Atena
Editora
Ano 2021

Ernane Rosa Martins
(ORGANIZADOR)

Ciência, tecnologia e inovação:

2

Fatores de progresso e de desenvolvimento

Atena
Editora
Ano 2021

Ernane Rosa Martins
(ORGANIZADOR)

Ciência, tecnologia e inovação:

2

Fatores de progresso e de desenvolvimento

Editora chefe
Profª Drª Antonella Carvalho de Oliveira
Editora executiva
Natalia Oliveira
Assistente editorial
Flávia Roberta Barão
Bibliotecária
Janaina Ramos
Projeto gráfico
Natália Sandrini de Azevedo
Daphynny Pamplona
Camila Alves de Cremo
Luiza Alves Batista
Maria Alice Pinheiro
Imagens da capa
iStock
Edição de arte
Luiza Alves Batista

Atena Editora
Ano 2021

Ciências Humanas e Sociais Aplicadas

Atena Editora
Ano 2021

Ciência, tecnologia e inovação: fatores de progresso e de desenvolvimento 2

Diagramação: Maria Alice Pinheiro
Correção: Amanda Costa da Kelly Veiga
Indexação: Gabriel Motomu Teshima
Revisão: Os autores
Organizador: Ernane Rosa Martins

Dados Internacionais de Catalogação na Publicação (CIP)

C569 Ciência, tecnologia e inovação: fatores de progresso e de desenvolvimento 2 / Organizador Ernane Rosa Martins. – Ponta Grossa - PR: Atena, 2021.

Formato: PDF
Requisitos de sistema: Adobe Acrobat Reader
Modo de acesso: World Wide Web
Inclui bibliografia
ISBN 978-65-5983-600-0
DOI: https://doi.org/10.22533/at.ed.000212010

1. Ciência. 2. Tecnologia. 3. Inovação. I. Martins, Ernane Rosa (Organizador). II. Título.

CDD 601

Elaborado por Bibliotecária Janaina Ramos – CRB-8/9166

Atena Editora
Ponta Grossa – Paraná – Brasil
Telefone: +55 (42) 3323-5493
www.atenaeditora.com.br
contato@atenaeditora.com.br

Atena Editora
Ano 2021

DECLARAÇÃO DOS AUTORES

Os autores desta obra: 1. Atestam não possuir qualquer interesse comercial que constitua um conflito de interesses em relação ao artigo científico publicado; 2. Declaram que participaram ativamente da construção dos respectivos manuscritos, preferencialmente na: a) Concepção do estudo, e/ou aquisição de dados, e/ou análise e interpretação de dados; b) Elaboração do artigo ou revisão com vistas a tornar o material intelectualmente relevante; c) Aprovação final do manuscrito para submissão.; 3. Certificam que os artigos científicos publicados estão completamente isentos de dados e/ou resultados fraudulentos; 4. Confirmam a citação e a referência correta de todos os dados e de interpretações de dados de outras pesquisas; 5. Reconhecem terem informado todas as fontes de financiamento recebidas para a consecução da pesquisa; 6. Autorizam a edição da obra, que incluem os registros de ficha catalográfica, ISBN, DOI e demais indexadores, projeto visual e criação de capa, diagramação de miolo, assim como lançamento e divulgação da mesma conforme critérios da Atena Editora.

Atena Editora
Ano 2021

DECLARAÇÃO DA EDITORA

Ciências Humanas e Sociais Aplicadas

Atena Editora
Ano 2021

APRESENTAÇÃO

A presente obra tem como proposito ser um guia aos estudantes e profissionais de diversas áreas, auxiliando-os em diversos assuntos relevantes, fornecendo a estes novos conhecimentos para poderem atender as necessidades das organizações.

Deste modo, esta obra reúne debates e análises acerca de questões relevantes, tais como: indicadores de desempenho para monitoramento e medição do planejamento e desenvolvimento de produtos de vestuário; metodologia para a execução de testes em um ambiente de integração contínua (IC); forma eficiente e inteligente entre a comunicação do usuário do aplicativo de saúde com vítima e unidades de pronto atendimento de saúde e hospitais; roadmap do mercado cervejeiro, com foco na etapa de mosturação da fabricação de cerveja, de modo a diagnosticar a situação atual e apresentar tendências, por meio da construção de cenários futuros; discussão a respeito da relação das mulheres com a Ciência, em particular Marie Curie e Chien-Shiung Wu; uso da Inteligência Competitiva (IC) para o desenvolvimento de um modelo de negócios por meio de um tripé formado pela criação, configuração e apropriação de valor no segmento de Baby Shops; modelo de fundação para máquinas rotativas sob cargas dinâmicas e vibrações em arranque transitório e funcionamento contínuo, restringindo o seu modo de vibração usando três heurísticas diferentes; projeto “Pneumática Interativa” que tem como objetivo facilitar o aprendizado da pneumática básica para alunos da área de eletrotécnica, através de material interativo; Revisão Sistemática da Literatura (RSL), que pretende apresentar os estudos existentes sobre Geometria Espacial entre os anos 2015 e 2020; a influência do jogo de xadrez ao longo da história de vida da famosa Phiona Mutesi;

Nesse sentido, esta obra apresenta enorme potencial para contribuir com análises e discussões aprofundadas sobre assuntos relevantes, podendo servir de referência para novas pesquisas e estudos. Agradecemos em especial aos autores dos capítulos, e desejamos aos leitores, inúmeras e relevantes reflexões sobre as temáticas abordadas.

Ernane Rosa Martins

SUMÁRIO

CAPÍTULO 9

PATENTOMETRY: A DATA ANALYSIS PROCESS AS A FUNDAMENTAL TOOL FOR THE INNOVATION MANAGEMENT IN SCIENCE AND TECHNOLOGY INSTITUTIONS

Data de aceite: 01/10/2021
Data de submissão: 05/07/2021

Raphael da Silva Nascimento
Universidade Federal de Minas Gerais, Instituto de Ciências Biológicas, Departamento de Fisiologia e Biofísica, Belo Horizonte – MG - Brazil
http://lattes.cnpq.br/7385380355525722

Marcelo Gomes Speziali
Universidade Federal de Ouro Preto, Instituto de Ciências Exatas e Biológicas, Departamento de Química, Ouro Preto – MG – Brazil
http://lattes.cnpq.br/7307092459450276

ABSTRACT: The technology transfer process allows transferring the technologies created in Science and Technology Institutes to those interested in exploring them commercially or using them in internal processes, contributing to technological and economic development. Due to the increase in the volume of technology transfers and the need to manage the intellectual property generated in the Research & Development Institutes, the Technology Transfer Office figure emerges. A study was carried out analyzing three Science and Technology Institutes from universities in Minas Gerais - Brazil, represented by their Technology Transfer Offices (TTOs). Through the analysis of data contained in patents, a technical overview of these Institutes was carried out. This study proposed applying a patinformatic model to support Science and Technology Institutes to increase patent management maturity. With the model, an application was possible: to detail the technological predominance, measure indices for the technology transfer process and licensing success, get a co-development overview, and establish a technology comparison between institutes. This work proposes using patentometry to help decision-makers regarding the technological priority areas, market, strategic evaluation, attracting partners for co-development and licensing, optimizing the allocation of resources and efforts.

KEYWORDS: Patent information; technology transfer office; innovation management; intellectual property; science and technology institutes.

PATENTOMETRIA: O PROCESSO DE ANÁLISE DE DADOS COMO FERRAMENTA FUNDAMENTAL PARA A GESTÃO DA INOVAÇÃO NOS INSTITUTOS DE CIÊNCIA E TECNOLOGIA

RESUMO: O aumento do volume de transferências de tecnologia e da necessidade de gestão da propriedade intelectual nos Institutos de Ciência e Tecnologia fez surgir a figura do Núcleo de Inovação Tecnológica (NIT). Devido à importância destes Institutos na tríplice hélice, sua interação com empresas ea contribuição tecnológica para o país, este estudo aplicou um modelo de análise patentométrica em três Instituições do estado de Minas Gerias. Como resultado foram obtidos: detalhamento da predominância tecnológica, índices de sucesso

do processo de transferência de tecnologia e licenciamento e parâmetros de comparação tecnológica. Este trabalho propõe a utilização da patentometria como ferramenta de suporte aos Institutos, na gestão do portfólio e aumento da maturidade em gestão da propriedade intelectual. Ao final, o trabalho mostra que a patentometria pode auxiliar tomadas de decisões quanto ao desenvolvimento tecnológico de áreas prioritárias, movimentação de mercado, captação de parceiros, otimização de recursos e esforços, e transferência de tecnologia.
PALAVRAS - CHAVE: Patentometria; Núcleo de Inovação Tecnológica; Gestão da Inovação; Propriedade Intelectual; Institutos de Ciência e Tecnologia.

1 I INTRODUCTION

According to WIPO,[1] 3.2 million patent applications were filed worldwide in 2019. If we consider that all patent documents had at least 16 INID codes, in 2019, at least 51.2 million patent data were available on the web. As the number of PCTs continued to grow in 2020[1], the filing of local patents is expected to increase.

Patent's database is an essential source for new developments and research. The use of patent information can assist economic growth through data-driven R&D, in addition to providing subsidies for better decision-making and innovation strategies. Analyzes carried out based on patent data generate patent intelligence, transforming the content in patents into technical, commercial, and legal information (ARISTODEMOU; TIETZE, 2018; ASCHE, 2017; PARK; KIM; CHOI; YOON, 2013).

A significant part of the technology generated and protected in Brazil has its origin in research carried out by Science and Technology Institutions (STI)[2]. Despite its importance, the effective use of analysis based on patent information is poorly explored by STIs. It is an area of recent studies in Brazil. Discussions on that topic date from the eighties and have reduced literature (CALZOLAIO; MATEI; POHLMANN; MENDINA *et al.*, 2018; TANAKA; INUI, 2016; TEIXEIRA, 2013). For Abbas, Zhang and Khan (2014), patent research as a helpful tool has not yet been fully explored in the literature. However, some methods for this have been reported.

STIs assume the role of spillover the knowledge generated in their laboratories, having one of the most critical goals in strategic plans - the commercialization of its developed technologies. The technology transfer from STI to the productive sector is seen as a driving factor for regional economic growth. It means that the technology generated and transferred may results in new revenues for the institution, development opportunities for researchers and students, attracting investments, establishing connections between academia and industries, and creating local jobs (BAGLIERI; BALDI; TUCCI, 2018; BRADLEY; HAYTER; LINK, 2013; CALDERA; DEBANDE, 2010; PHAN; SIEGEL, 2006; WU; WELCH; HUANG, 2015).

STIs must measure their performance to identify and treat the existing bottlenecks

1 Source: https://www.wipo.int/pressroom/en/articles/2021/article_0002.html
2 STI was used as abbreviation of Science and Technology Institutions

in their patent management processes to maximize results. According to Calzolaio *et al.* (2018), there is a lack of STIs in obtaining an analysis of intellectual property records that show their potential in academic knowledge. Quintella *et al.* (2011), Speziali, Guimarães and Sinisterra (2012) affirm that patent data should be studied be demystified and become part of the STIs routine, contributing to innovation management.

Trippe[3] defined the process of transforming patent raw data into relevant managerial information as "patinformatics". Patinformatics is a transdisciplinary approach that, through a multi-stage process, applies methods and tools (mathematics, statistics, computer programming, and operations research) to gain valuable knowledge from data (ARISTODEMOU; TIETZE, 2018; RATURI; SAHOO; MUKHERJEE; TIWARI, 2010). More information concerning the use of patinformatics can be found in the works published by Aaldering, Leker and Song (2019), that traced the technological development trajectory in post-lithium-ion battery technologies, Balconi, Breschi and Lissoni (2004) that used patent analysis as a tool to a business planning based on technical capabilities, and Altuntas, Dereli and Kusiak (2015) that established a forecasting methodology.

In addition to technical and prospective studies, patentometric data analysis is applied by organizations and institutions that rely on this source to define innovation and technology transfer indicators. However, although such metrics help depict results, none pay attention to efficiency measurement. Also, the reports of agencies and organizations that disclose innovation indexes do not have a standardization regarding metrics and indicators, which leads to information ambiguity (CHOUDHRY; PONZIO, 2020). In this context, some authors have developed indicators that allow comparison among institutions and measurement technology transfer performance (CHOUDHRY; PONZIO, 2020; ERNST, 2003; STEVENS; KATO, 2013).

Gusberti *et al.* (2014) point out that "the number of patents is an indicator widely used to compare the performance of countries, companies and research institutions regarding technological development." Other quantitative-based studies use as indicators the staff size, the qualification of a technology manager's team, and the revenue from royalties (CHAPPLE; LOCKETT; SIEGEL; WRIGHT, 2005; DI GREGORIO; SHANE, 2003; HSU; SHEN; YUAN; CHOU, 2015; POWERS, 2003; SIEGEL; VEUGELERS; WRIGHT, 2007; THURSBY; KEMP, 2002). However, other analyses must be considered, such as co-development networks, technological fields, and data contained in patents (BRESCHI; CATALINI, 2010; ERNST, 2003).

The models of patinformatics outline a way for answering a specific objective. However, they are generic in specifying indicators and metrics that can support a patent portfolio's management. On the other hand, studies that address indicators and the performance of organizations are rarely associated with a model of patentometric analysis.

In Brazil and many countries, patentometry is still emerging and necessary within

3 Source: https://www.infotoday.com/searcher/oct02/trippe.htm

Science and Technology Institutions. Therefore, this work proposes a merge of comparative and performance indicators with patentometry, which allows an overview of technologies developed, identification of technological predominance, and establishing parameters of comparison between technological areas and organizations. This model aims to assist institutions in enhancing management practices, using patinformatics to support strategic and managerial definitions, and contributing to the organization being data-driven.

This study was structured in five parts: i) introduction about the subject; ii) the patinformatics model: tasks and tools; iii) description of how the model was applied in the institutions; iv) discussion of the results obtained by applying the model; v) conclusion.

2 | THE PATINFORMATICS MODEL: TASKS AND TOOLS

The use of patent data analysis by STIs is closely related to its potential to help minimize and mitigate process disconnections, improve the management model, and monitor indicators. Also, it can be used to support innovation policies and innovation programs. However, patinformatics is a recent subject date to the 1950s in the USA and 1980s in Brazil, which has limited literature (TEIXEIRA, 2013). For Abbas *et al.* (2014), the use of patent data analysis has not yet been fully explored by researchers. However, some methods for this have been reported.

Moehrle *et al.* (2010) divided the patinformatics process into three main stages: i) pre-processing – data collect, treatment, and cleaning data to provide a high quality, correctness and completeness data to analyses; ii) patent analysis - consists of using different methods to obtain insights from information, in this stage non-text analysis and text analysis can be used; iii) discovered knowledge – in this stage, the aim is to provide analytics results of high quality, measurements, and visualizations of the obtained information. Abbas, Zhang and Khan (2014) propose a similar process to perform the patent data analysis, divided into three stages: pre-processing, processing, and post-processing. The first stage is to define the database, recovered it, and structured it into tables. A text mining analysis based on the subject-action-object relationship is proposed in the second stage, aiming to establish standards for future analysis.

In the third stages, Moehrle is more synthetic at the end of the process while Abbas defines that the approach to be applied in the last stage will depend on the objectives of the patentometric study. Abbas's third stage presents a series of analyses to support decisions, which will vary according to the purpose. Some feasible approaches based on the methodologies include trend analysis, technology forecasting, technology roadmapping, and others.

The model proposed in this paper uses the generic base of Abbas and Moehrle to guide the composition of the database and treatment. However, it distances itself from the models when suggesting comparative indicators of IP (ERNST, 2003), network analysis, and data analytics (TRIPPE, 2003). The general process is divided into four stages: 1) Define; 2) Treatment, Cleaning, and Clustering; 3) Indicators, 4) Business Intelligence Features Tools (*c.f.* Figure 1). Like Moehrle *et al.* (2010), the proposed process is linear for didactic reasons. However, the interactions among the steps may exist to improve the analysis.

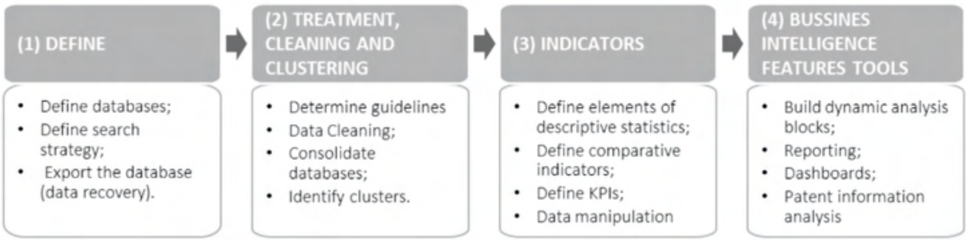

Figure 1: Proposed method to be applied by STIs

The described model was applied to investigate the main technological field in three different STIs, its technical co-development networks, frequencies and the average number of publications and licensing of the technologies, the success rate of licensing, and national or international joint intensity ownership. Microsoft Excel® was used to compile and process data, analyze descriptive statistics, and create data clusters, pivot tables, queries (Power Query), and comparative tables. The Gephi® software was used to analyze co-development networks.

3 | APPLICATION OF THE MODEL

The model was applied in three STIs located at Minas Gerais State – Brazil, chosen according to the number of patents filed with the INPI (National Institute of Industrial Property) and their relative position in the number of transfers/licenses communicated to the Intellectual Property Association of Minas Gerais (RMPI). In the INPI accumulated (2000-2017) ranking, five universities from Minas Gerais are among the 30's main patents assignees: Federal University of Minas Gerais - UFMG (3rd), Federal University of Viçosa – UFV (14th), Federal University of Uberlândia (19th), Federal University of Juiz de For a – UFJF (18th) and Federal University of Lavras – UFLA (30th).

The technologies licensed ranking from RMPI showed that UFMG (102), UFV (45), and UFJF (12) held together 82.4% of the accumulated percentage of total technologies licensed by Minas Gerais universities between the 2009 and May / 2019. Therefore, in this study, those universities (STIs) were analyzed and discussed.

4 I RESULTS AND DISCUSSION

4.1 Technological Profile

The patent applications time series for UFMG, UFV, and UFJF are depicted in Figure 2. The sharp drop observed for those institutions in 2014 could be associated with the contingency in funds that the Brazilian universities were submitted from that year. This dropping in 2014 was a national trend, as observed in INPI reports (INPI, 2018). However, there is a new ascendancy in 2015, reaching a peak in 2016 (the year it was enacted in Brazil, the New Legal Act for Science, Technology, and Innovation).

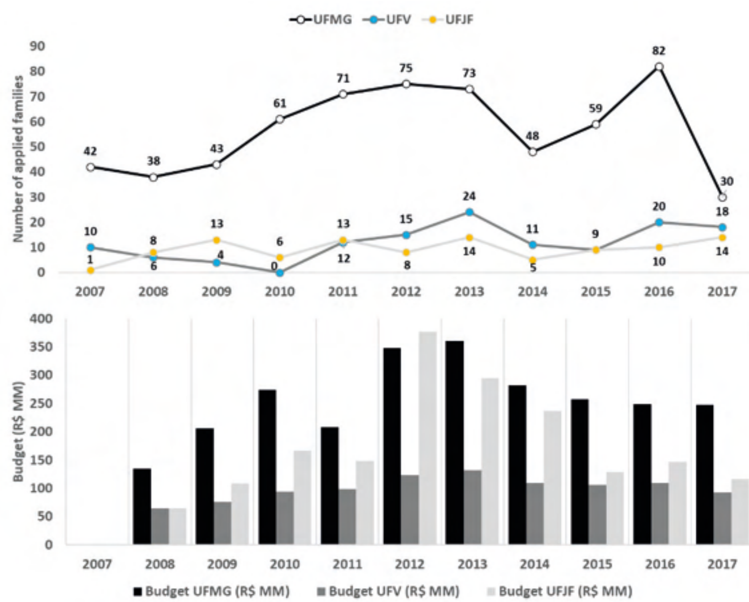

Figure 2: Upper line graph - Time series for applied patent families; Underside bar graph - Federal funding for universities by the Brazilian Ministry of Education (source: Ministry of Education published by G1 website - https://g1.globo.com accessed in 01/08/2020).

To get a technical overview from the STI's, the hierarchies of the IPCs were analyzed down to the subclass level, where it is possible to identify its technological role. For each IPC level studied (*c.f.* Table 1) were used: i) pivot tables and dynamic graphs; ii) Pareto's principle to emphasize the technological predominance; iii) top five concentrations.

Analyzed Items	UFMG	UFV	UFJF
(i) Number of applied patent families	622	139	101
(ii) Number of technological fields (IPC)*	1,995	390	228
(iii) Number of distinct IPC	1,141	238	192
(iv) Number of distinct IPC classes	75	33	33
(v) Number of distinct IPC subclasses	189	72	66
(vi) Main IPC sections**	**A (42.6%)** **C (28.1%)** G (12.2%)	**A (46.4%)** **C (36.9%)** B (9.5%)	**A (50.4%)** **C (17.0%)** G (16.1%)
(vii) Main IPC classes	**A61 (35.3%)** **C07 (9.5%)** **G01 (8.9%)** **C12 (7.7%)** B01 (4.0%)	A61 (23.6%) A01 (11.3%) C12 (11.0%) A23 (11.0%) C07 (10.0%)	A61 (42.8%) G01 (11.0%) C07 (7.2%) A01 (6.4%) C12 (4.2%)
(viii) Main IPC subclasses	**A61K (17.4%)** **A61P (9.9%)** G01N (6.7%) C12N (4.8%) C07K (4.7%)	**A61K (13.3%)** **A61P (10.0%)** C12N (8.5%) A01N (6.2%) A23L (5.4%)	**A61K (19.9%)** **A61P (13.1%)** G01R (5.1%) C07C (4.2%) A01N (4.2%)

Table 1 – Technology Concentration of STIs

Source: Derwent Innovation Index and Espacenet (EPO)

Note: items vi, vii, and viii are relative to the number of non-distinct IPC (ii).

*count of equal (not distinct) IPC

** A – Human Necessities; B - Performing Operations; Transporting; C – Chemistry and Metallurgy; G – Physics.

The main IPC section does not make clear the technological difference between STIs. This similarity remains at the hierarchical levels below, so it is necessary to narrow the characterization of IPC to obtain the technological predominance present in the patent portfolio.

When decomposing the UFMG subclass A61K, it is possible to notice a dispersion of technological fields, denoting the diversity of research and new technologies developed in these knowledge areas. Around 8% of the A61K subclass is distributed, in order of predominance: A61K 39/008 (medicinal preparations containing antigens or antibodies, leishmania antigens) and A61K 9/127 (medicinal preparations characterized by special physical forms, liposomes). On the other hand, subclass A61P has a slight predominance (27%) of two levels: A61P 33/02 (antiparasitic agents, antiprotozoal) and A61P 35/00 (antineoplastic agents).

A breakdown of the UFV's A61K and A61P subclasses does not show a technological concentration. The first item in each field represents less than 1.5%. Therefore, it can be inferred that there are transdisciplinary and collaboration among areas in developing technologies, mainly those focused on plants and biotechnology for agriculture.

For the UFJF, 19.15% of occurrences in the sphere of A61K are found in three areas of technological knowledge: i) A61K 127/00 (medicinal preparations containing indeterminate materials derived from algae, lichens, fungi or plants, or derivatives thereof - containing or obtained from leaves); ii) A61K 9/51 (medicinal preparations characterized by special physical forms – nanocapsules); iii) A61K 36/185 (medicinal preparations containing indeterminate constitution materials derived from algae, lichens, fungi or plants, or derivatives thereof - Magnoliopsida (dicots). In the A61P field, 25.8% of the technologies classified in this subclass are concentrated in two areas: i) A61P 29/00 (non-central, antipyretic, or anti-inflammatory analgesic agents, e.g., antirheumatic agents; non-steroidal anti-inflammatory drugs); ii) A61P 35/00 (antineoplastic agents).

Although the institutions have their history and reputation in research, the analysis shows an overlap of the technological aptitude of the institutions. Because they are institutions belonging to the same state and which are physically close, some points can be inferred as negatives impacts on local technological development: i) similar R&D can generate competition for financial resources from the local innovation promotion agency; ii) similar research with different technological levels may indicate a waste of resources by efforts already made; iii) there may not be communication or partnership for co-development.

4.2 Comparative analysis among STI's

The analysis was composed of indicators adapted from the study published by Ernst (2003). A synthesis of the leading indicators of the institutions was elaborated (*c.f.* Table 2), considering the interval between the years 2007 and 2017.

[ID]	Indicators	UFMG	UFV	UFJF
(4)	The total number of patent families filed	622	139	101
(5)	Co-ownership intensity	0.339 (211)	0.547 (76)	0.336 (34)
(6)	Technological scope (focus)	75	33	33
(7)	International scope (triadic US, JP, EP)	27	5	0
(8)	% Number of families with development involving STI and research support foundations (RSF)	18.33% (114)	35.97% (50)	19.80% (20)
(9)	% Number of families with development involving STI and others STI	19.45% (121)	20,89% (36)	12.87% (13)
(10)	% Number of families with development involving STI and firms	5.79% (36)	6.47% (9)	6.93% (7)
(11)	Number of technology licensing contracts	98	20	12
(12)	(12) Number of licensed technologies (patent family)	36	4	5

(13)	Licensing success rate (LSR)	0.0579 (5.78%)	0.0287 (2.87%)	0.0495 (4.95%)
		Global LSR = 0,0606 (6,06%)		

Table 2 – Comparative indicators among STI's patent portfolio

Source: Adapted from Ernst (2003)

An essential dynamic for successfully transferring technologies and STI advancement is the interaction between academia - companies. The global LSR (total of licensed technologies [12] divided by the sum of patent families filed [4]) can be considered low, and it was verified in the collaboration networks elaborated for each institution.

Applied patents by UFMG have 93 partners, of which 50.5% were classified as STI, followed by companies (24.2%), individual inventors (12.6%), foundations in general/public agencies (8.4%), and research support foundations (RSF) (3.1%). The UFV portfolio has 29 technological development partners divided into STIs (61.3%), companies (22.6%), individual inventors (9.7%), foundations in general/public agencies (3.2%), and research support foundations (RSF) (3.22%). When observing the collaboration networks for the UFJF portfolio, it appears that a significant part of the applied patent families was developed without the involvement of third parties. Throughout history, 23 organizations interacted with UFJF for technological co-development, the vast majority of which are STI (60.9%), companies (26.09%), foundations in general/public agencies (8.7%), and research support foundations (RSF) (4.35%).

However, the number of partners is not reflected in the institutions' co-development panorama. In addition to the numerical analysis of the number of co-developers, the network analysis indicates a predominance in the relations established between universities and the Minas Gerais Research Foundation (FAPEMIG). The Foundation's internal policy can explain the presence of FAPEMIG as a co-holder of most technologies developed by universities because all projects financed by FAPEMIG imply its co-ownership. In contrast, university-company interactions [10] presented low recurrence or interactions, which may have directly impacted the performance of the STIs in the technology transfer rate [13].

Regarding the triadic patents,[4] documents filled between 2007 and 2017 were analyzed for each STI. The UFMG has licensed thirty-six technologies that had a total of 54 applications: 36 in Brazil and 18 in other countries, especially Japan (2 applications), the USA (7 applications), and Europe (5 applications). Three of those technologies were jointly owned by companies, three with FAPEMIG, and one with an individual researcher. The UFV licensed 11 technologies simultaneously, totaling 25 applications; ten applications were applied in Brazil and 15 in other countries (triadic USA= 2, Japan=0, Europe= 2). FAPEMIG was involved in only two of those technologies. Regarding the UFJF scenario, four

4 OECD Triadic Concept: https://data.oecd.org/rd/triadic-patent-families.htm

technologies were licensed, and all applications were done in Brazil. Only one technology was developed in partnership with third parties (company).

The technology transfer points to a scenario in which there is a disparity in the commercialization of technologies developed in the universities when the number of agreements is analyzed isolated. In this perspective, UFMG presented a number considerably above those exhibited by UFV and UFJF. Friedman and Silberman (2003), Lach and Schankerman (2004) reports in their studies a relationship between the efficiency gain in the number of licenses and the experience acquired over the years by STI in management technology transfer. According to Junior (2013), UFMG is one of the first universities to introduce patent provisions in its internal regulations, which occurred in 1977. The temporal evolution allowed UFMG to mature and better define its internal processes and procedures in its organizational structure. Currently, UFMG is seen as a benchmark by other universities in Minas Gerais Estate and a case of national success, together with Unicamp – São Paulo and USP – São Paulo.

5 | CONCLUSIONS

This paper presents an alternative patentometry framework that STIs can use to support managerial and strategic decisions in the patent portfolio. This framework can be summarized in four strands of information: i) overview of the institution’s technological predominance; ii) comparative analysis of research and development (R&D); iii) support networks for co-development or technological commercialization; iv) measurement of the performance of the patent management and technology transfer process.

The view of technological predominance showed that the information from the IPCs contained in patents can be a critical element to support innovation and development policies. However, this analysis points out technological spheres that can bring more significant benefits to the institutions, which are not being explored well. On the other hand, the proposed analysis model assists in identifying technological points of interest within the patent´s portfolio that promote lower benefits than patent maintenance and R&D costs.

The comparative analysis allowed a panoramic overview of the technological share and similarities of developments. In the studied cases, a predominant partnership among universities at the expense of collaboration among universities – companies were detected. In this sense, R&D redundancies could be seen among institutions that receive financial support from Foundations. In addition, the networks analysis and interaction indicators set a pathway to identify strong and weak ties in the relationship, establish ways of diversifying partnerships and technological commercialization, measure the impact of development redundancies on the same link in the network.

Performance measurement allows the institution to discuss improvements in its innovation process to maximize the financial return generated by technological transfer (licensing) or exploitation. It is estimated that the performance analysis can be associated with valuation methods in the composition of an analysis of the patent portfolio.

This work shows the technological landscape for specific Brazilian STIs, identifying similarities and discrepancies and its R&D network. Thus, the findings in the studied cases can be applied in any institution that develops technology and needs to manage better the IP portfolio and the performance of the innovation process.

However, the discussion of patinformatics models is far from wholly resolved. This relatively new topic attracts even more researchers who use data to solve complex issues and seek a data-driven mindset for better performance of processes and decisions. Thus, the model presented uses patent information and may have natural limitations. It is an alternative proposition that should mature over time for future applications, including other types of IP protection.

In addition, this work highlights the importance of technological development in Brazilian STIs. It guides the local technological development regarding the specialization in some areas of knowledge explored by R&D&I institutions, contributing to new actions and policies to encourage science, technology, and innovation. Finally, it is expected that this paper can broaden the debate on applying patent information (patentometry) as strategic support for the decision and management of the technology's portfolio, being a supplementary model for the management of IP in STIs.

ACKNOWLEDGMENTS

The authors acknowledge the post-graduation program in Technological Innovation and Intellectual property and UFMG, UFV, and UFJF TTOs for the valuable discussions.

REFERENCES

AALDERING, L. J.; LEKER, J.; SONG, C. H. Analysis of technological knowledge stock and prediction of its future development potential: The case of lithium-ion batteries. **Journal of Cleaner Production**, 223, p. 301-311, 2019.

ABBAS, A.; ZHANG, L.; KHAN, S. U. A literature review on the state-of-the-art in patent analysis. **World Patent Information**, 37, p. 3-13, 2014.

ALTUNTAS, S.; DERELI, T.; KUSIAK, A. Forecasting technology success based on patent data. **Technological Forecasting and Social Change**, 96, p. 202-214, 2015.

ARISTODEMOU, L.; TIETZE, F. The state-of-the-art on Intellectual Property Analytics (IPA): A literature review on artificial intelligence, machine learning and deep learning methods for analysing intellectual property (IP) data. **World Patent Information**, 55, p. 37-51, 2018.

ASCHE, G. "80% of technical information found only in patents" – Is there proof of this [1]? **World Patent Information**, 48, p. 16-28, 2017.

BAGLIERI, D.; BALDI, F.; TUCCI, C. L. University technology transfer office business models: One size does not fit all. **Technovation**, 76-77, p. 51-63, 2018.

BALCONI, M.; BRESCHI, S.; LISSONI, F. Networks of inventors and the role of academia: an exploration of Italian patent data. **Research Policy**, 33, n. 1, p. 127-145, 2004.

BRADLEY, S. R.; HAYTER, C. S.; LINK, A. N. Models and Methods of University Technology Transfer. **Foundations and Trends® in Entrepreneurship**, 9, n. 6, p. 571-650, 2013.

BRESCHI, S.; CATALINI, C. Tracing the links between science and technology: An exploratory analysis of scientists' and inventors' networks. **Research Policy**, 39, n. 1, p. 14-26, 2010.

CALDERA, A.; DEBANDE, O. Performance of Spanish universities in technology transfer: An empirical analysis. **Research Policy**, 39, n. 9, p. 1160-1173, 2010.

CALZOLAIO, A. E.; MATEI, A. P.; POHLMANN, J.; MENDINA, H. J. C. *et al.* Intellectual property (patent) picture of Federal University of Rio Grande do Sul - Brazil. **Brazilian Journal of Management & Innovation**, 6, n. 1, 2018.

CHAPPLE, W.; LOCKETT, A.; SIEGEL, D.; WRIGHT, M. Assessing the relative performance of U.K. university technology transfer offices: parametric and non-parametric evidence. **Research Policy**, 34, n. 3, p. 369-384, 2005.

CHOUDHRY, V.; PONZIO, T. A. Modernizing federal technology transfer metrics. **The Journal of Technology Transfer**, 45, n. 2, p. 544-559, 2020.

DI GREGORIO, D.; SHANE, S. Why do some universities generate more start-ups than others? **Research Policy**, 32, n. 2, p. 209-227, 2003.

ERNST, H. Patent information for strategic technology management. **World Patent Information**, 25, n. 3, p. 233-242, 2003.

FRIEDMAN, J.; SILBERMAN, J. University Technology Transfer: Do Incentives, Management, and Location Matter? **The Journal of Technology Transfer**, 28, n. 1, p. 17-30, 2003.

GUSBERTI, T. D. H.; DORNELES, C.; DEWES, M. d. F.; CUNHA, L. S. Monitoramento da multidisciplinaridade no processo de transferência de tecnologia em uma universidade: proposta de análise de cluster. **RAI Revista de Administração e Inovação**, 11, n. 3, p. 309-322, 2014.

HSU, D. W. L.; SHEN, Y.-C.; YUAN, B. J. C.; CHOU, C. J. Toward successful commercialization of university technology: Performance drivers of university technology transfer in Taiwan. **Technological Forecasting and Social Change**, 92, p. 25-39, 2015.

INPI. **Indicadores de Propriedade Industrial 2018**. 2018. Disponível em: http://www.inpi.gov.br/sobre/estatisticas/arquivos/pagina-inicial/indicadores-de-propriedade-industrial-2018_versao_portal.pdf. Acesso em: 10/07/2020.

JUNIOR, F. R. L. **Comparação entre os métodos Fuzzy TOPSIS e Fuzzy AHP no apoio à tomada de decisão para seleção de fornecedores**. 2013. Master - Escola de Engenharia de São Carlos, Universidade de São Paulo, São Carlos.

LACH, S.; SCHANKERMAN, M. Royalty sharing and technology licensing in universities. **Journal of the European Economic Association**, 2, n. 2-3, p. 252-264, 2004.

MOEHRLE, M. G.; WALTER, L.; BERGMANN, I.; BOBE, S. *et al.* Patinformatics as a business process: A guideline through patent research tasks and tools. **World Patent Information**, 32, n. 4, p. 291-299, 2010.

PARK, H.; KIM, K.; CHOI, S.; YOON, J. A patent intelligence system for strategic technology planning. **Expert Systems with Applications**, 40, n. 7, p. 2373-2390, 2013.

PHAN, P. H.; SIEGEL, D. S. The Effectiveness of University Technology Transfer. **Foundations and Trends® in Entrepreneurship**, 2, n. 2, p. 77-144, 2006.

POWERS, J. B. Commercializing Academic Research: Resource Effects on Performance of University Technology Transfer. **The Journal of Higher Education**, 74, n. 1, p. 26-50, 2003.

QUINTELLA, C. M.; MEIRA, M.; GUIMARÃES, A. K.; TANAJURA, A. S. *et al.* Prospecção Tecnológica como uma Ferramenta Aplicada em Ciência e Tecnologia para se Chegar à Inovação. **Revista Virtual de Química**, 3, n. 5, p. 10, 2011.

RATURI, M. K.; SAHOO, P. K.; MUKHERJEE, S.; TIWARI, A. K. Patinformatics - An Emerging Scientific Discipline. **SSRN Electronic Journal**, p. 35, 2010.

SIEGEL, D. S.; VEUGELERS, R.; WRIGHT, M. Technology transfer offices and commercialization of university intellectual property: performance and policy implications. **Oxford Review of Economic Policy**, 23, n. 4, p. 640-660, 2007.

SPEZIALI, M. G.; GUIMARAES, P. P. G.; SINISTERRA, R. D. Desmystifying Patent Protection in Universities. **Quimica Nova**, 35, n. 8, p. 1700-1705, 2012.

STEVENS, A. J.; KATO, K. Technology Transfer's Twenty Five Percent Rule. **Journal of the licesing executives society international**, XLVIII, n. 1, p. 8, 2013.

TANAKA, Y.; INUI, T. **Preliminary study on why university researchers do not utilize patent information for their academic research in the field of science and engineering in Japan**. 1609-1618, 2016.

TEIXEIRA, L. P. **Prospecção Tecnológica: importância, métodos e experiências da Embrapa Cerrados**. Embrapa. Distrito Federal. 2013.

THURSBY, J. G.; KEMP, S. Growth and productive efficiency of university intellectual property licensing. **Research Policy**, 31, n. 1, p. 109-124, 2002.

TRIPPE, A. J. Patinformatics: Tasks to tools. **World Patent Information**, 25, n. 3, p. 211-221, 2003.

WU, Y.; WELCH, E. W.; HUANG, W.-L. Commercialization of university inventions: Individual and institutional factors affecting licensing of university patents. **Technovation**, 36-37, p. 12-25, 2015.

ÍNDICE REMISSIVO

A

B

C

D

E

F

G

H

I

T

V

X

Atena Editora

Ano 2021

www.atenaeditora.com.br

contato@atenaeditora.com.br

@atenaeditora

www.facebook.com/atenaeditora.com.br

Ciência, tecnologia e inovação:

2

Fatores de progresso e de desenvolvimento

Atena Editora

Ano 2021

www.atenaeditora.com.br
contato@atenaeditora.com.br
@atenaeditora
www.facebook.com/atenaeditora.com.br

Ciência, tecnologia e inovação: 2

Fatores de progresso e de desenvolvimento