

# TECHNOLOGICAL ENTREPRENEURSHIP IN LA: WEAKNESSES, ACTORS AND CASE STUDY OF THE ARTIFICIAL INTELLIGENCE CENTER - IA.CENTER STATE OF CHIHUAHUA

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## ABSTRACT

The objective of this study is to analyze the weaknesses and actors of technological entrepreneurship in Latin America, as well as to describe a case study where its actors work to reduce these weaknesses. The methodology with a qualitative approach based on the theory of resources and capabilities is divided into two stages: the first is a documentary analysis of three international entrepreneurship reports: Global Entrepreneurship Monitor, Dynamic Entrepreneurship Index and Global Startup Ecosystem Index, identifying weaknesses and actors through content analysis; in the second, a case study organization is described at the meso level, focused on technological entrepreneurship and artificial intelligence called: Artificial Intelligence Center - IA.Center State of Chihuahua. The results present the weaknesses of the countries evaluated with the highest entrepreneurship in LA: human capital and entrepreneurial education, CTI platform, business structure, government policy, access to financing and R&D transfers; as well as the role played by its stakeholders in education, government, finance, and innovation and

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technology. Finally, it described the mission, business model and actions carried out by the case study to reduce the weaknesses of regional technological entrepreneurship.

**Keywords:** technological entrepreneurship, entrepreneurship weaknesses, entrepreneurship actors, Center of artificial intelligence, IA.Center State of Chihuahua.

### *Emprendimiento tecnológico en AL: debilidades, actores y caso de estudio del Centro de Inteligencia Artificial - IA.Center Estado de Chihuahua*

#### **RESUMEN**

El objetivo del estudio es analizar las debilidades y actores del emprendimiento tecnológico en América Latina, así como describir un caso de estudio donde sus actores trabajan por abatir esas debilidades. La metodología con enfoque cualitativo basado en la teoría de recursos y capacidades se divide en dos etapas: la primera, es un análisis documental de tres reportes internacionales de emprendimiento: Monitor de emprendimiento global, Índice de emprendimiento dinámico e Índice global de ecosistemas de Startups, identificando debilidades y actores a través del análisis de contenido; en la segunda, se describe a nivel meso, una organización caso de estudio, centrada en emprendimiento tecnológico e inteligencia artificial denominada: Centro de Inteligencia Artificial - IA.Center Estado de Chihuahua. Los resultados presentan las debilidades de los países evaluados con el emprendimiento más alto en AL: capital humano y educación emprendedora, plataforma CTI, estructura de negocios, política gubernamental, acceso a la financiación y transferencias I+D; así como el papel que juegan sus actores de educación, gobierno, finanzas, e innovación y tecnología. Finalmente, se describe misión, modelo de negocio y acciones que lleva a cabo el caso de estudio para abatir las debilidades del emprendimiento tecnológico regional.

**Palabras clave:** emprendimiento tecnológico, debilidades de emprendimiento, actores de emprendimiento, centro de inteligencia artificial, IA.Center Estado de Chihuahua.

#### **Introduction**

Entrepreneurship is a significant driver of Social and Economic Development in countries. Focusing in the specific type of this article, Technological Entrepreneurship helps to commercialize the emerging innovation and technological discoveries, this suggests the necessary involvement in the process of industrial innovation in the country's area (Siyabola *et al.*, 2011). Between innovation and entrepreneurship there is a recursive relationship, because innovation is the specific instrument of entrepreneurship, although there can be entrepreneurship without innovation and innovation without new companies (Marín and Rivera, 2014).

For example, the Information Technology enable Services (ITeS) in Latin America countries expanded uninterruptedly from 2005 to 2014 with negative balance of imports and exports. From 2015 to 2020, the trade balance was similar, but with a decrease in imports and exports due because of the economic stagnation in the region. During covid-19 pandemic, the ITeS exports were relatively minor as traditional services, but with the same trend of higher imports than exports. "This confirms that LA invests relatively little in R&D and absorbs most innovations through imports" (UN ECLAC-CII, 2021, p. 10) and although technological development in LA is currently driven by imported innovation, this situation also opens up a great opportunity for

technological entrepreneurs, due to the borderless use of innovation that is being generated worldwide.

The technological entrepreneurship (ET) definition "is an investment in a project that assembles and deploys specialized individuals and heterogeneous assets that are intricately related to advances in scientific and technological knowledge for the purpose of creating and capturing value for a firm" (Bailleti, 2012, p. 9). Under this logic, the ET is based on a vision shared at all levels of the company, focused on creating and capturing value considering technological changes. In this sense, it is a collaborative phenomenon in which teams of specialized talent participate in different fields embedded in technology, such as areas of finance (fintech), education (edutech), health (healthtech), among others.

Likewise, the ET applies to companies of any size (small, medium or large) and at any stage of their life cycle (startups or mature), which converge in an ecosystem of technological entrepreneurship made up not only of companies, but also of other actors that favor or stop this type of entrepreneurship, giving as visible results, the strengths and weaknesses of these ecosystems. Considering the above, the objective of this study is to analyze the weaknesses and actors of technological entrepreneurship in Latin America, as well as to describe a case study where its actors work to reduce these weaknesses. The following subtitles of the introduction cover the central points of the objective: weaknesses and actors of technological entrepreneurship and also, the theoretical basis on which the study is based.

### ***Weaknesses of LA entrepreneurship***

Latin America's potential as an entrepreneurial region has been discussed for years. Lederman *et al.* (2014) analyze entrepreneurship in the first decade of the 21st century in LA, finding as positive points, that it is a region of entrepreneurs with a high number of entrepreneurs per capita, strong export activity and the emergence of multi-Latin multinationals. On the negative side, the report reveals that the great weakness of the LA entrepreneurial landscape is the lack of innovation.

The Inter-American Development Bank (IDB) reveals in 2020 that the main weaknesses of technological entrepreneurship are in the dimension of "science and technology platform" and "business structure" since their profiles do not contribute significantly to innovation, while its greatest strength is in the dimension of "policies and regulations" where the governments of the main entrepreneurial countries in LA have a strong activity with programs and policies to promote entrepreneurship (Kantis and Angelelli, 2020), although not necessarily with a technological focus.

Even six years apart, both studies (Lederman *et al.*, 2014; Kantis and Angelelli, 2020) reveal, that the main weakness in LA entrepreneurship is the lack of innovation because the profiles of its business structure do not contribute to significant innovation, probably because in LA there is very low invested in R&D because innovation is imported (UN ECLAC-CII, 2021).

### ***Entrepreneurship actors***

Technological entrepreneurship research identifies at least seven key actors or elements linked to a new technology-based company: the technological entrepreneur, corporations or large companies, universities, capital, market/customers, government, and advisors (Prodan, 2007). Some authors consider that the set of these actors favors the introduction of the term

"entrepreneurship ecosystems" since entrepreneurship activities are mapped, in a context in which all these actors are interconnected (Audretsch *et al.*, 2019) In addition to the fact that they are no longer limited by the territory in cities, regions or countries, but technological advances have led to these delimitations disappearing, due to the use of technological platforms that connect them to digital entrepreneurial ecosystems (Muldoon *et al.*, 2022).

StartupBlink (2023a) considers three groups of actors as part of the entrepreneurial startup ecosystem: the obvious ones such as investors, accelerators and collaborative workspaces; startups that have evolved: unicorns and those that have been acquired by other companies; and special entities: the group they call Pantheon made up of global companies such as Microsoft or Netflix, and the influencer startups, which are usually CEOs of successful companies. Considering that the geographic delimitations of entrepreneurship ecosystems have blurred and that recent studies have incorporated new actors, entrepreneurship and geopolitics are closely linked. These new actors in the entrepreneurial ecosystems open up the range of interactions with the context.

### ***Theory of resources and capacities in entrepreneurship***

The theory of resources and capabilities (TRC) is based on the heterogeneous characteristics of resources and capabilities that the company controls to obtain and maintain its competitive advantage. In this sense, although his study focuses mainly on individual companies or groups of companies or sectors, in the last decade the TRC has been linked to intangible resources to explain entrepreneurship and also, on the importance of entrepreneurship networks and the mediation of their resources for the development of technological innovation (Fong *et al.*, 2017).

The TRC is pertinent in studies of emerging economies such as those of LA, due to the generation of sustainable competitive advantages that are achieved by the resources of the companies and that favor the realization of entrepreneurial strategies (Lucas *et al.*, 2019).

### **Methodology**

The methodology with a qualitative approach based on the theory of resources and capabilities is divided into two stages: the first one is a documentary analysis method and the second one, a case study method. The explanation of each stages is described in the next methodology subsections.

#### ***Documentary Analysis Method***

Williamson and Whittaker (2014) consider documentary analysis as "one of the lesser known and used social research methods" (p. 38) and its process has three steps: "deciding on a research question and designing plan; deciding which documents to analyze and what to include in the sample; collecting and analyzing the data" (p. 41).

##### **1.- Deciding on a research question and designing plan**

For the documentary analysis method, the specific objective is to analyze the weaknesses and actors of technological entrepreneurship in Latin America, and the qualitative designing plan is content analysis, because is the way of analyzing documents by measuring the prominence of specific phrases related with weaknesses and actors of technological entrepreneurship.

##### **2.- Deciding which documents to analyze and what to include in the sample**

The documents to analyze are the well-known international entrepreneurship indices and reports because international indices and reports have been measuring and analyzing entrepreneurship and startup ecosystems for years. The sample size is three: Global Entrepreneurship Monitor (GEM), Index of Dynamic Entrepreneurship (IDE) and Global Startup Ecosystem Index (GSEI) with the criteria of using the most recent publication of each of them in a period of time between 2022 and 2023. Also, these documents are selected for the “four criteria for judging documents for research purposes” (Williamson and Whittaker, 2014, pp.39-40): authenticity of the document and identity of the authors, that in the case of GEM (2023) is published by Global Entrepreneurship Research Association, IDE (2022) is published by Prodem and Global Entrepreneurship Network, and GSEI (StartupBlink, 2023a) is published by the Israel StartupBlink Company. The other three judging documents criteria are credibility, representativeness and meaning with clear comprehensible and public methodology of these report and indexes.

Another selection criterion is that the metrics used by each of the reports can be grouping them according to their similarities and differences (view in the table 1 the summarize).

**Table 1.**  
Similarities and differences of entrepreneurship indices and reports

	Global Entrepreneurship Monitor (2023)	Index of Dynamic Entrepreneurship (2022)	Global Startup Ecosystem Index (2023)
What it measures	Environmental conditions and business activity	Quantity and quality of emerging companies	Startup ecosystem
Indicators and sub-indicators	12 indicators	10 dimensions	Quantity (6 metrics), quality (13), and business environment
Government	--Policies, priority and support --Bureaucracy and taxes --Programs	--Policies and regulations	--Corporate taxes --Labor laws, --Nomadic or startup visas
Education	Entrepreneurial level in: --primary school and high school --universities	--Education system	--Top universities by location
Culture	--Cultural, social norms and societal support	--Culture, social conditions	--Diversity index --Corruption perception index
Innovation	--R&D transfer	--Science, technology and innovation platform	--R&D Centers --R&D investment
Market	--Inner dynamics --Internal loads	--Demand conditions	Quantity (6 metrics)
Financial	--Financial environment	--Financial environment	--Private investment
Companies	---	--Organizational culture --Social capital	Quality (10 metrics)
Infrastructure	--Professional and commercial	--Business structure	--Technological services (payment portals, apps)

	--General physics and services		--Internet (speed, cost and availability)
Skills and capabilities	---	--Human capital	---

Note: Own elaboration based on GEM (2023), IDE (2022) and StartupBlink (2023a)

The similarities in the metrics used by these three reports are grouped for this research into 8 groups of indicators: government, education, culture, innovation, market, financial, and infrastructure. Another similarity in two of the reports (IDE and GSEI) is that they measure the quantity and quality of companies, while GEM measures entrepreneurial activity in general and groups countries into three levels according to their gross domestic product per capita (GDPpc): at level A, countries greater than \$40,000 GDPpc dollars, level B between \$20,000 to \$40,000 and level C, less than \$20,000 GDPpc dollars. The differences lie in the way in which the indicators are measured by each of these reports. The GEM measures macro entrepreneurial business activity, the IDE focuses on entrepreneurial emerging companies and the GSEI on startups, but with metrics with a micro focus on the type of companies that make up the ecosystem.

In relation to what to include in the sample of the selected documents, it is the specific information of the indicators and sub-indicators of each one of the profiles of the LA countries, specifically focused on which of them have the lowest score, defining them as weaknesses and which have the highest score, defining them as strengths.

For the selection of the countries to be analyzed, the global score of each of the LA countries was considered, choosing those with the highest score, since it means that they are the countries with the best entrepreneurship profile. Table 2 lists the best qualified countries in the three selected indices and reports.

**Table 2.**

Best qualified entrepreneurship countries in LA

	Global Entrepreneurship Monitor (2023)	Index of Dynamic Entrepreneurship (2022)	Global Startup Ecosystem Index (2023)
	51 countries, level A, B y C, score	46 countries, rank and score	100 countries, rank and scores
1	Chile - level B – 4.5	Chile – 27 – 35.5	Brasil – 27 – 9.606
2	Uruguay - Level B – 4.5	Brasil – 29 – 34.8	Chile – 36 – 6.231
3	Colombia - Level C – 4.5	Argentina – 30 – 33.6	México – 37 – 5.940
4	Panamá - Level B – 4.3	México – 32 – 31.2	Colombia – 40 – 5.486
5	México - Level B – 3.8	Uruguay – 34 – 30.5	Argentina – 47 – 5.068
6	Guatemala – Nivel C3.8	Colombia – 37 – 28.0	Uruguay – 55 – 2.834

Note: own elaboration based on GEM (2023), IDE (2022) and StartupBlink (2023a)

In Table 2, the countries that remain as best qualified entrepreneurship in LA are: Chile, Mexico, Colombia, Uruguay, Argentina and Brazil (at least, in two of the reports), therefore, the analysis of their weaknesses and entrepreneurial actors will focus on those six countries to generalize entrepreneurship in LA.

**Case study**

Schwandt and Gates (2018) mention that a simple way “a case is an instance, incident, or unit of something and can be anything—a person, an organization, an event, a decision, an action, a location like a neighborhood, or a nation-state” (p.600) with three levels: micro (persons), meso (organizations) and macro (societies) and involve one or multiple actors.

For this research, the case study is a single actor in meso level, focused on technological entrepreneurship and artificial intelligence called: Artificial Intelligence Center - IA.Center State of Chihuahua. Investigations of technological entrepreneurship case studies have been carried out for several decades.

For example, King (1971) wrote about the case study of the development of Ovonic switches. More recent studies focus on case studies of technological ventures at the county level (Keikhakohan et al., 2020), industrial sector (Liu et al., 2022), among other levels, and that additionally include technology with artificial intelligence at the meta-organizational level of multinational companies, for example the studies of Battisti et al. (2022) and Gupta et al. (2023) but at the meso-organizational level are scarce. The justification for the selected case study for this research, is that "at the time, it has not been studied before" (Schwandt and Gates, 2018, p. 608).

The uses or design of the case study is descriptive because the “objective is to develop a complete, detailed portrayal of some phenomenon” (Schwandt and Gates, 2018, p. 607), being in accordance with the specific objective for this stage of the methodology to describe a case study where its actors work to reduce these weaknesses. The description of the case study will be based on the participant observation of the authors of the article, who are part of the human talent of the Artificial Intelligence Center, as well as on the documentary analysis of annual reports, internal and public reports and projects of the organization.

**Results**

The results are presented in two main segments: entrepreneurship in LA and the case study. The main findings of each of these themes are listed in the following subsections.

**Entrepreneurship in Latin America**

To analyze the weaknesses of the LA entrepreneurship ecosystem, in table 3 matches between the six highest ranked countries are summarized, selecting as a first step, the five main weaknesses of each country and second step, eliminating from the table those weaknesses that coincide in three or fewer countries.

**Table 3.**  
Weaknesses in the best qualified entrepreneurship countries in LA

Weaknesses	Brazil	Chile	Colombia	Argentina	Mexico	Uruguay
Government Policy: support and relevance (GEM)	x	x		x	x	x
Government Policy: taxes and bureaucracy (GEM)	x		x	x	x	
Ease of Access to Entrepreneurial Finance (GEM)	x	x	x	x		x

Entrepreneurial Education at School (GEM)	x	x	x	x	x	x
Entrepreneurial Human Capital (IDE)	x	x	x	X	x	x
R + D Transfers (GEM)	x	x	x	x	x	
STI Platform (IDE)	x	x	x	X	x	x
Business Structure (IDE)	x	x	x	X	x	x

Note: own elaboration based on GEM (2023) and IDE (2022)

The analysis derived from Table 3 reveals that the entrepreneurial weaknesses in which the six countries agree are: Entrepreneurial Education at School, Entrepreneurial Human Capital, STI Platform and Business Structure. Matches in five of the countries are: Government Policy: support and relevance, Ease of Access to Entrepreneurial Finance and R + D Transfers. These weaknesses seen from the theory of resources and capabilities, reveal the opportunity to refocus the business structure and CTI platform towards the dynamic capabilities that the external context of entrepreneurship presents in LA.

About tech startups, StartupBlink (2023a) presented in the report of countries and cities, the analysis of eleven types of industries, four of them tech specific, and another two related: healthtech, fintech, edtech, foodtech, software & data, hardware & IoT (see table 4).

**Table 4.**

Tech startups in *top* countries in entrepreneurship in LA

Startup Type	Brazil	Chile	Colombia	Argentina	Mexico	Uruguay
Total startup	1,138	311	1,324	527	436	33
Healthtech	80	20	100	57	38	2
Fintech	226	47	207	66	112	7
Edech	72	14	75	31	20	2
Foodtech	56	4	92	43	15	1
Software & data	352	110	382	129	103	9
Hardware & IoT	55	11	47	14	8	1
Total tech startup	841	206	903	340	296	22
% of tech startup	73.9%	66.2%	68.2%	64.5%	67.88%	66.6%

Note: own elaboration based on StartupBlink (2023b, 2023c, 2023d, 2023e, 2023f, 2023g)

The percentage of tech startups in the five countries showed in table 4, reveals that more than 60% of the startups included in StartupBlink (2023b, 2023c, 2023d, 2023e, 2023f, 2023g) are tech related. Brazil, Panama, Mexico and Chile present the most high expect to use digital technology to sell their products (GEM, 2023). This need for greater use of digital technology explains why the largest number of startups in LA are technology. Regarding the entrepreneurship of startups in LA, Torres and Jasso (2022) mention that at the international level, their participation is small but growing.

Brazil dominates the LA fintech sector, followed by Mexico, Colombia, Chile, Argentina y Peru. Fintech sector presents a big opportunity in LA region, for their lowest levels of formal financial inclusion, up to two thirds of their population don't have bank account or even a mobile money account. Chile has 74% of his population with bank o mobile bank account, while in



Mexico, just 37% of the population have it. LA living in the cash economy and have not been traditionally been seen as viable customers by banks (Findexable, 2022). GEM (2023) presented LA with the highest levels in the world with informal economy, in relation to the fact that their entrepreneurs are mainly financed by friends, relatives or acquaintances. IDE (2022) presents an overview of dynamic entrepreneurship globally, where LA and Africa are the least developed regions. This dynamic entrepreneurship is directly related to the dynamic capabilities of entrepreneurship which, according to Lucas et al. (2019), are made up of the acquisition and assimilation of external and internal knowledge that allow the reconstruction of other resources and capabilities.

### **Case study: Artificial Intelligence Center - IA.Center State of Chihuahua**

Center of Artificial Intelligence – IA.Center State de Chihuahua is located in Ciudad Juárez, Chihuahua, Mexico. It is a non-profit civil society organization that started operations in March 2020. The mission of Center of Artificial Intelligence – IA.Center State de Chihuahua is “deploy programs and projects for the development of talent, innovation and technology-based entrepreneurship, which promote the improvement of regional digital competitiveness, social mobility and links with industry, academia, government and the community in general” (IA.Center, 2023).

Its regional ecosystem of technological entrepreneurship is very poor. In Chihuahua State the entrepreneurial ecosystem is conformed of two regional/local ecosystems: Chihuahua City and Juarez City. Chihuahua City entrepreneurial ecosystem is bigger than Juarez City and with more actors. Chihuahua has 15 startups which represents about 3% of Mexico’s sampled startups and is the 5th best startup ecosystem in Mexico. Three are Tech startup: Pagando (fintech), Savefruit (Healthtech) and Mosha (Edtech). Another four are related with software & data: Nexum Legal, KeyA, Alex and Byeo. That means, that about 50% of startups are related to technology (StartupBlink, 2023h). It has 7 coworking spaces, 8 organizations involved with innovation, more than 25 leaders and 1 accelerator (MCFI, 2020a; DECJ, 2023).

Juarez City, entrepreneurship ecosystem entered to the global top 1,000 cities in the Global Startup Ecosystem Index with the 840th place. Juarez City has 3 startups which represents about 1% of Mexico’s sampled startups, all of them, related with technology: Lottus Education (Edtech), BildTek (Hardware & IoT) and RONDINC (software & data). Juarez City is the 11th best startup ecosystem in National Ranking, 15th in Central America Regional Ranking (StartupBlink, 2023i). It has 2 coworking spaces, 5 organizations involved with innovation, more than 20 leaders, 5 accelerator and 12 universities (MCFI, 2020b; DECJ, 2023). One of the organizations involved with technology in Juarez City is Center of Artificial Intelligence – IA.Center Estado de Chihuahua.

According with the specific objective of this case study is to describe where its actors (the actors of Center of Artificial Intelligence – IA.Center Estado de Chihuahua) work to reduce the weaknesses identify in Entrepreneurship in Latin America Results. Table 5 includes an alignment of the main entrepreneurial weaknesses in LA grouped by theme and actors, and those that are detected and worked on in the case study.

¿What is Center of Artificial Intelligence – IA.Center Estado de Chihuahua doing to reduce weaknesses detected? In the weaknesses of low technological and artificial intelligence (AI) qualification of the population IA.Center (2023) works with an organic and innovative operating model that integrates 3 strategic pillars: continuous learning, innovation and technological development using AI and technology-based entrepreneurship. It is an organic and innovative

model, because you cannot aspire to technological and AI entrepreneurship if you do not have pull talent that knows how to use and develop AI and technology. This is why in the continuous learning pillar IA.Center offers courses, diplomas and specializations in various technologies so that, with the talent pull is formed, they can be integrated into projects that solve technological problems of companies, using IA tools. And later, this talent that learns in practice with AI projects can develop technological ventures, or at least, this is the inspirational idea IA.Center is working for.

**Table 5.**

Alignment of entrepreneurial weaknesses in LA and case study

Actors	Weaknesses in LA	Weaknesses detected by Case study
Education	Entrepreneurial Education at School, Entrepreneurial Human Capital	Low technological and artificial intelligence (AI) qualification of the population
Government	Government Policy: support and relevance	Government, civil society, and universities entrepreneurship offices, mostly promote the initial stage of entrepreneurship
Economic and Civil society	STI Platform and Business Structure	
	R + D Transfers	Recurring idea of not giving recognition or economic participation to TE teachers or advisors in the ventures
Financial	Ease of Access to Entrepreneurial Finance	

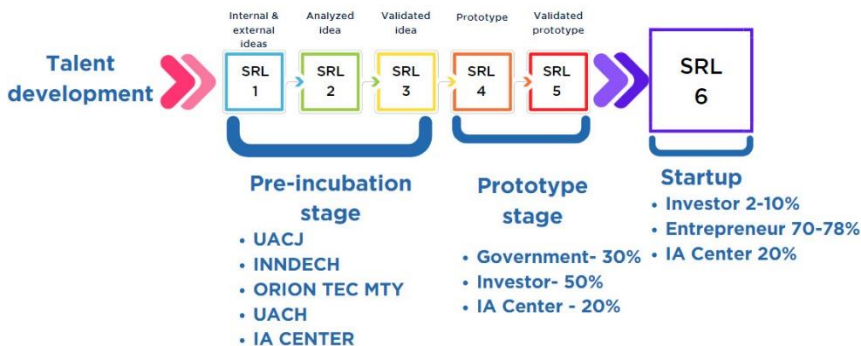
Note: own elaboration based on GEM (2023), IDE (2022) StartupBlink (2023a) and collection instruments of the case study

In the weaknesses where the different actors related to promoting entrepreneurship as government, civil society, and universities offices, mostly promote the initial stage of entrepreneurship, IA.Center (2023) works with IA Start as the technology-based entrepreneurship brand of the IA.Center. An open innovation model is used, where fits ideas and internal and external technological capacities, with support and investment from different sectors: government, companies, venture investors, angel investors or some other interest group. This model combines the support in talent development, including the Startup Readiness Level (SRL) in the entrepreneurship stages and finance suggest funding. Figure 1 presents IA Start tech entrepreneurship model with talent development, SRL and finance options.

The SRL is a entrepreneurship maturity model which involves taking an idea (SRL 1) to a validated idea (SRL 3); a prototype (SRL4) to a validated prototype (SRL 5); a product (SRL 6) to a profit product (SRL 8); and ideally generate a technology company with high value for the region (SRL 9). In IA Start of IA.Center (2023) works the first five levels of SRL, while the other actors in the ecosystem promote programs or initiatives that remain at level 1 or 2, very few at level 3.

Figure 1.

IA Start tech entrepreneurship model with talent development, SRL and finance options



For example, Chihuahua City entrepreneur ecosystem has a lot of inspirational events like Innovacion Week, Startup Weekend Chihuahua, among others. And in Juarez City entrepreneur ecosystem has just few inspirational events that have been growing in recent years like Startup Weekend Juarez, TEDx Juarez City, Roda movil, RESET, HUBARTE, among others (MCFI, 2020a; DECJ, 2023). Another example is Startup Chihuahua (2023) has a program that provides support in the initial stage of technological projects, before startup incubation, with four stages: ideas, projects, startups, companies. In the projects stage, they are given guidance from technology and business experts. But, there is a lack of spaces for technological validation (IDB-HolonIQ, 2021) and that is why, we incorporate the technological maturity of the venture into the model, using the Startup Readiness Level (SRL).

In the weaknesses of recurring idea of not giving recognition or economic participation to TE teachers or advisors in the technological entrepreneurship, in IA.Center, concrete actions have not yet been carried out, but there is planning to update our IA Start, taking as a reference the guides, policies and principles of universities with high rates of startups, to define the economic participation of professors and advisors.

## Discussion

The discussion is divided into three parts: weaknesses of entrepreneurship, actors in the entrepreneurial ecosystem and the case study.

### Weaknesses of LA entrepreneurship

The weaknesses of LA entrepreneurship detected in results section are Entrepreneurial Education at School, Entrepreneurial Human Capital, STI Platform and Business Structure. And also, Government Policy: support and relevance, Ease of Access to Entrepreneurial Finance and R + D Transfers.

Entrepreneurial Education at School and Entrepreneurial Human Capital are another entrepreneurial weakness in LA. According to OECD (2009) “education for entrepreneurship programmes can be delivered at different levels of the education System” (p. 5) that is, being imparted from the primary level to the university. Sánchez *et al.* (2017) found that entrepreneurial education in LA presents a diverse panorama due to political regimes and realities that exist in

each of the countries. Panamá, Costa Rica, México, El Salvador, Honduras, Guatemala, Nicaragua and Dominican Republic have few educational efforts comparing with Colombia or Brazil. These countries have few initiatives to introduce entrepreneurship to the primary level curriculum, concentrating most of their efforts in the university. In addition, the few initiatives developed at the primary level are civil society organizations programs instead promoted by government politics or educational regulations.

Related to R + D transfers, Amorós *et al.* (2019) found that is negative the impact on individual's innovative entrepreneurship expectations related with the efficiency of tech transfer between universities and firms. Stuart and Olaya (2018) mention that in LA the technology basically depend on direct foreign investment and little dependence on R + D. This confirms the example in the introduction of this article, that the balance in exports and imports of Information Technology enable Services revels, that LA invest very little in R + D because most innovations are through imports (UN ECLAC-CII, 2021). That means, that develop in technology and innovation in LA is not one of the matters in public and private environment, because the facility of imports allows them to use it quickly.

### **Actors in the entrepreneurial LA ecosystem**

As we mentioned in results section, weaknesses of entrepreneurship are very similar in LA countries and are grouped into four categories that are in themselves four actors in the entrepreneurial ecosystem: education, government, finance, and innovation and technology.

In education, three main topics: entrepreneurial education at school, entrepreneurial human capital and level of English proficiency. All these three main topics focused on the need to train the population in entrepreneurship from primary school levels to those who are already in the market. OECD (2015) suggest categorized into three approaches the entrepreneurial education: teaching "about", "for" and "through". Teaching "about" means to give a general understanding of entrepreneurship, like in higher education institutions. Teaching "for" gives the entrepreneurs the knowledge and skills them require and Teaching "through" means entrepreneurial learning process to all students and on all levels of education. This suggestion is clearly one of the weaknesses of LA and Mexico, since entrepreneurial education is focused mainly on the higher level and on those entrepreneurs, who approach government or civil society programs. This means that the actors in the educational system share an unequal role in entrepreneurship, while at the primary and secondary educational levels it is practically non-existent, at the higher-level efforts are concentrated on "about" type teaching in their curricula and teaching type "for" in those who have business incubators. In teaching type "for" other educational actors not immersed in the formal educational system also interfere in "for" type teaching: civil society organizations and government agencies, which also offer entrepreneurship courses as Artificial Intelligence Center - IA.Center State of Chihuahua.

The government as a weakness of entrepreneurship plays a very important role in implementing public policy mechanisms that can promote entrepreneurship, hence the analysis of global reports and indices, repeatedly mention the need for reforms to promote these businesses, reduce taxes and bureaucracy. The role that it is currently playing is differentiated at a national, regional or local level through programs and economic support that promote entrepreneurship; also, generating legal regulations by creating laws and regulations. However, much remains to be done, for example, specifically including technological entrepreneurship in

legal regulations, since unlike entrepreneurship in general, it requires greater investment in talent and money.

The other two actors mentioned in the weaknesses are even more linked to the third question that guides this study: Why is technological entrepreneurship so low in LA?

and the answer has several edges. One of them, perhaps the basis of all of them, is related to innovation and education. Just as we mentioned education for entrepreneurship at all levels, education in innovation and entrepreneurship must be promoted to make technological entrepreneurship grow. The IDB-HoloniQ (2021) finds that EdTech ecosystem in LA are growing fast but still in earlier maturity stages and classifies countries into five levels: nascent, foundational, late activation, acceleration and established. None of the countries in LA has established EdTech ecosystem and just Brazil in acceleration stage with “broad and deep ecosystem with strong funding and investor with unfulfilled potential” (p. 70). Guatemala, Uruguay and Caribbean in nascent level, Colombia and Chile in foundational level; Mexico, Peru and Argentina in late activation level, with “several advanced initiatives attracting and funding and developing talent within the ecosystem” (p. 70).

## Conclusions

The description and analysis of technological entrepreneurial activity in Latin America and Artificial Intelligence Center - IA.Center State of Chihuahua case study aligned on actors and detected weaknesses. In education actors, main weaknesses in LA are related to Entrepreneurial Education at School and Entrepreneurial Human Capital, and the one’s detected in the case study, are the low technological and artificial intelligence (AI) qualification of the population. AI and big data will comprise more than 40% of the technology training programmes (WEF, 2023) due to talent shortage.

Unfortunately, if innovation, technology and entrepreneurship are not teaching, it is difficult to advance without this knowledge platform. Teach this kind of issues is the first step to grow entrepreneur, entrepreneur tech-based and startup ecosystems. The weakness or EdTech Ecosystems are similar as the entrepreneur ecosystems mentioned before. IDB-HoloniQ (2021) mentioned EdTech needed to grow: initiatives to incentivize the use of EdTech in public and private schools and universities; better access to growth capital; better support in early stage; better interrelation with the regional actors that participate in the ecosystem; and easier access to talent regionally and globally. That’s why in IA.Center (2023) develop talent training programs in AI, technology and entrepreneurship simultaneously in university students and professionals, as well as in basic educational levels

Another find in government, economic and civil society actors, main weaknesses in LA are related to Government Policy: support and relevance, STI Platform and Business Structure and R + D Transfers, and the one’s detected in the case study, are Government, civil society, and universities entrepreneurship offices, mostly promote the initial stage of entrepreneurship.

In the IA Start model of IA.Center (2023), SRL allows defining with metrics similar to the technological readiness level (TRL) not only the progress they have made, but also the actors that can contribute to their financing. To incorporate TRL for startup, is not new, since it has been studied by Hasenauer et al. (2016), Boburg and Mazariegos (2022) and others. Specifically, in Juarez City entrepreneurship ecosystem, the first three SRL stages participates government, civil society, and universities entrepreneurship offices. But from SRL 4-6 stages of technological

prototyping, another type of financing is required, since the actors involved must be experts in AI and Tech.

The last find in Financial actors, main weaknesses in LA are related to Ease of Access to Entrepreneurial Finance, and the one's detected in the case study, are the recurring idea of not giving recognition or economic participation to TE teachers or advisors in the ventures. In IA Start tech entrepreneurship model with talent development, Startup Readiness Level and finance options (see figure 1), IA.Center (2023) propose 20% of financial participation from SRL 6, offering its AI, technological and talent structure available to entrepreneurs, to develop the prototype and once the company is established, that percentage is returned in a medium-term time ramp that allows other entrepreneurs to be financed.

It is in this learning of technological prototyping, where has it been learned that many times the work that is develop, goes beyond what entrepreneurs seek, since many times not even they know that so much technology exists for the development of their venture. In this sense, it is the proposal of update the regulations of entrepreneurship offices, taking as a reference the guides, policies and principles of universities with high rates of startups, that define the economic participation of entities, professors and advisors. For example, in MIT University separate and distinct the entrepreneurship and research activities, because the research that students make in tech-labs is fundamental for their course approval and by its nature publishable, while entrepreneurship activities like commercialization, are not research activities and are intended for financial gain. They also present the guidance for different circumstances with Startup Scenario flowchart and define different forms of support depending if the startup is going to use MIT-owned technologies or not (MIT Office of Graduate Education, 2023).

The analysis of the weaknesses and actors of technological entrepreneurship in LA, as well as the description of the actions that the case study is carrying out to reduce the weaknesses that it detects in its own entrepreneurial ecosystem, contribute to the theory of resources and capabilities, since they show in the case study, for example, the valuable human, technological, infrastructure and relational resources available to it to develop its business model. Likewise, they demonstrate their capacities to implement, coordinate and combine their different resources through organizational processes that allow them to contribute to the development of technological entrepreneurship in their regional ecosystem.

The pillar of technological entrepreneurship is extremely important for the IA.Center (2023), because it is where value begins to be generated for our region. It is not enough to bring foreign investment to our state, but we must create an entrepreneurial base with a sense of relevance and regional roots, so that our communities can evolve, generating opportunities for the population and our companies, as well as supporting, promoting and taking advantage of the innovation capabilities that are brewing in our state.

### Interest conflict declaration

N/A.

### Authors contribution

Author	Concept	Data curation	Analysis/ Software	Research/ Methodology	Project/ sources	Supervision/ Validation	Initial write	Final editon
1	X	X	X	X	X		X	X
2	X		X	X	X	X	X	X

3					X		X	X	X
4					X			X	X

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N/A.

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