consumer perception about products. *Journal of Business Research*, 57(2), 108-124. http://dx.doi.org/10.1016/S0148-2963(01)00296-X.