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DIAGNOSING THE VALORIZATION OF UNIVERSITY-INDUSTRY INTERACTION BY INDUSTRIAL COMPANIES: EVALUATION BASED ON INDUSTRIAL ASSOCIATIONS' WEBSITES

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ABSTRACT: This work aims to identify ways to which companies and universities relate to each other and the importance attributed by companies to this kind of interaction. Specifically, it seeks to understand the degree to which university-industry interaction is approached, comparing Brazilian industry to that of so-called developed countries. We use a qualitative and exploratory approach, specifically content analysis, and industrial associations' websites as a data source. Results indicate that there is emerging conscience in Brazilian strategic industries about universities as a source of useful technology, but not about the role of university spin-off generation as an essential element for technological and industrial development. Participation of Universities as members of industrial associations appears to be similar to benchmark associations. The promotion of university-industry interaction as core mission is uncommon either in benchmark associations nor Brazilian associations, but Benchmark associations, in more dynamic industries always mention universities as a source of technological service (by various technology transfer mechanisms), a situation which was not observed in the Brazilian reality. Hence, data shows that the connection between Brazilian Industry and Universities has yet to be improved. The results also suggest that Brazilian Medical Industry Complex, Industrial Chemistry, Electronics, Materials, and Information Technology present less conscience and valuation of University as a potential source of innovation, in comparison to the international benchmark.

Keywords: University. Dynamic Industries. Industrial Association. Technology Transfer. Business Incubation.

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1 INTRODUCTION

Technology transfer is defined as the process through which knowledge, abilities, and procedures applicable to specific problems are transferred, through economic transactions, from one organization to another, expanding the innovation capacity of the receptor organization. Not all companies can invest in R&D; for many small businesses, the challenge resides in finding means of using technology generated by others or complementing basic technologies developed internally with the largest possible set externally available. In the same manner, even large companies, which invest billions of dollars in research, are increasingly conscious of the need to search for external knowledge and to build connections in their innovation systems. In this way, universities, due to their potential of producing scientific and technological information and participating in networks with scientific and technological capacity, play a major role in building a closer relationship with companies in the country's productive sector. This relation is known as university-industry interaction, and this interaction contributes to a better technological capacity building for industry and its members. These are the resources necessary to generate and manage technological change. These resources are cumulative and incorporated in abilities, knowledge, experience and organizational systems (Bell & Pavitt, 1997).

In the knowledge economy, product development process is specialized and segmented in a knowledge creation value chain. This creates markets for technologies, knowledge, ideas that enable Research and Development outsourcing (Arora, Fosfuri, & Gambardella, 2001; Howells, 1999; Teece, 1998), technological entrepreneurship, open innovation, research funding (Arora et al., 2001; Carraz, Nakayama, & Harayama, 2014; Chesbrough, Vanhaverbeke, & West, 2006; Etzkowitz & Leydesdorff, 2000; Pénin, 2008, 2011; Teece, 1998). Companies and industries in this chain adopt new business models. Emerging private Research and Technology Organizations (Leitner, 2005; Teece, 1998), and market intermediators (Hoppe & Ozdenoren, 2005; Knockaert, Spithoven, & Clarysse, 2014) are possible. However, these concepts are still incipient, and there are differences between industries and countries (BioStorage Technologies, 2016; Carraz et al., 2014; PwC, 2013).

This work aims to identify the various ways through which companies and universities relate to each other and the importance attributed by companies to this kind of interaction. Specifically, it seeks to understand the degree to which university-industry

interaction is approached, comparing Brazilian industry to that of so-called developed countries.

2 LITERATURE REVIEW

Innovation system is usually described as composed of triple helix's innovation agents or components - Companies, University, and Government (Etzkowitz & Leydesdorff, 2000). The notion of science, technology, and innovation systems derives fundamentally from the interaction between companies and external knowledge sources (Lundvall, 1988). Government's role in developing science, technology, and innovation, intensified since the 1940's when a much larger scale of scientific, technological, and industrial production infrastructure development started to take place. The government was thus converted to the most prominent promoter of the innovation process. Due to changes in the innovation process, with the transition from a linear model to a nonlinear model, later evolving to an "open" model, greater complexity was introduced in national innovation systems, presenting new challenges for innovation systems policy making. According to existing indicators, Latin America as a whole is a latecomer in this sense. To emphasize new perspectives for innovation systems policies is crucial in this context. Institutional arrangements include norms and incentive structures, which shape interaction between different agents, public and private, involved in managing resources for innovation. Lundvall (2007) refers to the need of building institutions and the open character of innovation systems, and its application in developing countries.

One literature stream analyses the so called market for knowledge, know-how, technologies or ideas comprised by the flux of knowledge and technology from one company to another, or from university and research institutes to the industry in a process called as open innovation (Chesbrough et al., 2006). However, there are different levels of openness in the industries (Carraz et al., 2014; Pénin, 2008, 2011).

The industrial association is defined as a formal organization to represent members' interests, promote lobby, joint activities such as group insurance and purchasing, and also social events. For this purpose, it comprises a network with several functions, which, by definition, enables meaningful relationships (Bennett & Robson, 2001). Although lobby for tax reduction or governmental incentives is possibly the most frequent, in the innovation context, and in the triple helix view of innovation, industrial associations are considered public agents with the role of connecting different companies,

Industrial associations may also act as intermediaries in the innovation system, connecting companies, and other agents (Etzkowitz, De Mello, & Almeida, 2005).

3 METHODOLOGY

This research comprises a qualitative and exploratory study, specifically content analysis (Bazeley & Jackson, 2013; Krippendorff, 2003) using QSR NVIVO® 10, and industrial associations' websites as a data source.

In the content analysis, the coding unit was comprised by specific paragraphs of the website, and the content unit for analytical purposes, the Association. A premise of this study was the use of data from some reference outsiders (and globalized) associations as a benchmark. Benchmark associations are from USA, Japan, United Kingdom, and also European and International Associations.

Quantitative analysis, specifically descriptive statistics, was used to identify main behavioral differences between industrial sectors, regarding the valuation of interaction and related technology and knowledge acquisition from University.

3.1 Data Codification

The main research question was deployed in the following specific issues:

> Does Brazilian Industry consider universities as a source of useful technology?
> Does Brazilian Industry consider university spin-off generation as an essential element for technological and industrial development?
> Do Brazilian industrial associations consider the promotion of university-industry interaction as their mission?
> How are Brazilian industrial associations connected to Universities?

Using these specific questions as guidelines, and deploying them in a focused discussion, the classification categories summarized in Table 1 were obtained.

Mission-Vision		Association's Mission/ vision definition. In the present Project, we consider only those parts mentioning companies' technological development.
University		Parts which express interaction between member companies and a university, in all sectors and activities (research, services, technologies, etc.)
	University spinoffs	New companies launched for exploring intellectual property or knowledge developed in an academic institution.
	Incubators	The mechanism for stimulating creation and development of nascent technology-based companies in manufacturing or services, through entrepreneurial education.
	University laboratory	Use of university labs or research groups for developing technology or technological solutions for partner companies
	Research partnership	Research partnerships between university and company
	University services	Services made available by universities to companies
	University technology	Technology created/developed in universities which may be applied in companies. Includes patent licensing.
University as member of an association		When university departments or labs, or university as an institution participate as members of the industrial association
	Researchers as members	When university researchers and/or professors take part of an association's board, or as individual members

Table 1 - Coding categories

The data collected was codified using QSR NVIVO ® 10 software, using the categories related to University-Industry Interaction presented in Figure 1. Codification was conducted mainly by a single person, although discussions with other research group members were conducted. The authors considered that coding by one person was sufficient because of the low subjectivity level of the defined classification categories.

3.2 Data Source Description

Data was collected using web search results between September 2014 and January 2015. The search was conducted using Google® search engine and the keyword (in both English and Portuguese) "*Industrial Association*". Secondary results comprising a list of industrial associations were used, as well as the links to other associations presented by an association's website.

A total amount of 228 documents were collected and analyzed, from websites of 32 industrial associations (16 Brazilian and 16 foreign) using QSR NVIVO® 10 software. Table 2 characterizes the analyzed associations.

Sectors	Benchmark	Brazilian	Total
Medical Industrial Complex	9	8	17
Electronics	6	8	14
Industrial Chemistry	6	9	15
Industrial Equipment			
Materials	3	7	10
Information technology	6	4	10

Table 2 - Number of studied associations

Some benchmark associations are located in countries where neither English nor Portuguese is the native language. In these situations, the English version of the web page was used to conduct the evaluation, but it is accepted that this version may present less information than its native language version.

Some associations include and represent more than one industry. Although data from several industrial associations were collected, we decided to analyze only associations that act in industries with the absence of clear or quasi-monopoly, which are dominated by a few large companies, imposing its' standards on suppliers. This decision was taken because in this context the role of an industrial association is less relevant for cooperative actions, and, hence, the data source is less useful for our purpose. The analyzed industries are (i) Medical Industrial complex; (ii) electronics (iii) materials (iv) Industrial Chemistry and (v) Information technology.

4 RESULTS

Using the defined categories, graphs with the comparative amount of associations presenting specific features were used to compare the group of Brazilian and Benchmark associations.

The participation of Universities in Industrial Associations appears to be similar for both Brazilian and benchmark Industrial Associations, as shown in Figure 1.

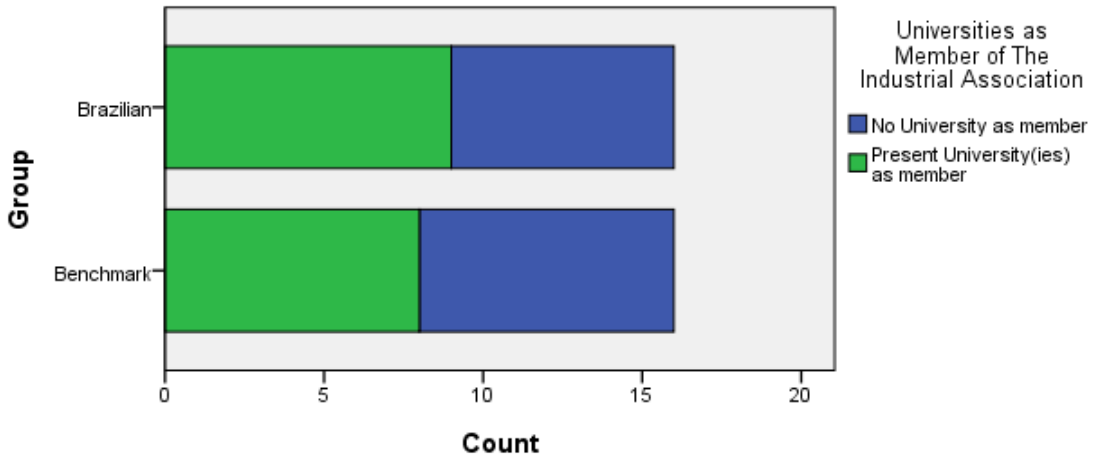


Figure 1 - group difference regarding the participation of Universities in Industrial associations

Both benchmark and Brazilian associations present similar profiles regarding university membership. Figure 2 deploys the data by strategic industries.

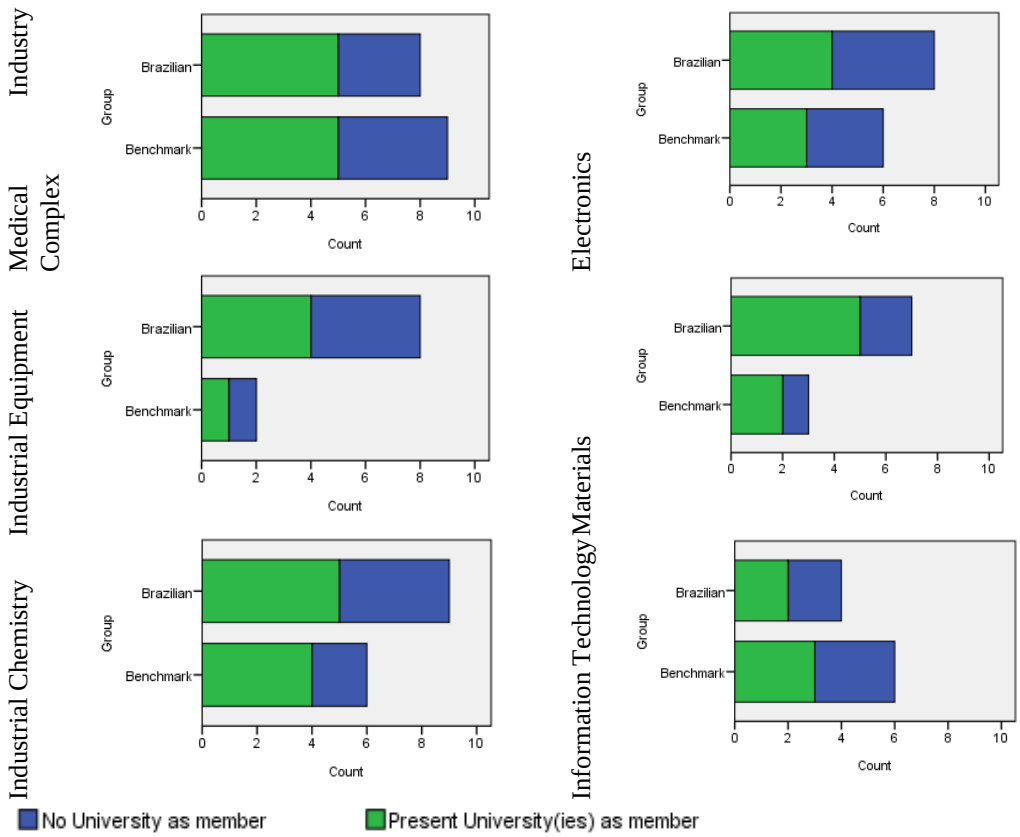


Figure 2 - group difference in strategic industries regarding the membership of Universities in the Industrial associations

Figure 2 shows that groups (benchmark and case study associations in several industries) present a similar proportion participation of universities. The variables industrial sector and university membership are not associated.

To answer the question "Do Brazilian industrial associations consider the promotion of university-industry interaction as their mission?", other variables were considered. Specifically mentioning concern about University-Industry Interaction in the Associations "Mission and Vision" statements was used to evaluate the question. Figure 3 presents the quantification of industrial associations for related Industries.

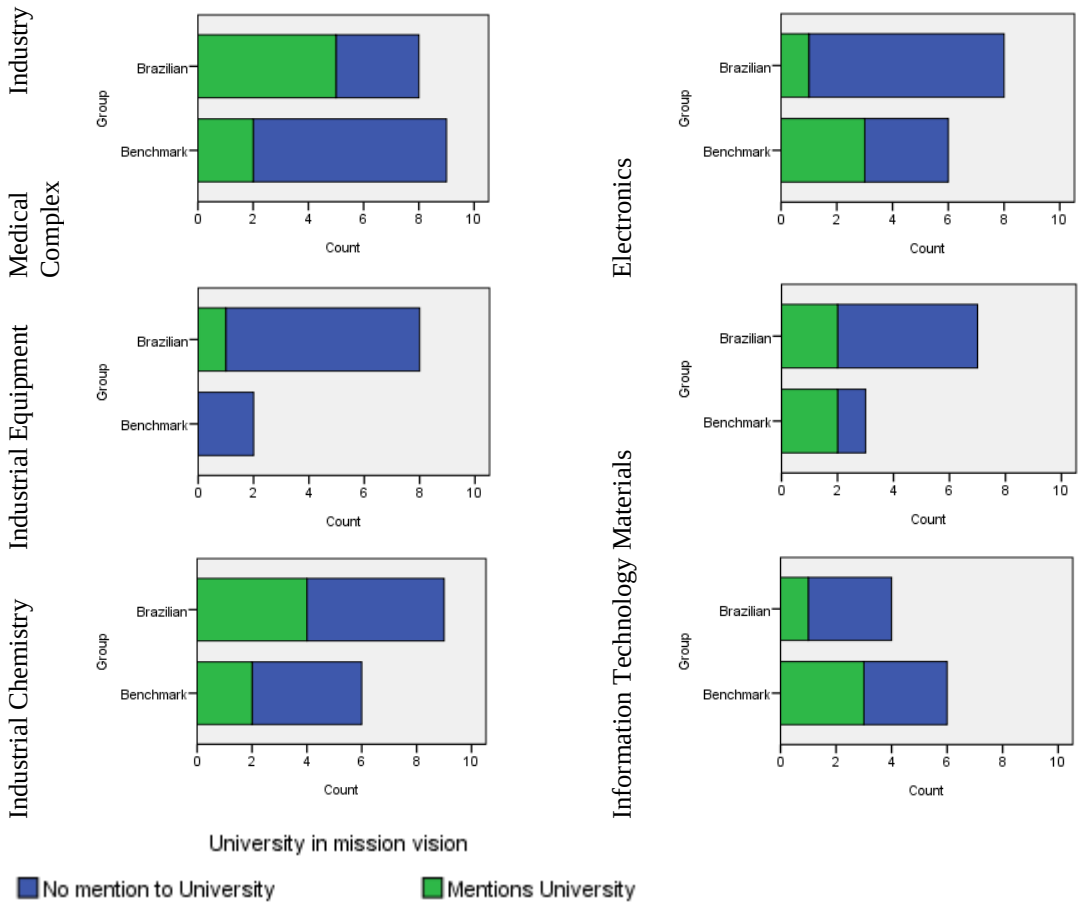


Figure 3 - group difference in the strategic industries regarding the mention to Universities on the Industrial associations' mission and visions definition

This figure shows that the pattern of mentioning "University" in the Associations' mission statement and vision definition varies significantly between industries. Considering the question ", "Do Brazilian industrial associations consider the promotion of university-industry interaction as their mission?" it can be argued that the association may be concerned about university-industry interaction but does not consider it in a way as to highlight it in mission-vision statements for several reasons. For this reason, other contents of the association's website were also analyzed. To analyze the topic in greater depth, the following question was investigated: Does Brazilian Industry consider universities as a source of useful technology?

Mentions about university labs, technologies, services, research & development partnership opportunities or spin-off generation were used as a proxy for "university as a technology source" Figure 4 summarizes the final count of mentioning at least one mode of technology (or technological knowledge) transference.

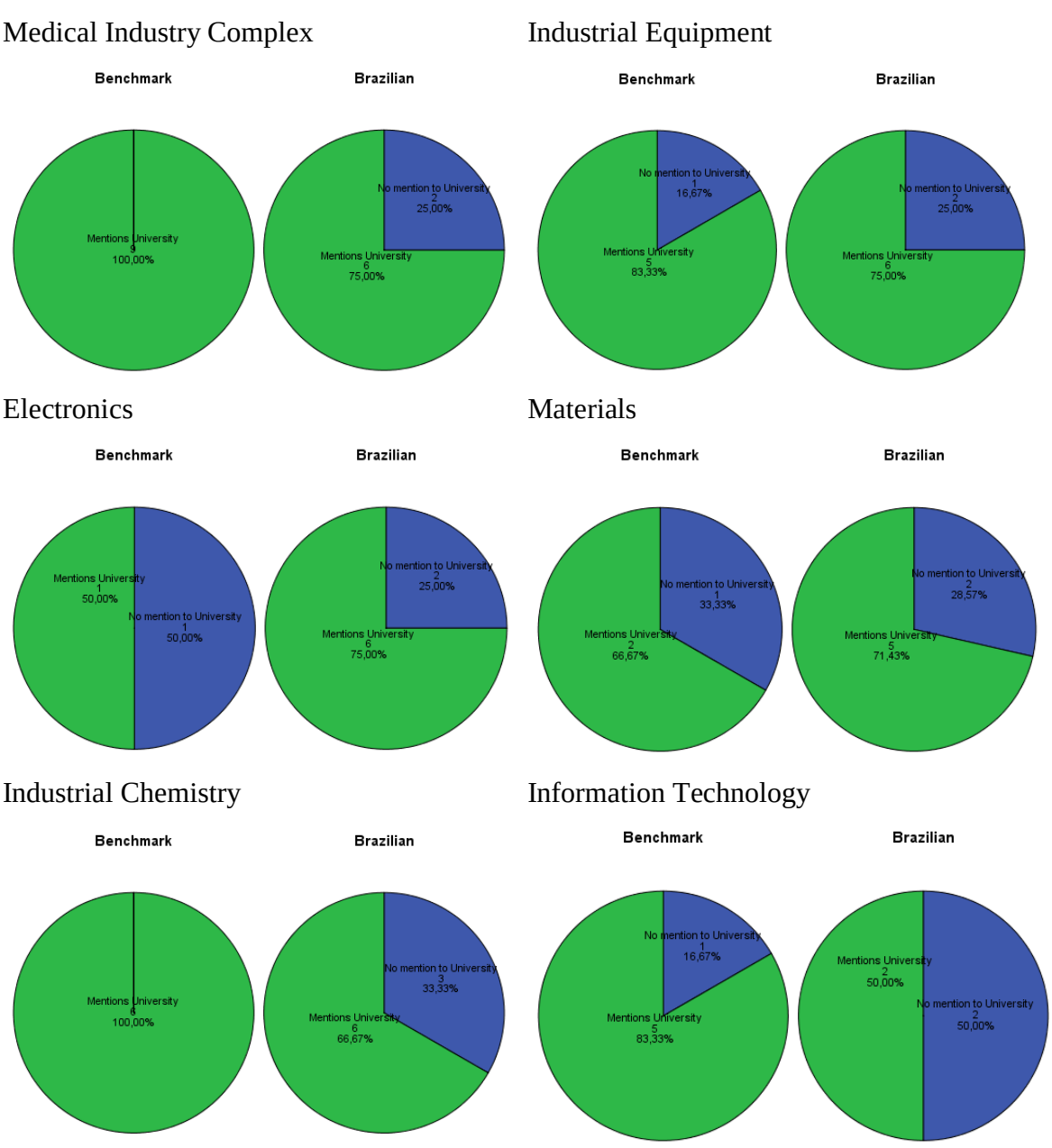


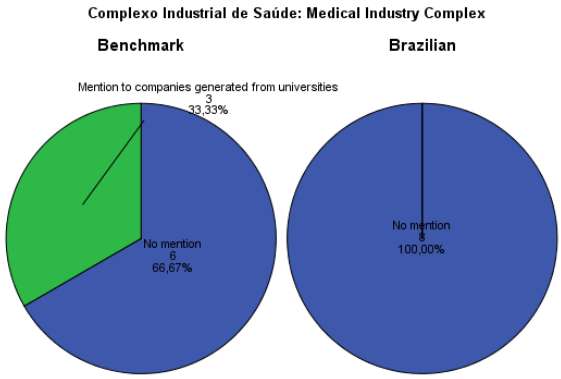
Figure 4 - group difference in the strategic industries regarding intention to use University technological sources

It is shown that some high technology and dynamic industries such as Medical Industry and Industrial Chemistry present a critical difference between Brazilian and benchmark Industrial Associations. In these industries, some Brazilian Associations do not mention University as a technological (knowledge) source, but all benchmark associations mention university. It calls attention to the difference between University-Industry interaction culture in Brazilian industries compared to benchmark industries.

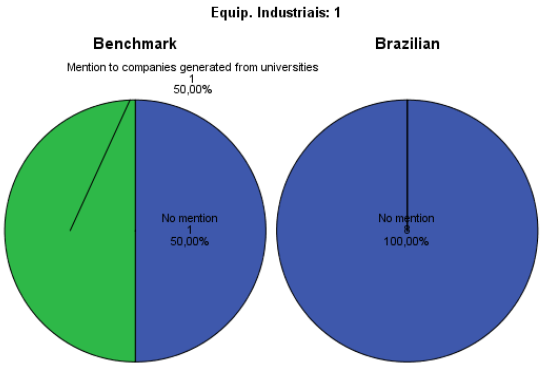
The following question was investigated: "Does Brazilian Industry consider university spin-off generation as an essential element for technological and industrial

development?". To this purpose, "University spinoffs" category was used to obtain Figure 5.

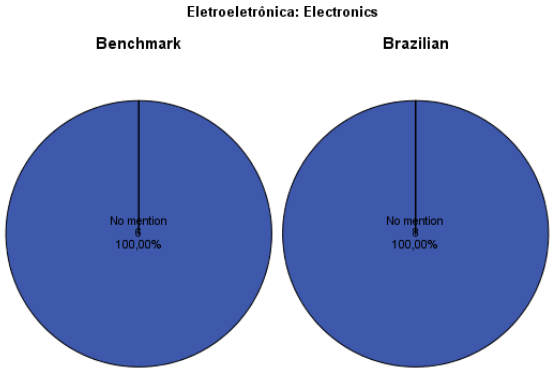
Medical Industry Complex



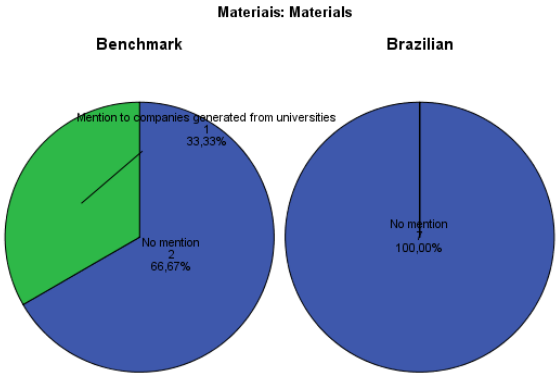
Industrial Equipment



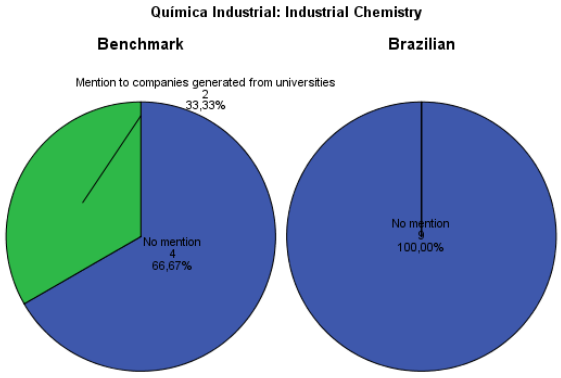
Electronics



Materials



Industrial Chemistry



Information Technology

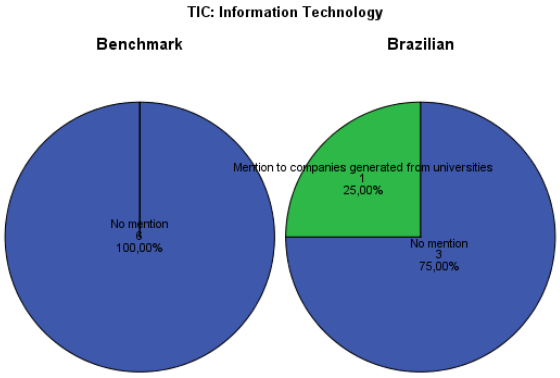


Figure 5 - group difference in strategic industries regarding University spin-off generation

It is possible to observe that the university spin-off generation topic is not so frequent in industrial associations' website. However, it was noted that specifically, benchmark industrial associations in the Medical Industry Complex, Industrial Equipment and Materials and Industrial Chemistry present this kind of topic, whereas Brazilian associations' websites do not present it.

5 DISCUSSION

The difference between Figure 3 and Figure 2 raises some new questions. In all industries, it was more frequent to mention universities on the website as a whole than in the Mission & Vision statements. The reference about Universities in its mission and vision statements are a clear indication of the Association's worry about their role as a promoter of University-Industry interaction. Hence, the context of these mentions was analyzed in detail:

For example, Japan Bioindustry Association (JBA) website mentions:

> *"unique organization able to comprehensively promote the advancement of bio industries through the cooperation of industry, academia, and government"(JBA, 2015, our translation).*
>
> *The Information Technology Telecommunications and Electronics Association (TECH UK):"where industry and technology stakeholders meet to identify current and future market challenges and work together to identify how best to overcome them."*

The same is also observed in some Brazilian associations, as ABIFINA:

> *"Strategic alliances between companies, universities, and research centers" (TECH UK, 2015, our translation)*

The associations that do not mention university in its mission-vision statements comprise a divergent group. For example, one mentions concerns related to new technological patterns, without mentioning University, whereas others appear to be concerned solely about commercialization. The analysis of selected contents also enables to infer that for some benchmark industries it is evident that innovation and technological development comprises interaction with the university, without a need to specify it. For example, some associations that do not mention University in its Mission & Vision Statements mention innovation and research.

Pharma, which mentions university on its website, but not in its Mission & Vision Statements:

> *"support innovative medical research, yield progress for patients today and provide hope for the treatments and cures of tomorrow.*
>
> *(...)PhRMA's mission is to conduct effective advocacy for public policies that encourage discovery of important new medicines for patients by pharmaceutical and biotechnology research companies." (Pharma, 2015)*

The International Technology Roadmap for Semiconductors (ITRS), that mentions university on its website, but not in its Mission & Vision Statements:

> *"The objective of the ITRS is to ensure cost-effective advancements in the performance of the integrated circuit and the advanced products and applications that employ such devices, thereby continuing the health and success of this industry.*
>
> *(...) These teams are joining with other strategic road mapping efforts [such as electronics and nanotechnologies], so the Roadmap effort comprehends the spectrum of needs for basic research capabilities and product potentials."*

Regarding Brazilian associations, it is observed that some associations mention innovation or technological development but do not mention University:

> *ABIFINA understands that technology, industrial, and foreign trade policies are part of an integrated system, with impacts on economic development as a whole. Based on this principle, ABIFINA elaborates studies and technical documents to build positions and negotiate issues with the Executive, Legislative, and Judiciary spheres, on technological innovation, intellectual property, defense of the internal market, access to external markets, rules of origin and non-tariff barriers on foreign trade.*
>
> *(...) The entity's strategic agenda covers issues such as innovation, local manufacturing, access to internal markets, foreign trade, intellectual property and productive investment. Observant of the latest technology trends, ABIFINA has been actively involved, in the last years, in technical and regulatory issues in biotechnology. (source: ABIFNA, our translation)*

For example, ALANAC

> *"to find solutions for genuine Brazilian laboratories' problems, and to establish interaction of companies in the sector with governmental authorities, consumer market, suppliers, and society to discuss, in a broad and transparent manner, issues such as regulatory affairs, clinical research, access to health, biotechnology, pharmacovigilance, manufacturing best practices, among others, with the aim to further develop Brazilian laboratories, collaborating to find solutions to improve public healthcare in the country"*

These sections indicate several concerns about regulatory issues and investment attraction and export.

Another indicative is mentioning new company generation in universities. Academic spin-offs are presented as the sole way to enable new technology conversion into products and processes in specific technological areas (Shane, 2004). One such area is biotechnology, very relevant for the mentioned industries. For example, PhRMA (Pharmaceutical Research and Manufacturers of America), one benchmark associations in its report "Profile 2014":

> *"biopharmaceutical companies contributed more than $1.7 billion in support of biotech start-ups."*

Moreover, from UK Bioscience:

> *"The BIA is at the forefront of UK bioscience, serving as its voice, connecting individuals and organizations, from SMEs, including innovative start-ups, to multi- national companies, helping to shape the future of the sector."*

Although benchmark associations present a small percentage of references in the Medical, Materials, and Industrial Chemistry industries, Brazilian associations present no references. For this reason, it is possible to affirm that this is a clear indication of limited conscience about the reality of these industries. These data indicate the low maturity of the analyzed Brazilian industries regarding university-industry interaction compared to Benchmark associations.

Considering these results, several pieces of evidence to answer the previously defined research question were collected. Results indicate that there is emerging conscience in Brazilian strategic industries about universities as a useful technology source, but not about the role of university spin-off generation as an essential element for technological and industrial development.

The participation of Universities as a member of the Industrial associations appears to be similar to the benchmark associations. The promotion of university-industry interaction as core mission is uncommon either in benchmark associations nor Brazilian associations, but Benchmark associations, in more dynamic industries, always mention universities as a source of technological service (by various technology transfer mechanisms), a situation which was not observed in the Brazilian reality. Hence, data shows that the connection between Universities and Brazilian universities has yet to be improved.

6 FINAL CONSIDERATIONS

The analysis revealed that industrial associations' websites are useful as a data source for content analysis, to initiate a diagnosis and promote discussion regarding University-industry interaction valorization by industry, at least for industries without monopoly. However, some limitations (and, hence, research bias) of using this data source must be mentioned. Some benchmark associations are located in countries where neither English nor Portuguese is the native language, and, thus it is not the language used to communicate with its associates. Consequently, the English version of the web page can present less information than the version in its native language.

Although this paper presents results based on preliminary data, this provided information for further discussion while offering some directives to improve University-Industry interaction processes, in public policy as well as at the technology transfer office level. In the triple helix view of innovation, industrial associations are considered public agencies, with the role to establish connections between companies, not only for lobby purposes for tax reduction or governmental incentives but also as innovation intermediaries, connecting companies and other agents in the innovation systems. University as a source of technological innovation is evident to chemical, biotechnology, and pharmaceutical industries. Data from benchmark associations of these industries clearly represent these concerns. Obtained data shows that Brazilian industrial associations are concerned with innovation issues, but apparently in a different way than the benchmark associations. Brazilian medical industrial complex, industrial chemistry, electronics, materials and information technology present less conscience and valuation of University as a potential source of innovation.

Some unanswered questions that emerge for future study comprise: Why do some Brazilian chemical and medical industry associations not consider University technological sources? How may institutional rules and incentives make industrial associations more active in the dissemination of triple helix view to effectively promote industrial competitiveness? What are the reasons for these differences? Is it immaturity of companies and associations? Alternatively, the shortcomings in the university's technology transfer processes, which lead companies and associations not to value or to undervalue interaction with the University?

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DIAGNÓSTICO DA VALORIZAÇÃO DA INTERAÇÃO UNIVERSIDADE-EMPRESA POR ASSOCIAÇÕES INDUSTRIAIS: AVALIAÇÃO BASEADA EM WEBSITE DAS ASSOCIAÇÕES

RESUMO: Este trabalho tem como objetivo identificar maneiras como empresas e universidades podem interagir entre si e a importância atribuída por empresas a este tipo de interação. Especificamente, busca compreender em que medida se aborda a interação universidade-empresa, comparando a indústria brasileira àquela de países desenvolvidos. Utilizamos uma abordagem exploratória qualitativa, especificamente a análise de conteúdo e as páginas na internet de associações industriais como fonte de dados. Resultados indicam que existe, em setores estratégicos da indústria brasileira, uma conscientização emergente a respeito da universidade como uma fonte de tecnologia útil, mas não sobre o papel da geração de empresas spin-off como um elemento essencial para o desenvolvimento tecnológico e industrial. A participação de universidades como membros de associações industriais parece ser similar à de associações benchmark. A promoção da interação universidade-empresa como missão é um tanto incomum, tanto entre as associações benchmark ou brasileiras, mas as associações benchmark em indústrias mais dinâmicas sempre mencionam universidades como uma fonte de serviços tecnológicos (por diversos mecanismos de transferência de tecnologia), uma situação não observada na realidade brasileira. Os dados mostram, portanto, que a conexão entre universidades e associações brasileiras ainda precisa melhorar. Os resultados também sugerem que o complexo industrial da saúde, a indústria química, eletroeletrônica, de materiais e de tecnologia da informação apresentam menor conscientização e valorização da universidade como potencial fonte de inovação, em comparação com o benchmark internacional.

Palavras-chaves: Universidade. Indústrias dinâmicas. Associação Industrial. Transferência de tecnologia. Incubação de empresas.

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APPENDIX – ANALYZED INDUSTRIAL ASSOCIATION WEBSITES

ABCERAM Associação Brasileira de Cerâmica. Available at: http://www.abceram.org.br/site/ accessed in january 2015.

ABESPEtro Associação das Empresas de Serviços de Petróleo. Available at: http://www.abespetro.org.br/ accessed in january 2015.

ABIFINA Associação Brasileira das Indústrias de Química Fina, Biotecnologia e suas especialidades. Available at: http://www.abifina.org.br/ accessed in january 2015.

ABIHPEC Associação Brasileira da Indústria de Higiene Pessoal, Perfumaria e Cosméticos. Available at: https://www.abihpec.org.br/ accessed in january 2015.

ABIMAQ Associação Brasileira da Indústria de Máquinas e Equipamentos. Available at: http://www.abimaq.org.br/ accessed in january 2015.

ABINEE Associação Brasileira da Indústria Elétrica e Eletrônica. Available at: http://www.abinee.org.br/ accessed in january 2015.

ABIQUIFI Associação Brasileira da Indústria Farmoquímica e de Insumos Farmacêuticos. Available at: http://abiquifi.org.br/ accessed in january 2015.

ABIQUIM Associação Brasileira da Indústria Química. Available at: http://www.abiquim.org.br/home/associacao-brasileira-da-industria-quimica accessed in january 2015.

ABM Associação Brasileira de Metalurgia, Materiais e Mineração. Available at: http://www.abmbrasil.com.br/ accessed in january 2015.

ABPI The Association of the British Pharmaceutical Industry. Available at: http://www.abpi.org.uk/Pages/default.aspx accessed in january 2015.

ABPOL Associação Brasileira de Polímeros. Available at: http://www.abpol.com.br/ accessed in january 2015.

ABRACI Associação Brasileira de Circuitos Impressos. Available at: http://www.abraci.org.br/ accessed in january 2015.

ACC American Chemistry Council. Available at: http://www.americanchemistry.com/ accessed in january 2015.

ALANAC Associação dos Laboratórios Farmacêuticos Nacionais. Available at: http://www.alanac.org.br/ accessed in january 2015.

ASSESPRO Associação das Empresas de Tecnologia da Informação, Software e Internet. Available at: http://assespro.org.br/ accessed in january 2015.

BIA The UK Bioindustry Association. Available at: http://www.bioindustry.org/home/ accessed in january 2015.

BIO Biotechnology Industry Organization. Available at: https://www.bio.org/ accessed in january 2015.

CompTIA The IT Industry Trade Association. Available at: http://www.comptia.org/ accessed in january 2015.

EBE European Biopharmaceutical Enterprises. Available at: http://www.ebe-biopharma.eu/ accessed in january 2015.

EFPIA European Federation of Pharmaceutical Industries and Associations. Available at: http://www.efpia.eu/ accessed in january 2015.

IBP Instituto Brasileiro de Petróleo, Gás e Biocombustíveis. Available at: http://www.ibp.org.br/ accessed in january 2015.

INTERFARMA Associação da Indústria Farmacêutica de Pesquisa. Available at: http://www.interfarma.org.br/ accessed in january 2015.

IPDFARMA Instituto de Pesquisa e Desenvolvimento de Fármacos e Produtos Farmacêuticos. Available at: http://ipd-farma.org.br/ accessed in january 2015.

ITRS The International Technology Roadmap for Semiconductors. Available at: http://www.itrs.net/ accessed in january 2015.

Japan Bioindustry Association. Available at: http://www.jba.or.jp/pc/en/ accessed in january 2015.

JPMA Japan Pharmaceutical Manufacturers Association. Available at: http://www.jpma.or.jp/english/ accessed in january 2015.

Oil & Gas UK The UK Oil and Gas Industry Association Limited. Available at: http://www.oilandgasuk.co.uk/ accessed in january 2015.

PHRMA Pharmaceutical Research and Manufacturers of America. Available at: http://www.phrma.org/ accessed in january 2015.

SIA Semiconductor Industry Association. Available at: http://www.semiconductors.org/ accessed in january 2015.

SIRIJ Semiconductor Industry Research Institute Japan. Available at: http://www.sirij.jp/index_e.html accessed in january 2015.

Tech UK Information Technology Telecommunications and Electronics Association. Available at: https://www.techuk.org/ accessed in january 2015.