Revista Gestão & Tecnologia
e-ISSN: 2177-6652
revistagt@fpl.edu.br
http://revistagt.fpl.edu.br/

CONTRIBUTIONS FROM ENTREPRENEURIAL UNIVERSITIES TO THE REGIONAL INNOVATION ECOSYSTEM OF BOSTON

CONTRIBUIÇÕES DAS UNIVERSIDADES EMPREENDEDORAS PARA O ECOSSISTEMA DE INOVAÇÃO REGIONAL DE BOSTON

CONTRIBUCIONES DE UNIVERSIDADES EMPRESARIALES AL ECOSISTEMA REGIONAL DE INNOVACIÓN DE BOSTON

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Editor Científico: José Edson Lara
Organização Comitê Científico
Double Blind Review pelo SEER/OJS
Recebido em 18.10.2020
Aprovado em 20.01.2021

Abstract

Objective of the study: the objective of this research is to analyze how entrepreneurial universities in the Boston region, USA, contribute to the local innovation ecosystem.

Methodology / approach: used was the qualitative paradigm, classified as a multiple case study and with data collection through semi-structured interviews, document analysis and observation. For analysis used for strategic content analysis.

Originality / relevance: this research aims to contribute to society and dedicate itself to reflecting on the role of the university in modern society. The entrepreneurial universities provided a relevant research field, since this model of academic institution presented economic and social potential for regions where it is located.

Main results: as contributions by universities to the ecosystem: training of technologically selected students; building an entrepreneurial mindset in students; research groups with a multidisciplinary character; collaborative research groups with industries and companies; research groups for requested demands; competitions that include extra-university students; formation of start-ups with business model validation; contribution to economic development through the application of financial resources received and contribution to social development by fostering the development of the region.

Theoretical / methodological contributions: this study helps to identify the elements that make up an entrepreneurial university in a joint analysis of six universities in the Boston region; to characterize Boston's innovation ecosystem, which deals with branding an item for the university segment and to identify the set of actions and infrastructures connected as entrepreneurial universities to the ecosystem.

Keywords: Innovation ecosystem; Entrepreneurial university; University innovation.

Resumo

Objetivo do estudo: o objetivo desta pesquisa é analisar como as universidades empreendedoras da região de Boston, Estados Unidos, contribuem para o ecossistema de inovação local.

Metodologia/Abordagem: utilizou-se do paradigma qualitativo, classificado como um estudo de caso múltiplo e com coleta de dados por entrevistas semiestruturadas, análise de documentos e observação. Para análise utilizou-se de análise de conteúdo categórica.

Originalidade/Relevância: esta pesquisa visa contribuir com a sociedade ao dedicar-se à reflexão do papel da universidade na sociedade moderna. A universidade empreendedora constitui um campo de pesquisa relevante, uma vez que esse modelo de instituição acadêmica tem apresentado potencial econômico e social para as regiões onde está localizada.

Principais resultados: as contribuições das universidades para com o ecossistema: formação de alunos qualificados tecnologicamente; construção de mentalidade empreendedora nos alunos; grupos de pesquisa com caráter multidisciplinar; grupos de pesquisa colaborativas com as indústrias e empresas; grupos de pesquisa para demandas governamentais; competições que englobam alunos extrauniversidade; formação de *start-ups* com validação do

modelo de negócios; contribuição para desenvolvimento econômico por intermédio da aplicação dos recursos financeiros recebidos e contribuição para desenvolvimento social ao fomentar o desenvolvimento da região.

Contribuições teóricas/Metodológicas: este estudo contribui ao identificar os elementos que compõem uma universidade empreendedora em análise conjunta de seis universidades da região de Boston; ao caracterizar o ecossistema de inovação de Boston que trata-se de um *benckmarking* para o segmento universitário e ao identificar o conjunto de ações e infraestruturas que conectam as universidades empreendedoras ao ecossistema.

Palavras-chave: Ecossistema de inovação; Universidade empreendedora; Inovação universitária.

Resumen

Objetivo del estudio: el objetivo de esta investigación es analizar cómo las universidades empresariales de la región de Boston, USA, contribuyen al ecosistema local de innovación.

Metodología / Enfoque: Se utilizó el paradigma cualitativo, clasificado como un estudio de caso múltiple y con recolección de datos a partir de entrevistas semiestructuradas, análisis de documentos y observación. Para el análisis utilizado para el análisis de contenido.

Originalidad / Relevancia: esta investigación tiene como objetivo contribuir a la sociedad y dedicarse a reflexionar sobre el papel de la universidad en la sociedad moderna. La universidade empreendedora proporcionó un campo de investigación relevante, ya que presentaba potencial económico y social para las regiones donde está ubicado.

Resultados Principales: contribuciones de las universidades al ecosistema: capacitación de estudiantes tecnológicamente; construir una mentalidad emprendedora en los estudiantes; grupos de investigación con carácter multidisciplinar; grupos de investigación colaborativos con industrias y empresas; grupos de investigación para las demandas; competiciones que incluyen estudiantes extrauniversitarios; formación de nuevas empresas con validación de modelo de negocio; contribución al desarrollo económico a partir de la aplicación de los recursos financieros recibidos y contribución al desarrollo social mediante la promoción del desarrollo de la región.

Contribuciones teóricas / Metodológicas: este estudio ayuda a identificar los elementos que componen una universidad empresarial en un análisis de seis universidades en la región de Boston; caracterizando el ecosistema de innovación de Boston, que trata de marcar un *benckmarking* para el segmento universitario e identificar el conjunto de acciones e infraestructuras conectadas como universidades empresariales al ecosistema.

Palabras clave: Ecosistema de innovación; Universidad emprendedora; Innovación universitaria.

1 INTRODUCTION

The social changes occurred by the development of science and technology and the need for sustainable development of organizations have provided growth in innovations both at the firm level, as well as at the regional and countries level. This is proven through regional, countries and also economic blocs indicators (Vasconcelos, 2017). As a consequence of the competitive condition of contemporary society and the exponential advance of knowledge and innovation, it is necessary for universities, important institutions that cooperate with the development of knowledge and innovation, to readjust their role in the accomplishment of their social function. It is in this context that the university, in addition to fulfilling its basic missions, it also currently has one more mission: to collaborate for economic and social development. As a consequence of this evolution in the role of universities, the expression "entrepreneurial university" emerged. (Etzkowitz & Zhou, 2017; Centobelli, Cerchione & Esposito, 2019).

Universities as an innovation center present differences in the structure and internal organization of the institution, in the transformation of science, in the ways of financing, in the profile of researchers and in teaching. Universities incorporate entrepreneurial dimensions and the interconnected companies absorb academic dimensions, providing society with socioeconomic development and important competences (Fagerberg, Mowery & Nelson, 2005).

In this study, the research scope is directed to the entrepreneurial university and its participation in this interface, belonging to the system of local innovation which in this research is characterized as an innovation ecosystem, classification resulting from the intrinsic characteristics that make up the innovation system of the region of Boston. The Boston ecosystem is internationally recognized for presenting an innovation center and global entrepreneurship based on knowledge, resulting from the largest concentration of colleges and universities in the world (Mashiter, 2018; Verleun, 2018).

However, the contributions of these entrepreneurial universities to the innovation ecosystem are not clearly known, including companies, research centers, networks, start-ups, etc. The guiding question is: *how do entrepreneurial universities contribute to Boston's innovation ecosystem? The g*eneral objective is to analyze how entrepreneurial universities in the region of Boston, USA, contribute to the local innovation ecosystem.

This research is justified due to Boston's innovation ecosystem being recognized as one of the most active centers of global innovation. The Boston ecosystem is among the five largest start-up ecosystems in the world (Start-up genome, 2019). It is the innovation ecosystem most focused on innovation derived from universities, once there are 74 colleges and universities in the region, more than 265,000 students and eight research universities, which introduce 7 billion into the regional economy annually (Mashiter, 2018).

The entrepreneurial university constitutes a relevant research field, since this model of academic institution has presented economic and social potential for the regions where it is located. This study also aims to contribute with academic managers who wish to implement programs and projects in educational institutions that are interconnected to the regional or national innovation ecosystem.

2 THEORETICAL REFERENCE

2.1 The phenomenon of innovation and its ecosystem

The term innovation ecosystem only came into use in 2000 and the areas that use this concept are commonly: technology, open innovation, strategic management, economics, regional development and entrepreneurship. The innovation ecosystem presents similarities with the innovation system with regard to the study of the existing relations between economic, social and political actors, however it differs in emphasizing the interrelations and interdependence that the innovation ecosystem presents, because, the interactive parts need each other for the access to resources on which the entire ecosystem depends (Russo-Spena *et al*., 2017).

The definitions of the innovation ecosystem, presented in Figure 1, bring some elements in common: the interaction between inter-organizational agents; the inclusion of the environment, both physical and virtual; the existing flows between the agents and the unpredictability of actions and rules between the elements of the ecosystem.

Authors	Definitions
Namba, 2006	"an infrastructure to foster innovation where innovation providers and demanders interact as a strategic public. The user is called to participate as a co-creator of innovation".
Sawatani *et al*. 2007	"network structure that englobes connections for all participants, such as consumers, service providers, suppliers for companies, including the environment. These connections show value flows. [...]"
Guo, 2009	"it is an innovation system that contains innovative organisms and innovation environments with innovative material flow, energy flow and information flow in some time and space".
Jishnu, Gilhotra, Mishra, 2011	"inter-organizational, political, economic, environmental and technological systems through which an environment is propitious to growth"...
Thompson *et al.* 2012	"it is a set of components that work together to create an environment favorable to innovation and allow technology to last the entire life cycle".
Komninos, Pallot, Achaffers, 2013	"a combination of 'bottom up' and 'top down' initiatives leading the collaboration network between the interested parties, which will finally be extending to real innovation communities".

Figure 1: Framework of definitions of innovation ecosystem
Source: adapted from Koslosky and Gauthier (2015)

In the innovation ecosystem, the intrinsic characteristic for it to be healthy and prosperous is when investments in research (whether from private, governmental or organizational sources) produce an increase in the development of ecosystem cooperation.

2.2 University: evolution and contemporaneity

Originating in the medieval institution, which had an emphasis on conservatism and knowledge transfer, the university, over the centuries, has evolved into an institution that generates knowledge and puts it to use (Etzkowitz, 2013).

Being recognized as generators of knowledge, universities at the beginning of the industrial revolution became part of the interests of private capital, coming up the approach to the productive sector and the attraction of investments. This approach resulted in new technical-scientific knowledge with industrial application, generated at the academy, which resulted in the "translation of research results into intellectual property and marketable

knowledge products" (Plonski & Carrer, 2009, p. 109). From this milestone in the mid-twentieth century, another important transformation for the university emerged, the second academic revolution, in which the intense involvement with technological innovation was incorporated into the university's mission (Plonski & Carrer, 2009).

This new generation of the university started to have significant relevance for the economic and social development, with more participation in the society in which it is inserted. The university emerged with a proactive function in the transfer of human resources and technology, not limited only to the generation of knowledge (Laredo, 2007; Carayannis & Campbell (2009).

In this context, it is understood the existence of two academic revolutions that affected the university and provided changes in its mission and, consequently, the improvement and development of the knowledge produced by it. These factors gave origin to the technological programs and triangular researches (with the participation of a candidate, a research program and a company's R&D department) and the "industry-university" collaboration (Laredo, 2007).

The denomination of entrepreneurial university to the third generation of universities comes from its dynamism in seeking new sources of resources and relations with the environment (Etzkowitz, 2013; Salamzadeh, Salamzadeh & Daraei, 2011).

2.3 The entrepreneurial university and its conceptualization

The third generation of universities, known as entrepreneurial universities, plays a significant role in the knowledge economy (Sooreh, Salamzadeh, Salamzadeh & Salamzadeh, 2011). Figure 2 presents some definitions of the entrepreneurial university provided by the international literature. Guerreiro *et al*. (2006) mention that there are some similar characteristics, which present the importance of elements that reach these universities, among them: the entrepreneurial activities of community members (academics and professors), the implementation of different strategies to improve the creation of new enterprises and the adjustments in the organizational structure of the universities.

Year-author	Definition
2003 - Etzkowitz	The entrepreneurial university is a natural incubator, providing support structures for professors and students to start new intellectual and commercial ventures.
2006 - Guerrero-Cano, Urbano and Kirby	An entrepreneurial university is defined as one that has the capacity to innovate, recognize and create opportunities, work as a team, take risks and respond to challenges and, by itself, seeks to discover a substantial change in the organizational character to get to a more promising posture for the future.
2012 - Audretsch *et al.*	The role of universities is more than generating transfer of technology (patents, spin-offs and start-ups) and, on the contrary, contributing and providing leadership for the creation of entrepreneurial thinking, actions, institutions and entrepreneurial capital.
2014 - Guerrero Urbano, Cunningham and Organ	The nature of an entrepreneurial university is such that graduates are seen not only as future job applicants, but also as future job creators, and the organization and content of teaching activities reflect this conception.
2015 - Cunha, Maculan	Term that characterizes universities in which the dimension of economic and social development gained strength and made them become proactive in seeking applications for their researches.
2015 - Trippl, Sinozic & Smith	The entrepreneurial model claims that universities promote the development of their regions by engaging in patents, licensing and academic activities derived from university disciplines, such as engineering, information technology and biotechnology, in which the knowledge produced overlaps products and processes more easily than industry and market structures can absorb.

Figure 2: Reference framework of entrepreneurial university
Source: adapted from Budyldina, (2018); Guerrero, kirby & Urbano, (2006).

Upon analyzing Figure 2, it can be concluded that the entrepreneurial university is a phenomenon that arose from the preparation of an "internal logic" of universities for academic development and that it was expanded from conservative academic entrepreneurship to knowledge-creating entrepreneurship (Etzkowitz, 2013). Today, entrepreneurial universities play an essential role in the economic development of different countries (Etzkowitz & Zhou, 2017; Centobelli *et al*., 2019).

However, universities must retain their role of independence or freedom of choice regarding the definition of research areas that they consider important, aiming to evolve in theoretical knowledge and understandings (Redford & Fayolle, 2014).

With the evolution of traditional teaching and research functions to activities that involve the transfer of technology through links with industry and the dissemination of entrepreneurial thinking in the university community, entrepreneurial universities already

consolidated have facilitated organizations the creation of an innovation infrastructure and, consequently, of evolution, with direct links with them, which causes economic impact on a local, regional and national scale (Budyldina, 2018).

As the expansion of the university's role in society is verified, the image of an institution source of technological innovation and economic development is projected, which results in a trajectory of university transformation (Etzkowitz & Zhou, 2017). The entrepreneurial university is the improvement of the research university, which unites an inverse linear and feedbacked dynamics with the society, which uses the problem of industry and society for research in search of solutions (Etzkowitz & Zhou, 2017).

3 METHODOLOGY

This research was classified as descriptive, of qualitative character, using the procedure of multiple case study (Yin, 2015). The unit of analysis for this research is six us entrepreneurial universities: Babson College, Massachusetts Institute of Technology, Boston University, Northeastern University, Harvard University and Olin College, all located in the Boston region. The researched institutions were selected by accessibility to the data, for they belonged to the “entrepreneurial universities mission of Boston, Massachusetts”, held in september 2018 and promoted by the brazilian micro and small business support service (Sebrae), Paraná.

As an observation unit, there are the actions developed by the six universities and which contribute to the development of the innovation ecosystem of the Boston region.

Data collection occurred through interviews, direct observation and documentary research and was carried out in two moments. The first moment happened during the participation of one of the authors of the article in the “entrepreneurial universities mission of Boston, Massachusetts”. This mission had as objective to know and understand the structure and management of initiatives of the universities of Massachusetts, aiming to obtain concepts that can be implemented in universities of Brazil.

One of the techniques used for data collection was the non-participant observation carried out in the universities, more specifically in laboratories, entrepreneurship centers and incubators of the referred universities, in addition to the incubators, accelerators and private institutions belonging to the Boston innovation ecosystem. The data collection by observation took place from september 24th to 28th, 2018, which was documented through field notes. It

was sought to observe how entrepreneurial education occurs in these universities and what links they develop with the nearby community, in this case, the innovation ecosystem of the locality. Structured interviews were also conducted with the subjects of research belonging to the groups of the entrepreneurial universities and Boston's regional innovation ecosystem. The interviews and oral communications also took place during the same period, which generated recordings of the audios that, added together, provided a total of 6 hours and 23 minutes. The recordings were authorized by the interviewees and lecturers.

In a second moment, documentary analysis on printed materials was carried out, collected *in loco*, virtual documents from universities and from incubators and accelerators belonging to the Boston's regional innovation ecosystem, which develop a work of mutual collaboration with the universities in the region. The documents analyzed were: slides provided by the lecturers at Babson College and MIT; reports: "a year in entrepreneurship at the martin trust center, (2017)" and entrepreneurship system assessment from northeast university"; in addition to the websites of the educational institutions and of the other organizations that make up the regional innovation ecosystem.

Figure 3 outlines the route of the visits made to the Boston ecosystem. In the first part are the six universities with their respective researched sectors. In the sequence, other places visited and researched which are part of the regional ecosystem.

	Technical visits theme	**Lecturers and/or interviewees**	
Babson College	Babson College about university	Dr. David Roache - director of business and development at Babson	I1
	Babson College workshop: entrepreneurial and leadership & innovation program for faculty	Dr. Jay Rao - strategy and innovation professor at Babson	I2
	Babson build: the entrepreneurship program for university students	Dr. Nan Covert - regional director at Babson	I3
Olin	Olin College visit	Student brainstorming	Lecture
MIT	MIT - Industrial Liaison Program – how to relate to MIT	Dr.Anthony knopp - director of the MIT corporate relations program	I4
	MIT_the martin trust center for entrepreneurship (MIT entrepreneurship center)	Prof. Bill Aulet - director of the entrepreneurship center	I5
	MIT - visit to the campus and mechanical engineering and aircraft laboratories	Prof. Marcos Vinícius de Souza - participant of md-lab	Lecture

	Entrepreurship competition MIT $100 k	Ms. Sandra Coralles - program manager	Lecture
	MIT media lab - (computing and communication)	Dr. Caroline Rozendo - research assistant	Lecture
Boston University	Boston University - Boston como um ecossistema de inovação	Dr. Ian Mashiter - diretor de atividades empreendedoras	I6
	Boston university - teaching entrepreneurship within the curriculum	Dr. Joe Lipuma - college director	Lecture
	Boston university - buzz lab and the role of extracurricular activities- (question)	Dr. Peter Marton - professor of strategy and innovation	I7
	Boston university - build lab - student-led entrepreneurship center	2 students - center program managers	Lecture
	Boston university - student projects pitch	2 entrepreneurial students	Lecture
Harvard	Harvard - Conor j. Walsh lab - bio design laboratory	Dr. Vinicius Cene - cnpq researcher	I8
Northeastern University	Northeastern university center for entrepreneurship education	Mrs. Kate Murdock - member of the board of idea incubator	I9
	Northeastern university idea incubator	Dr. Greg Collier - professor of practice entrepreneurship and innovation	Lecture

Figure 3: Entrepreneurial universities mission, Boston, Massachusetts
Source: research data (2019)

Figure 4 presents the script for the interviews conducted with the subjects of the research.

Categories		Questions	Authors
Entrepreneurial university.	Resources	What resources are available from the university to encourage entrepreneurship and innovation?	Salamzadeh *et al.* (2011); Etzkowitz (1983);
	Infrastructure	How does the university's infrastructure contribute to the development of the innovation ecosystem in Boston's region?	Salamzadeh *et al* (2011); kirby, *et al*. (2011);
	Teaching	How is the teaching of entrepreneurship and innovation structured at the university?	Salamzadeh *et al.* (2011); kirby *et al.* (2011); Etzkowitz & Zhou (2017);
	Networking	What are the existing collaboration networks between the university and the actors of the regional ecosystem?	Salamzadeh *et al*. (2011); Guerrero *et al*. (2006);
	Entrepreneurship centers	how do entrepreneurship centers work at the university? How do entrepreneurship centers work at the university and how do they contribute to the innovation ecosystem?	Salamzadeh *et al.* (2011); kirby *et al*. (2011); Audretsch, Hülsbeck & Lehmann (2012);
Ecosystem	Actors	Which actors make up the Boston ecosystem?	Etzkowitz & Leydesdorff, 2000; Carayannis & Campbell (2009)
	Context	Why does the Boston region make up an ecosystem that fosters entrepreneurship with innovation?	**Carayannis & Campbell (2009);**

Figure 4- interview script and analysis categories
Source: research data (2019)

For the analysis of the qualitative information collected, the thematic categorical analysis technique was used, which inserts in the ambit of content analysis techniques and aims to identify the items of significance from the set of statements obtained. For Bardin (2010, p. 48), "the objective of content analysis is the manipulation of the message (content and expressions of that content) to present the evidence that allow inferring about a reality other than that of the message".

4 DATA ANALYSIS AND DISCUSSION OF RESULTS

The grouping of data occurred in accordance with the categories and subcategories of analysis presented in table 4, which constitutes of “a priori category”, which come from the literature. The statements correspond to the respondents mentioned in Figure 3.

4.1 Resources

Babson's university has shown that its human resources have the greatest focus of action. It aims to stimulate the development of professors so that they act increasingly closer to the reality in which the student is inserted.

> Our resources are directed to a creative environment. We provide current courses and materials so that students have access to a new way of thinking, a developed mindset to develop business in an innovative way (I2).

The MIT university proposes to enhance investments. This occurs by the use of a “high practical impact” research and also by searching for the best students (I4). It can be considered as a culture for the institution, since “hands and minds” has been its motto since its foundation, that is, the valorization of useful work and economic and social development is the institution's primary philosophy. This fact is emphasized by Roberts & Eesley (2009).

Our resources are designed to bring the best minds to study here. Here there is meritocracy in the honest and complete sense of this thought, it is not only people with money who can enter MIT, here more than 25% of incoming students every year are the first in the family to enter higher education. In financial resources, 20% of the amount allocated to research comes from industries. But at MIT we do not do R&D (research and development), we do the research and later students do the development through their founded companies (I4).

It was emphasized, therefore, that the financial resources to give support to the scholarships of the MIT research groups come from the government, from organizational foundations that generate scholarship for students or fellowships, destined to students of higher level as master's and doctorate. Another source of funds is the endowment, which is the financial resources donated by the institution's alumni.

At Harvard University, physical and intellectual resources provide students with world-class academic and research experience, and the university aims to develop leaders who make a difference in the world, its physical and intellectual resources provide students with a world-excellence academic and research experience and the university aims to develop leaders who make a difference in the world (Harvard, 2019). As a result of its structure and success history, it has predisposition to attract financing from different sources. Harvard controls about us$ 37.6 billion in patrimonial funds, the largest university fund in the world.

*4.*2 Infrastructure

MIT's internal infrastructure is directed to provide interdisciplinarity, for the facilities are integrated. This thought is important for the institution, the buildings are connected by tunnels and walkways. In the educational structure, an interdisciplinary nature is also perceived, which is made available by the format of the research programs. The disciplines act in a vertical way, for the educational background of students. The research structure is aligned in a horizontal way, in which the different fields act in an interdisciplinary manner, depending on the research theme.

Harvard university's infrastructure has research centers and dozens of laboratories that receive more than us$ 800 million in funds intended for innovation development (Harvard, 2019). Among the various laboratories present is Conor J. Walsh lab – biodesign laboratory observed *in loco* that serves as an example to understand the idiosyncrasy of the university's research laboratories. The biodesign laboratory aims to increase and restore human performance using a range of research tools that create medical electromechanical and robotic devices for use by humans with certain physical and motor disabilities.

Northeastern university is a teaching and research university involved in innovation and has in its culture an entrepreneurial action, the various programs, laboratories and spaces are destined for entrepreneurship. Figure 5 shows the university's involvement with the innovation ecosystem in which it is inserted and its organizational infrastructure for the encouragement and development of innovation and entrepreneurship.

Idea Venture Accelerator	Idea is a venture accelerator administrated by students that provides a variety of resources for northeastern affiliate entrepreneurs who wish to start their own businesses.
Entrepeneurs Club	The entrepreneurs club brings together students from different fields to build meaningful relationships and companies.
Center for Entrepreneurship Education	It is a resource of every university that integrates courses in entrepreneurship and innovation, entrepreneurial cooperatives in early stage companies, incubation of ventures from our venture accelerator in the campus, idea, and financing and launch of ventures, helping our network of entrepreneurs, the local angel community and venture capital.
Health sciences entrepreneurs	It is a group of alumni dedicated to promoting entrepreneurship in the world in rapidly evolution of health care.
Michael j. And Ann Sherman center for engineering entrepreneurship education	The sherman center's mission is to allow students' interdisciplinary entrepreneurship in the broadest sense, providing education on tools, concepts and resources to promote creativity and the capacity to develop commercially viable ideas.
Scout	It is the student-led design studio at northeastern university. Creative problem solvers who use design thinking to create innovative experiences for our customers, our team and the university community.

Figure 5- Northeastern university innovation structure
Source: research data (2019)

Some highlights points appear in the ice venture accelerator, which is managed by students and has the purpose of developing and launching successful companies in the market. The financial resources for the accelerator are raised through sponsorship from companies and alumni. Northeast university does not use government incentives in these programs, it uses them uniquely in research programs.

4.3 Teaching

By the research data, it was found that Babson College bases its teaching philosophy focused on the of entrepreneurship teaching, innovation and leadership. This way, some data are presented that base and describe the prevalence of the university in this direction.

Babson college is a century-old university that calls itself a business school. It acts with an educational orientation focused on entrepreneurial thinking in all its activities and is also intended to train professors of entrepreneurship and innovative leadership.

From the theories and activities of practical laboratories in the university, entrepreneurial thinking and action are disseminated, which occurs in a curricular and co-curricular form. Some disciplines are mandatory, such as the foundations of management and entrepreneurship, however, there are 25 disciplines of entrepreneurship between the mandatory and the elective ones for undergraduate and postgraduate *lato sensu* and *stricto sensu.* Among the disciplines and short term courses offered, there are more than 80 different types, from theoretical foundations to practical disciplines, such as the purchase of a small company or the commercialization of technology. The university seeks to distinguish itself by offering a practical and collaborative environment in which suppositions are questioned and ideas are valued.

At university, 40% of students come from family businesses and must be prepared to be future chief executive officers to think and act as ceos, to make decisions on boards of directors. The university's main objective is to shape the mindset and focus on building students' skills, as business tools are easily available in the mass media.

Franklin w. Olin University of Engineering is a college of engineering with prominence in the country due to its classification in the courses of electrical engineering and mechanical engineering. The foundation of the culture and philosophy of this university is “first do and then learn”. Thus, students start with practical activities and test new ideas and then develop theoretical classes on applied concepts. It is about a new university, for it was created in 1997 and is built on a campus attached to Babson College university (Olin, 2019).

The teams receive training for entrepreneurs to know more deeply about the markets and customers for which they are developing products. The last year students participate in the Olin’s Senior capstone program in engineering (scope), a development program of a real project, with a year-long duration, which is sponsored by engineering and technology customers from the Boston ecosystem.

The Massachusetts institute of technology (MIT) is made up of three emphasis of actuation: the research, with laboratories, nuclei and programs; the education, with a structure of 32 departments in five colleges - 1st is engineering, 2nd is science, 3rd is architecture and urban planning, 4th is humanities, arts and social sciences and 5th is business school (sloan school of management) - and innovation, which occurs through 85 interactions (courses, activities, programs, competitions, among others) that promote innovation through the effect of entrepreneurship. It is noted in Figure 6 the view offered by MIT.

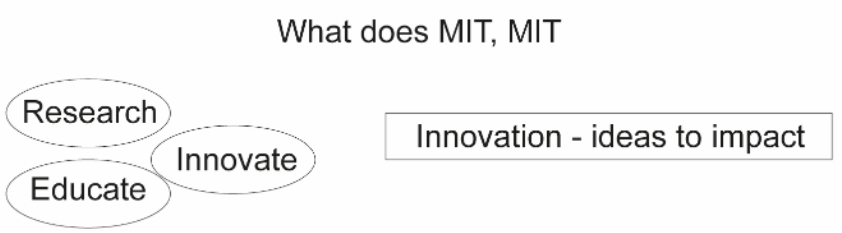

Figure 6: Acting areas of MIT
Source: research data (2019)

The structure of MIT courses is vertical and horizontal. In the vertical scope are the different areas of training, it is the structure that provides classes and academic training. In the horizontal structure there are research centers, programs or laboratories, which are organized in an interdisciplinary way, and not in the of a discipline format. The entire teaching staff is also involved in research, thus, existing a network of contacts that is formed within the university itself that contributes to educational training.

Boston university denotes a vision of the teaching of entrepreneurship driven to show what entrepreneurship is in an integral way. Transposes technological entrepreneurship, seeks to provide a vision of business focused on various areas such as arts, architecture, sciences, among others. The vision of teaching entrepreneurship is worked mostly by teamwork and develops in curricular, co-curricular and extracurricular activities, surpassing the university barrier. The curriculum provides a wide variety of courses related to entrepreneurship. For graduation there are more than 30 elective disciplines to be chosen, depending on the student's training concentration.

4.4 Networking

Babson college's collaboration network is more targeted at other universities and institutions around the world. The Babson collaborative for entrepreneurship education association is a membership organization for institutional members, who pay annual fees in order to build and expand their capacity of education for entrepreneurship.

Babson collaborative for entrepreneurship education aims to increase the capacity of education for entrepreneurship through the sharing of beliefs between the institutions, by the search for orientation and network formation. Therefore, it has the mission of connecting institutions that aspire to build and develop programs to encourage entrepreneurship (I3).

The MIT teaching and research institute has attributes that distinguish it from other higher education institutions. At MIT there is a search for “practical impact” research, and this is achieved through different means of contact with society and also with the local innovation ecosystem, which is called by them as “open-air incubator”. One of the predominant programs of information network is the visiting comMITtees. This program consists of 31 comMITtees that meet every two years, on average. It has already existed for 120 years and operates as an advisory group on academic programs. The composition of these comMITtees is representative, with scientists, engineers, entrepreneurs, executives and educators, many of whom are graduates of the institute. It is normally composed of 17 members, including five members of the corporation (with the president included), six alumni and six members appointed by the president of the institution (MIT, 2019).

	Offices
a)	MIT technology licensing office (tlo) directed to intellectual property issues, which is basically a technology that comes out from the university for the industry to create new products.
b)	MIT office of sponsored programs (osp), which is a large accounting firm, which manages the researches financial negotiations.
c)	Office of corporate relations - the industrial liaison program (ilp) and MIT startup exchange - the first office acts to create and maintain mutually beneficial relations between MIT and the corporations all over the world. Liaison is a french word that provides the idea of “midfield”. “we do this in an easy way and custom-made for both sides, we provide information to affiliated industrial companies” (i4). The second office actively promotes collaboration between start-ups and industries already connected to MIT (2019).

Figure 7: Interaction with the innovation ecosystem
Source: research data (2019)

Formal infrastructures contribute to the interaction with the innovation ecosystem, not only local, but worldwide and are divided into three acting offices, described in Figure 7.

4.5 Entrepreneurship centers

The MIT entrepreneurship center is called the martin trust center for MIT entrepreneurship and its mission is to promote entrepreneurial knowledge and education orientated to innovation in a way that meets the needs of the 21st century world. Provides service to all MIT students, regardless of college or disciplines attended.

> Here we have educators, entrepreneurs, economic developers and we also have investors, they are all different pillars. However, our job is not to focus on the fish, it is to teach how to fish, our aim is to create entrepreneurs. We are always asked: "how

> many companies have you already started?" and we answer: "we can answer the question, but it is the wrong question", there are many companies created, but our focus is on creating more entrepreneurs, increasing the quality of entrepreneurs, and also seeing if they are connected (I5).

According to the interviewee's report 5, it is possible to see that university educators need to have clear objectives of what the entrepreneurship center wants. Stimulate the entrepreneurial mindset, create business models in their distinct phases and create companies that, linked to the local innovation ecosystem, can develop satisfactorily.

The student is at the core of the activities of the MIT entrepreneurship center, the activities are divided into five groups presented in detail in Figure 8.

Division	Description
Infrastructure	Composed of a network of businesmen, MIT resources for entrepreneurship, state-of-the-art multipurpose installations, research and a network of professional consultants;
Programs	They are currently operationalized by the summer startup studio activities in new york, MIT's delta v, bu law clinic, practice leaders of the sector, eship traineeship, student clubs and initiatives, awards (eddies, mcgovern, nomosson) and MIT fuse;
Events	T = o (event that occurs at the beginning of the school year). It is identified among students by the expression “the time is now” and also special activities (distinguished visitors, series of lectures, among others);
Divulgation	It occurs through executive education, regional entrepreneurship acceleration program (reape), corporate donors, relations with alumni, partnerships between campus and edx-MITx - edx is a massive provider of open online courses / MITx is an open online program of the Massachusetts institute of technology;
Academy and classes	in this segment, it's worked with entrepreneurship and innovation in a focus on skills development, partnerships with industries and in-company experiences (Aulet, Chen, Cotter, & Hunter, 2017).

Figure 8: Activities of the MIT entrepreneurship center
Source: research data (2019)

At the martin trust center for entrepreneurship is the e-center, which concentrates exclusively on the commercialization of technologies developed by MIT students. Through the e-center, it is developed one of the most well-known annual entrepreneurship competitions in the USA, the MIT $100k.

When the student goes through a competition among students, it is the moment when the student's mindset changes from researcher to entrepreneur. This type of simple award is intended to change the mindset and build a business model to be tested (I9).

The center's programming of Boston University that is called *The Build Lab Space* is structured from a funnel that has its flow from top to bottom. The funnel represents the application of activities that take place during an academic year and is a competition that aims to activate the entrepreneurial spirit and unleash impact for society (BU, 2019). Figure 9 illustrates the steps taken during the school year in this competition called new venture competition.

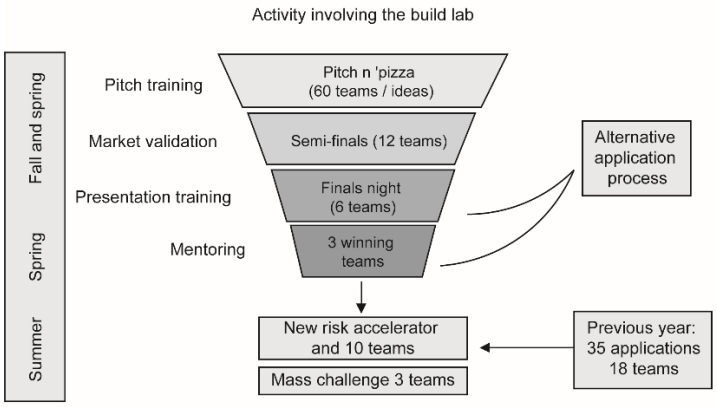

Figure 9: Competition steps for entrepreneurs at Boston university.
Source: research data (2019)

One of the main activities of the Boston university entrepreneurship center is the new venture competition, which is a competition for new ventures. It is developed in three steps that offer winners the opportunity to receive us$ 18,000 in investments in their ideas. It is also divided into two distinct groups: line for technological ideas and line for social impact businesses. This broadly corroborates the thinking of some authors such as Redford and Fayolle (2014) and also Siegel & Wright (2015) regarding the structure of the entrepreneurial university with a center for entrepreneurship, competitions, accelerators and incubators.

4.6 Ecosystem actors

Universities are predominant institutions in the Boston innovation ecosystem. In this region there are 74 colleges and universities, among them many punctuated in world classifications as the best in their sector of actuation. In this region, more than 265,000

students are studying, who are inserted with a great impact on the region's ecosystem. The Massachusetts institute of technology (MIT) is one of the institutions that most relate to the ecosystem. The institution began a collaborative relation with the electrical industries more than 100 years ago. At the time, these industries depended on cutting-edge science for their advances. These industrial relations fostered an entrepreneurial approach to some researches with the inclusion of patenting and dismemberment. Over time, collaborative relations expanded and the contributions that academic knowledge provided to society and, also in a reverse way, society contributed to researches, formed the profile of institutions that today constitute the university of MIT (Etzkowitz & Zhou, 2017).

The government is one of the actors argued by the triple helix theory (Etzkowitz, 2009), which is also active in this ecosystem. A clear intervention by this body is viewed by the Cambridge Innovation Center Institute, which is a co-working space that aims to strengthen the local innovation ecosystem. It is used by entrepreneurs who use information services there, sharing state-of-the-art laboratories and a network of possible contacts due to the peculiarity of the location. The local government, in the person of mayor martin j. Walsh, also acts in the development of the ecosystem by facilitating financing and other government instruments that stimulate the creation of new ventures (Verleun, 2018).

4.7 Ecosystem context

When an innovation ecosystem is developed, there is a behavior common to large corporations that, in the search for reduction of internal research and development costs, use open innovation. This process occurs with the purchase of start-ups, which are often already obtaining real profits from the sale of their products or in the purchase of start-ups that do not have profits yet and, thus, are sold below the investments raised and their evaluation. The gain for corporations is in technology and the business developed idea. Some authors, such as Adner (2006), Adner & kapoor (2010), Chesbrough & Appleyard (2007), report the importance of the innovation ecosystem for the development of open innovation. It is relevant as a way of growing way for the large corporations and the generation of economic and social development for the installed locations.

For a start-up to exist and develop, investments are needed, which in the context of Boston's innovation ecosystem begins from small internal competitions at the university and

later international competitions, until it reaches the first round of external investments, a moment when the documentary formalization of the company is carried out.

In American culture, there is a usual behavior of investments in companies bigger than in other countries, this can occur through investments in the stock exchange or through investments in start-ups. Traditional investment funds like banks provide very low income (I10).

Boston's innovation ecosystem works in different ways, depending on the university. Each university also acts differently for the several stages of the formation of a start-up.

4.8 Actions by universities that contribute to the local innovation ecosystem

Etzkowitz and Zhou (2017) state that the university takes a proactive role in the region's innovation capabilities when it is in the third phase, already consolidated as an entrepreneurial university. This third phase refers to the completion of the first and second phases (development of the entrepreneurial mindset and complete implementation of the infrastructure for the creation of new businesses).

The entrepreneurial university, has the capacity of absorption of regional innovation and is operationalized as a business support structure for networks of angel investors, capital ventures, public relations and law firms specialized in supporting the formation of companies and the development of clusters (Etzkowitz & Zhou, 2017). The elements presented in Figure 10 can be considered as being actions of entrepreneurial universities in the Boston region, USA, which contribute to the local ecosystem.

	Actuations
a)	Training of technologically qualified students;
b)	Building of an entrepreneurial mindset in students;
c)	Research groups with a multidisciplinary character;
d)	Collaborative research groups with industries and companies;
e)	Research groups for governmental demands;
f)	Competitions that include extra-university students;
g)	Formation of start-ups with business model validation;
h)	Contribution to economic development through the application of financial resources received;
i)	Contribution to social development by fostering the development of the region.

Figure 10: Actions of entrepreneurial universities towards the ecosystem
Source: research result (2019)

Nine contributions were detected as a result of the analysis of the data obtained. Thus, it is hoped that the high development of Boston's innovation ecosystem can somehow provide contributions of paths of conduct and actions for the development of other ecosystems also led and developed from the local universities. These contributions meet the thinking of Budyldina (2018), who defends the entrepreneurial university as an institution with direct links to the economic impact on a local, regional and national scale.

4 FINAL CONSIDERATIONS

The main objective of this research was to answer the following question: how do entrepreneurial universities contribute to Boston's innovation ecosystem? For this, technical visits were made at the universities: Babson College, Olin College, Massachusetts Institute of Technology, Boston university, Northeastern university and Harvard university, all located in the region of Boston, USA.

As a result of the research elements were raised that provide evidence of the contributions described in the results. As the main limitation of the research, there is the lack of answers by all respondents to all questions of the interview, so it was not possible to seek data saturation nor the formation of new categories *a posteriori.*

This research aimed to contribute with different channels of society, considering that the university model called entrepreneurial university has presented potential for economic and social progress in the regions in which they are located.

As a contribution to the academy, this investigation provides a framework of definitions of the entrepreneurial university and for the innovation ecosystem, the contributions that the entrepreneurial universities provide to the Boston innovation ecosystem were also presented and analyzed, data that cannot be generalized to the population, but possible to provide theoretical generalizations. This study also aimed to contribute with academic managers who want to know more about the ways to implement programs and projects in educational institutions that are interconnected to society.

It is suggested, for other researches, the verification of the contributions that brazilian entrepreneurial universities have provided to ecosystems of local innovation. And also, what are the fundamental steps for entrepreneurial universities to start implementing an innovation ecosystem from the university, having it as the center of an innovation hub.

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