PUERTO RICO AS ISLAND OF KNOWLEDGE: LESSONS LEARNED FROM SUCCESSFUL ENTREPRENEURS

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Abstract

Entrepreneurs from 10 different companies in the knowledge economy sector of Puerto Rico (PR), varying in operation from two to 25 years, were interviewed to understand which innovation ecosystem elements have contributed or hindered their companies' growth. We learn about the journey of these companies and explore their leaders' perception of how creating and operating a knowledge company in PR benefits or hampers their businesses. Entrepreneurs assess what could the commercial sector, educational institutions, and the government do to help their companies be more successful. They also reflect on the concept of Puerto Rico as an Island of Knowledge. Through the analysis of ten case studies, the article provides original and valuable insight into the entrepreneurial ecosystem in Puerto Rico to help researchers and policy makers understand the opportunities and pitfalls faced by Island-based innovators seeking to make their mark in the knowledge economy. We conclude that Puerto Rico is an Island of Knowledge in progress. The innovation ecosystem is currently growing but it remains smaller than needed to foster explosive growth. We found that entrepreneurship and company acceleration programs are having positive impact in growing the creation and sustainability of new knowledge companies on the Island. Puerto Rico is a good source of human capital for knowledge enterprises, but it could do better. Schools and universities need to teach entrepreneurship and bring more students to tech careers. Higher education curricula needs to be updated to cover a variety of new technologies and provide a myriad of practical skills and technical certifications to make graduates productive on day 1. Government and employers alike need to implement creative strategies to retain qualified talent on the Island.

Keywords

Knowledge economy, entrepreneurship, tech sector, knowledge islands, company acceleration

Introduction

This study provides a voice to entrepreneurs vying to grow knowledge and tech-based companies to compete in the knowledge economy. This study follows-up on previous research conducted by Flores-Caraballo (2018) examining incubation and acceleration programs that seek to foster innovation in Puerto Rico. The current study helps to assess the impact of these programs in the establishment, growth and long-term viability of companies participating in these innovation and entrepreneurship programs. This study also broadens the scope of our analysis, discussing -from the entrepreneur perspective- the challenges and assistance they encounter in the processes related to finding financial capital, qualified workers, an adequate customer base, and supportive systems from their interaction with governments, trade organizations, and other elements.

We conducted interviews with 10 successful entrepreneurs in Puerto Rico to gain understanding and insights on the impact that company vision and innovation support ecosystem play in building –or hindering- the growth of their knowledge enterprises. These businesses leaders reflect on what it takes to build a company on a Caribbean Island and to export their products and services beyond their shores. They tackle the challenges of meeting financial, human, structural and relational capital needs. These entrepreneurs offer recommendations to overcome challenges, to grow their companies, and to build Puerto Rico's might as a knowledge island. These insights are valuable to researchers and policy makers focused on the business and development opportunities that innovation ventures can yield to grow the economy of Island nations or territories.

Theoretical Background

Freitas and Kitson (2018) posit that the existence of an effective entrepreneurial ecosystem is important for economic development and growth. They contrast how these ecosystems are perceived on Island economies and core/central regions in Spain (Canary Islands vs Catalonia) and Portugal (Madeira vs. Lisbon), concluding that "firms in remote islands perceive that they operate in a less favourable entrepreneurial ecosystem compared to firms in core regions". These authors hypothesize that "in terms of new firm formation, the support from governmental policy will be more important for firms in remote islands compared with firms in core regions". Their survey research found that the private ecosystem is indeed stronger in core regions while government incentives were more readily sought by Island-based entrepreneurs.

Access to financing is a critical component of the innovation ecosystem. Klonowski (2020) argues that "At least four pillars have played an important role in the development of the entrepreneurial ecosystem in emerging markets: general economic development and transformation, systemic infrastructure improvement, access to finance, and the advisory sector." (p376). These pillars interact with one another in a synergistic and interdependent fashion. In most emerging markets these pillars are underdeveloped and thus "The challenge of financial access, along with other problems corresponding to emerging markets, has perhaps motivated many governments to embrace the idea of public assistance in the SME sector" (p379).

The creation of the Puerto Rico Science and Technology Cluster and various other actions of the government of PR over the last 20 years (EFE News Service 2018) have shown their awareness of entrepreneurship deficiencies and of the high potential of the otherwise capable

Puerto Rican workforce in the new economy: "To buoy the tech sector, Puerto Rico is trying to reinvent itself as a knowledge-based economy that will compete globally in part by creating a thriving entrepreneurial ecosystem" (Glade 2017). While Puerto Rico is still far away from adopting a national system of innovation (Lundvall 2016), a number or government, business, and educational initiatives are contributing to build the innovation ecosystem on the Island. While the size and capital availability in Puerto Rico present sizable challenges, there is a collective perception that the Island could become a tech cluster (Kerr, W., & Robert-Nicoud, F. 2020).

Puerto Rico's ecosystem for innovation is small and growing. In fact, "Puerto Rico ranked as the seventh-best tech hub in Latin America and 70th globally in a set of 2019 rankings from "StartupBlink" (Krumholtz, M. 2021). The Foundation for Puerto Rico (2021) highlights the importance of making this ecosystem work for every town on the Island and for every sector, not just the knowledge economy. They highlight the seven pillars for an innovative ecosystem: Market potential, networks, access to capital, culture, infrastructure, skilled talent, and regulations (p32). The Foundation conducted a study in PR that examined all these ecosystem pillars and makes recommendations to improve and grow the entrepreneurial ecosystem on the Island and to make it a key component of economic growth and resiliency for the country, even in the face of huge natural disasters such as Hurricane María, which devastated PR in 2017. Lovato et al (2020) found out that "Despite the fact that Puerto Rico's entrepreneurial activity suffered an initial strong negative effect, it reemerged with strength after the hurricanes." In this paper, we focus our discussion on networks, access to capital, culture, skilled talent, and regulations.

Berríos (2017) conducted a survey on entrepreneurship among Puerto Rican private university students and found that seven out of ten don't have entrepreneurs in their family and he concludes that "a supportive entrepreneurial environment is needed to nurture the new ventures". Furthermore, Berríos found that dominant traits of Puerto Rican survey respondents indicate "high levels of confidence, energy levels and thinking ability, but low presence of business knowledge, use of outside resources, initiative and responsibility and number sense traits." Given that Puerto Rico is a heavily indebted colony of the United States, with an economy highly dependent on imports, it is not surprising that up to this point the cultural orientation of most people seems to favor steady employment over taking risks creating a business of their own. Rivera et al (2021) studied the impact of entrepreneurship and innovation

courses among college students at the University of Puerto Rico Mayaguez campus (well known for its engineering and agricultural prowess) and found that these courses were quite influential on students and concluded that these findings are "important to keep incentivizing entrepreneurship and reach the less represented populations." (p1134).

The quest to make IT innovation a strong component of an incursion into the knowledge economy is not unique to PR, many other Island-nations and small countries are making efforts in this area. Sanz, Luis J and Román E Porrás (2012) examine the case of Costa Rica, a Central American nation with approximately five-million inhabitants. The IT industry in Costa Rica faces similar challenges to Puerto Rico: limited access to risk capital and to specialized human capital, inadequate government regulations, and uneven access to infrastructure. A notable observation by Sanz and Porrás regarding personnel mirrors Puerto Rico's current IT labor force situation: "The small size of the specialized workforce supply and a growing demand from the software industry compel existing companies to compete fiercely for qualified collaborators, pushing sector wages above the national average. Interesting, this salary structure is still below the level of developed economies, allowing Costa Rica to compete in the nearshore outsourcing market" (p185). Also, as is the case in Puerto Rico, in Costa Rica there is little collaboration between universities and the private sector: "It seems the university–company relationship is limited to the search for talent, wasting some of the human capital available at universities." (p.186). Costa Rica and PR have too few students pursuing careers in tech. Sanz and Porrás present valuable advice that applies to all small countries and Island nations trying to make it in the knowledge economy: "it is important to work on the dissemination of success stories and previous experiences to motivate future entrepreneurs, while at the same time working in high schools and colleges across the country to foster an entrepreneurship culture among the young." (p187).

Method

Dr Flores-Caraballo conducted in-depth interviews -at least one hour long each- with owners and leaders of 10 private companies based in Puerto Rico. Respondents were asked to provide informed consent to speak on the record so that we could reference openly their companies' case studies. Considering how small the entrepreneurial ecosystem in Puerto Rico is, it would have unfeasible to shield their identities.

The convenience sample was chosen on the criteria that these were Puerto Rican companies related to the tech, innovation, or knowledge sector. Some participants were known to Dr. Flores and others were referred by several entrepreneurship and company acceleration programs on the Island. Specifically, we approached for referrals the Puerto Rico Science and Technology Trust, Parallel18, Grupo Guayacán, and the Puerto Rico IT Cluster. Most of these organizations have entrepreneurship and acceleration programs or are comprised of innovative tech companies on the Island. We compiled a list of all the recommended companies, evaluated their websites to ensure they complied with our selection criteria, and then established communication via email and or telephone to explain the study and request participation. All potential subjects were sent the IRB-approved consent form via email and were explained that all interviews would be conducted on the record, meaning that their company and personal names would be divulged on the final publication. Once we obtained signed copies of the consent forms, interviews were coordinated by Dr. Flores-Caraballo' research assistants via email and telephone.

All interviews were conducted and recorded online by Dr. Flores-Caraballo, using the Microsoft 365 Teams platform following a semi-structured list of questions, previously cleared by the University of Puerto Rico-Río Piedras IRB. Artificial Intelligence (AI) utilities in the Microsoft 365 Stream video platform generated a transcript of each interview which were later cleaned up and summarized by Dr. Flores-Caraballo' research assistants per the interview guide sections.

We tabulated the participants' responses per the study objectives, preserving time code references to the specific recording sections of their interviews. We analyzed the content of the responses and incorporated direct quotes as deemed necessary to illustrate the findings. An online literature search was conducted on trade and academic journals to complement the study. We sought studies on entrepreneurship, Island-economies, and challenges developing a tech strategy for developing countries.

Study limitations include its small sample size and the potential underrepresentation of companies and perspectives unknown to the author. These limitations can be overcome in subsequent studies, expanding the sample size, and using survey methods to consider the opinions of a much broader base of participants.

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Results and discussions

The first objective of the interviews was to learn about the journey of these companies. The range of years in operation of these companies spans two to 20 years. All of them were established in Puerto Rico, mostly by Puerto Ricans, and a vast majority of these companies have participated in one or more entrepreneurship or company acceleration programs. Several have received grants from local organizations and others have received federal (USA government) innovation grants. A few have also received funding from investors. All the companies in the sample are exporting products and services already, some to the United States, or the Caribbean, others to Latin America, Europe, and beyond. These companies represent several innovative fields in the tech sector: Analytics, GIS, marketing intelligence, research and development, software as a service, mobile apps, technological services, design and training.

The key attribute of our sample is the varied experiences contained in this group of entrepreneurs. We interviewed three women and seven men, nine of them owners or founding partners of their businesses, the 10th was a senior founding executive in the company. Table 1 identifies the members of our sample and provides links to their companies' websites:

Table 1: Knowledge Entrepreneurs Interviewed

Name of the interviewee	Name of the company	Position	Company website
Kevin González	Abexus PR	Managing Partner	https://www.abexuspr.com/
Manuel Ortiz	Burea PR	CTO	https://burea.app
Edisa Albino González	CDI Labs	Operations, Sales, Business Development	https://cdi.bio
Alberto Lugo	INVID	President and founding partner	https://invidgroup.com/es/
Jose Bartolomei Díaz	OutcomeProject	Founder and CEO	https://outcomeproject.com
Martin Troisi	Overactive	CEO, chairman, and majority shareholder	https://insights.overactive.com/es/
Tommie Hernández	Sirena Patterns	Founder, Fashion Designer & Stylist	https://www.sirenapatterns.com/home-esp
Manuel Ramírez	Strain	CEO, and founder	https://thestrainapp.com
Vanessa Quiñones Orfila	TrackIt	CEO, and owner of the company	https://trackitpr.com
Carlos Meléndez	Wovenware	COO and Cofounder	https://www.wovenware.com

We have placed in the Appendix short profiles highlighting key accomplishments of the companies in the sample.

Assessing the Impact of Entrepreneurship Programs

There are many other innovative companies in Puerto Rico's tech sector. This cross section of companies interviewed range from the new to the well-established, from small to sizable. We asked these entrepreneurs if any of them had participated in business incubators or company acceleration programs. Most of them had at one stage or another of their development. As expected, the older companies did not have access to such programs in PR back in the 1990s and early 2000's. Virtually all the newer companies have benefited from participating in such programs, discussed at length in Flores (2018).

Competitive entrepreneurship programs such as Pre18 and Parallel 18 (P18), sponsored by the PR Science and Technology Trust, or PRSTT, provide seed grants, workspace, training and high-level consultancy to startup teams. They also provide access to angel investors and even venture capital investors. Grupo Guayacan offers business concept validation through its I-Corp program and helps established companies ready themselves to accelerate and export services through their Guayacan Venture Accelerator (GVA) program. There are several other entrepreneurship programs available on the Island, some sponsored by specific cities or regional economic development organizations. Furthermore, most US Federal grants are available for Puerto Rican innovators to compete. The best well known are the SBIR/STTR programs issued by several US government agencies. These are US nation-wide highly competitive calls for proposals. With the support of the PRSTT and other organizations, more and more Puerto Rican entrepreneurs and researchers are applying for these grants, although their success rate is still fairly low. The government of PR has also revamped its tax incentives, originally created to attract foreign investments, to promote entrepreneurship and exports among PR companies. These incentives are coded in several laws (Act 73, 20, 22, 60), which heavily lower the tax burden for companies manufacturing in PR or exporting products and services from PR. Altogether, entrepreneurship programs in Puerto Rico have brought forward the development of an entrepreneurship mindset and support systems for people interested in creating and growing their own business. More specifically, and pertaining our research sample:

1. Abexus PR has benefited from multiple entrepreneur and incentive programs: Pre18, P18, Guayacan I-Corps); PR tax incentives through Act 60, and the Bravo Family Foundation Rising Enterprise Program
2. Burea PR participated in the P18 and Banco Popular de Puerto Rico (BPPR) entrepreneur programs. They are also enjoying tax incentives from Law 73 and Act 60. As mentioned elsewhere in this paper, they are the first Puerto Rican owned startup to receive five million dollars in Series A investments.

3. CDI Labs benefited from multiple entrepreneur and incentive programs (P18, MIT, Puerto Rico Industrial Development Company (PRIDCO), GVA), They have also received grants through: SBIR, STTR, National Institutes of Health, PRSTT programs.
4. INVID Participated in the Guayacán Venture Accelerator and enjoys tax incentives through Act 73 and Act 60.
5. OutcomeProject validated its concept through Guayacan's I-Corps program. They also participated in the PRSTT's Pre18 and Parallel 18 programs, and received support from Puerto Rico's Trade and Export Company, with courses offered through INprende and the Puerto Rico Emprende Academy.
6. Sirena Patterns participated in P18 and received the Investor Choice Award. They also won second place in Guayacan's EnterPRize startup competition. They also participated in the Bravo Family Foundation's Rising Entrepreneur program.
7. Strain was part of the PRSTT's Parallel 18 program and they have applied for Act 60 tax incentives.
8. Years before founding TrackIt, Vanessa Quiñones received a sizable grant from the National Aeronautics and Space Administration (NASA) to conduct measurements in El Yunque National Forest in PR. That opportunity seeded in her the idea of creating her own company.
9. Wovenware has received incentives from PRIDCO and has earned Act 73 and 60 tax decrees for their software production and exports.
10. Overactive has not participated in entrepreneurship programs in PR.

Entrepreneurship programs were heavily praised by our interview subjects. They rated the theoretical foundation provided as excellent and the advice given was quite sound, helping them mature their ideas and become market savvy much faster than they could on their own. Several also attested that the entrepreneurship/seed grants, usually ranging between $15,000 and $45,000USD afforded them the freedom to dedicate more time to their venture and to invest in development and marketing activities that would have been difficult to finance through commercial banks or otherwise.

Finding and Keeping Qualified Human Capital

Securing qualified human capital was a major topic of discussion during our interviews. Seeking competent personnel for a knowledge-based company in PR seems to be both a blessing and a curse: On the one hand, entrepreneurs praised the quality of Puerto Rican technical workers; on the other hand, all these entrepreneurs complained about the extremely limited pool of candidates available and how difficult it was to retain them in the face of continuous offers these employees receive from higher-paying competitors in the continental US.

Martin Troisi provided us with an interesting insight into this topic. Uruguayan by birth, he studied in PR and created his company on the Island. He's deeply impressed with the quality

of PR workers, and he posits that knowledge workers in PR have a significant advantage over many other Latin American countries. Given their immersion in US culture and open access to US educational and commercial resources, people in PR have a rather bilingual and bicultural upbringing and a good understanding of the US work ethic. Furthermore, many Puerto Ricans with higher education have well developed bilingual skills, earning them a wider range to work with, and serve, customers across the Americas. He believes many underestimate the great potential of Puerto Rican knowledge workers. Nonetheless, he also laments the very small pool of tech sector talent available in Puerto Rico. That reality forced him to open offices in other countries in Latin America to meet the demand for talent in his company, which today employs over 1,000 people. That's a strategy that several other entrepreneurs interviewed for this study have been forced to adopt.

Pertaining employee retention, these tech company owners have come up with creative incentives to attract -and keep- their personnel. Vanessa Quiñones from TrackIt told us that she has very low employee turnover because she gives her people a deep sense of purpose and pride in working for their company, always challenging them with innovative projects and providing a collaborative environment that keeps them growing, interested, and feeling respected. Alberto Lugo from INVID explained that his retention strategy starts with building a "solid and perfect work culture." INVID also adopted attractive compensation plans and quality of life assurances. They listen intently to their staff and seek employee feedback on a quarterly basis. Several of our respondents explained that they invest significant resources paying above average salaries and quarterly productivity bonuses than usually paid on the Island, particularly to attract highly specialized talent. Abexus has, on occasion, paid college tuition for talented employees who are still studying.

Paying high salaries is not always feasible for small companies, stated Manuel Ramírez from Strain, and he sees many young and promising developers leaving for the US seeking high compensation packages. Larger companies like Wovenware invest significant resources to pay salaries on par with similar companies based in Florida or Texas, for example, explained Carlos Melendez.

Several companies in the sample offer internships to college students, some paid and others unpaid, to help identify and mentor new talent for their companies. These programs slowed down during the past year due to COVID restrictions, but they will be restarted in earnest as the situation normalizes.

Building up Puerto Rico's Human Capital

We asked respondents to tell us what could educational institutions do to make their companies' work easier. The overriding ask from all of them was that universities and technical schools need to recruit and graduate a significantly higher number of students in computer science and information technology professions. Companies like Burea PR, need engineers, developers, and graphic designers.

Kevin Gonzalez, from Abexus PR, would like to have universities provide higher level technological training to students, particularly in software programming and analytics. He would also like universities help students attain technical certifications to make them more productive on day one after they graduate. Manuel Ramírez from Strain went further, advising K12 schools to teach and develop software programming skills at an early age.

Virtually all respondents stressed that universities in PR need to update their curricula more often, and to develop students' technological and scientific skills, especially pertaining emerging technologies such as GIS and artificial intelligence. Carlos Meléndez from Wovenware stressed that universities' curricula need to be agile and responsive to the needs of the market.

Edisa Albino, from CDI Labs, argued also that universities need to teach real-life skills, expose students to the work environment through internships; develop professional maturity, critical thinking, and emotional intelligence in their students. Specifically, she contended that students need to understand how pharma and medical devices manufacturing works. This knowledge is vital to recruit talent to work in the Bio Tech industry.

Tommie Hernández from Sirena Patterns stated that educational institutions should prepare students to be self-sufficient, problem solvers, and public speakers. They should also have access to entrepreneurship courses in schools and universities.

Some of the companies in our study collaborate directly with universities and with entrepreneurship programs hoping to grow and improve the quality of the pool of workers in the tech sector. INVID has partnerships with Parallel 18, and with universities such as Universidad Politécnica, University of Puerto Rico at Mayagüez and Bayamón.

Why base your knowledge enterprise in Puerto Rico?

Puerto Rico shares many attributes with other Islands trying to build a niche in the knowledge economy. We asked respondents to reflect on the positive and negative aspects of building their company on this Caribbean Island. Manuel Ortíz from Burea and José Bartolomei from the OutcomeProject value Puerto Rico as a test market. The Island is a densely populated location which provides an ideal setting to test data science services in many disciplines, from marketing to health data.

Newer companies are very satisfied with the value added to them by entrepreneurship programs. Puerto Rico being a smaller market it was easier to win entry into these programs and benefit from their training and seed grants.

Several respondents highlighted that operational costs are lower in PR than in the US, and they still have access to the US market, provided they find the right model to sell abroad. In that regard, Puerto Rico's extremely generous tax incentive programs provides additional value to having PR as HQ.

Puerto Rico is also an attractive location to work in, with its fantastic weather, warm waters, high-quality entertainment options, and other quality of life elements that sometimes helps bring back or attract to PR talent from abroad, as stated by Wovenware's Carlos Meléndez.

The negative aspects of creating your knowledge company in Puerto Rico include the small size of the innovation ecosystem on the Island. This limits the availability of qualified talent, risk capital investors, additional knowledge companies to complement yours, and of a large market for products and services.

Furthermore, the Puerto Rican government has an uneven record in fostering innovation. While the creation of the PRSTT and the passing of Act 60 contribute to grow the knowledge economy, most government agencies on the Island have antiquated requirements and bylaws that seem to be blind to the unique characteristics of knowledge companies. These agencies are still geared to expect brick and mortar offices (as opposed to virtual companies where everyone works from home), full-time employees (instead of contractors and other work arrangements), retail or manufacturing operations (instead of web services, SaaS, consulting, R&D).

Most respondents complained about Puerto Rico's government bureaucracy. They deem it backward, complex, and slow. Edisa Albino from CDI Labs stated that "the government should

help, not hinder, the creation of innovative companies; learn about the unique characteristics of R&D work; and assist in the development of specialized talent." Kevin González from Abexus PR highlighted that the government "needs to reduce bureaucracy and simplify accounting and taxing systems" and should also "clarify its economic development objectives for the tech sector and help provide more access to risk investors." Alberto Lugo from INVID would also like to see the PR government "do away with the inventory tax, find a way to lower energy costs on the Island, and provide additional capital sources for tech/innovation companies." Mr. Lugo went further, suggesting additional incentives that the government could bring forth to create more opportunities for future entrepreneurs in technology: "like not paying taxes for the first 5 years or offering tuition-free university degrees and free equipment to young talent who choose to stay in Puerto Rico to work or create an innovation business." In that regard, Jose Bartolomei from the OutcomeProject, would like to see the PR government "strive to become the Silicon Valley of the Caribbean, developing its innovation ecosystem." Martin Troisi from Overactive made a comprehensive statement regarding the direction he'd like the government take: "The PR Government needs to acknowledge that the knowledge industry is vital for the growth of the country, empowering the ecosystem generated by technology, working with the private sector, and adopting specific objectives and a vision to encourage entrepreneurs to not leave the Island."

The commercial sector also needs to do more

During the interview, we asked these business leaders to also comment on what could the commercial sector of the country do to help their business. Here the responses went in two directions:

First, most respondents would like to see private banking more willing to provide risk capital for budding knowledge companies with great ideas and no prior track record. The banking industry on the Island is very conservative and often proves to be uninterested in financing non-traditional companies unless sizable personal guarantees are provided by the principals. "The commercial sector should help companies establish those first lines of credit that are required for capital" argued Carlos Meléndez from Wovenware. The challenge to achieve local financing stems partly from the entrepreneur's ability to "explain to your investors your line of business", recognized Edisa Albino from CDI Labs, a highly scientific knowledge company. Most banking organizations in PR don't have risk analysis personnel qualified to assess bleeding edge technological ventures.

Second, our respondents also called for private corporations to renew their thinking, welcoming analytics, and web-based solutions. We heard from new companies that come out with innovative data management services, only to strike out with many potential customers on the Island who are reticent to try new services. Jose Bartolomei from the OutcomeProject put it this way: "Institutions need to be more open about their problems, to help entrepreneurs create pertinent solutions. The commercial sector should be more open to collaborate with private and emerging companies." Manuel Ortiz, from Burea PR, realizes that much of this burden falls on entrepreneurs themselves, needing "to educate the commercial sector for better understanding of marketing analytics", for example.

Puerto Rico as Island of Knowledge

Towards the end of the interviews, we asked all respondents to reflect on the concept of Puerto Rico as Island of knowledge. We didn't provide additional prompting, we wanted to give them a few seconds to take that concept in, and to share with us their reaction to it. Responses were varied and insightful:

Vanessa Quiñones, CEO, and owner of the company TrackIt stated that "I believe that Puerto Rico is a knowledge island. Puerto Ricans have vast knowledge in various subjects. Students overcome the adversities and challenges they face. What needs to be encouraged is will power, knowledge, innovation, and leadership." This quote tells us that Ms. Quiñones values primarily the quality of Puerto Rico's human capital and believes that what it needs to excel is additional formation and support.

"There are two ways of looking at knowledge, from the point of view of consumption and production. We believe that Puerto Rico is a consumer of knowledge and a consumer of entities of technology. However, we can see that Puerto Rican companies can be developers of technology and producers of knowledge.", said to us Kevin González, Managing Partner, Abexus PR. Mr. González highlights the need for Puerto Rican entrepreneurs to shift their focus from consumption or distribution to creation. Sustainable success lies in producing knowledge capital.

Manuel Ortiz, CTO for Burea PR argued that "Puerto Rico is an excellent bilingual market, but more capital investment is required. Give importance to the development of human resources to keep talent in Puerto Rico. The money in Puerto Rico needs to be moved better". To Mr. Ortiz, financial and structural capital need to increase to grow the knowledge economy.

"Puerto Rico has a lot of work to do to become an Island of Knowledge, we have the tools to achieve the objective, but we are far from achieving it. I believe it depends mostly on people having the will power to prioritize becoming an Island of knowledge. We need to improve education, increase our talent pool with digital skills to become a worthy competitor in the world market", reflected Alberto Lugo, president and founding partner at INVID. Mr. Lugo has a realistic assessment of the lacking country-project surrounding the knowledge economy in Puerto Rico.

Jose Bartolomei Díaz, founder, and CEO OutcomeProject argues that we need to change the way students are educated in PR. Human capital on the Island needs to be pushed in a new direction: "Puerto Ricans are educated and knowledgeable people. The problem is that the talent leaves Puerto Rico and that students are trained to be employees. Universities like Stanford, teach their students to be, not only knowledgeable, but also business oriented. They foster that knowledge or business idea and then they assist them in finding the funds necessary to have that idea grow into fruition. That doesn't happen in Puerto Rico. We need to change people's mindset to allow them to desire becoming entrepreneurs instead of workers." One would argue that we also need workers; however, flaming the entrepreneur mindset in young talent may make them more open to join startups, even if they don't create their own.

"We must highlight the quality of Puerto Rican talent and the differences it has with other Latin American countries, especially because this is not always recognized. Puerto Ricans are well educated, bilingual and bicultural; they understand enterprise work ethics. Many entrepreneurs do not realize the potential Puerto Rican talent has, which makes it difficult for them to stay in the country. Additionally, we must underscore the systemic issues the Island faces to become a well-balanced innovation ecosystem." Martin Troisi, Overactive CEO, chairman, and majority shareholder. For decades, PRIDCO promoted PR to foreign investors as an ideal location with an ample supply of highly skilled, cheap workers. Mr. Troisi's take on this topic is that Puerto Rican talent has competitive advantages over many other countries, which would allow the country to promote the Island's workforce as a premium resource, not a cheap one.

Relational capital is what came to mind to Tommie Hernández, founder, Sirena Patterns: "I would say that collaboration is crucial, creating an environment in which designers help each other instead of seeing others as competitors. Collaboration is key in all aspects when working as an entrepreneur." Building trust among members of the entrepreneur ecosystem is always challenging. Trade organizations and talent development initiatives can be used to bring these

people together so that they can get to know one another and be more open to trust and collaborate with their colleagues, whether they are a direct competitor or not.

"We have to focus on making Puerto Rico an island of knowledge. We can innovate on everything well, but we are missing the opportunity to focus on certain areas to become a world class knowledge producer. We need to innovate on pharmaceuticals, aerospace, artificial intelligence, and software development." Carlos Meléndez, COO and Cofounder of Wovenware, argues in favor of building the innovation ecosystem around a cohesive effort to produce structural capital in select areas of innovation where PR could build a niche in the knowledge economy. This could be a useful strategy to also help universities prepare students in areas of need, and for government investment and support focus.

Manuel Ramírez, CEO and founder of Strain adopted a philosophical stance: "We should reflect on the concept of knowledge. How limited is our knowledge because we live on an Island and don't relate sufficiently with people from around the world? PR's government needs to invest in risk capital to open opportunities for Puerto Ricans to innovate and create new knowledge. It is important to have focus and yet we need to make strategic investments in several innovation fields so that we can respond to changes in the market. We can't invest everything in one discipline that may go belly up in a couple years".

Taken as a whole, the reflections made by these entrepreneurs coincide that the Puerto Rican innovation ecosystem should not act constrained by the fact that the country is an island. They argued that if the country adopts the objective of becoming a serious player in the knowledge economy, all members of the innovation sector need to motivate themselves to achieve it. They need to become their own cheerleaders and yet be willing to accept criticism and learn from their own mistakes. Most importantly, the innovation ecosystem needs to foster collaboration and listening to different points of view. These traits and having the willingness to change are essential to create knowledge. Ultimately, entrepreneurs in the knowledge island of Puerto Rico need to be export-oriented and to see the whole world as their potential market.

Conclusions

Puerto Rico is an Island of Knowledge… in progress. The innovation ecosystem is currently growing but it remains smaller than needed to foster explosive growth. The government has put in place alluring tax incentives that are finally relevant to the tech and innovation sector, but it has failed to update the bylaws and practices of the agencies that handle permits and impact the

creation and operations of new businesses, sabotaging the capability of the government to grow the innovation business sector in the economy. Following on Freitas and Kitson's (2018) assertion that Island entrepreneurs are more reliant on government incentives and startup policies, it can be disheartening for many to face half measures in which ambitious policies are enacted, only to be hampered by poor procedures and support systems.

Our interviews validated the positive impact that entrepreneurship and company acceleration programs have in growing the creation and sustainability of new knowledge companies on the Island. These programs need additional resources and risk capital investors to continue and expand their work, as stressed by Klonowski (2020), who identified for four pillars in the development of the entrepreneurial ecosystem in emerging markets: general economic development and transformation, systemic infrastructure improvement, access to finance, and the advisory sector.

Puerto Rico is a good source of human capital for knowledge enterprises, but it could be better. Schools and universities need to teach entrepreneurship. Higher education curricula need updating to cover a variety of new technologies and provide a myriad of practical skills and technical certifications to make graduates productive on day 1 on the job. Moreover, all sectors in PR need to encourage a higher number of students to go into tech programs to supply the talent demand. By the same token, government and employers alike need to implement creative strategies to retain qualified talent on the Island. It is very easy for them to apply for well-paying jobs in the US. Salaries and work conditions in PR need to become more competitive to halt the ongoing brain drain. In comparing the case of Puerto Rico to Costa Rica, based on what we learned from Sanz, Luis J and Román E Porrás (2012), we can conclude that Puerto Rico has structural advantages over Costa Rica, but the Central American country seems to be more effective in capitalizing government policies and foreign investment to empower the IT/knowledge economy in country.

This study will be presented to researchers and to leaders of innovation programs, government agencies, financial companies, and educational institutions to foster the strengthening of those aspects of their operations that are being effective and to foster the adoption of new practices to address those concerns that remain. Ultimately, our research series aims to improve the innovation ecosystem in Puerto Rico and to yield valuable lessons for other knowledge islands striving to grow their economies and to become significant players in the knowledge economy.

Our research on Puerto Rico as an Island of Knowledge is ongoing, we'll continue to interview policy makers, entrepreneurs, and other players in the innovation ecosystem to broaden our understanding and to explore how to project our findings and lessons learned to other island nations vying to become significant players in the knowledge economy. We'll seek the opportunity to launch comparative research efforts with fellow academics in other Island-nations and emerging markets.

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Appendix

Profiles of the companies included in the sample (in alphabetical order):

1. Abexus PR is an ecosystem technology company that was created in 2019 to offer software as a service (SaaS). It provides an analytics component that has developed proprietary technology to perform market analysis. The company has several products like the Profile Finder and Profile Generator through their platform KHORA AI. The platform allows companies, especially in areas of the United States market to distinguish the optimal points for discerning existing potential consumers and to perform segmentation analysis.
2. Burea PR developed a mobile application that allows consumers to save and receive cashback on purchases, without the need to clip or search for physical

coupons, compare prices, or go from store to store. Commercial customers pay for the marketing of their products and for analytics on product distribution and sales demographics. Burea PR was established in 2015 and it is the first Puerto Rican owned startup to gain five (5) million dollars in Series A investments. They serve customers in PR and Mexico.

3. CDI Labs provides scientific services to customers in China, the United States, Korea, and London. Focused on the development of Antigen HuProt™ Human Proteome Microarray. The company was founded in 2008 and it has been awarded eight (8) patents for technologies related to the expression and purification of thousands of proteins in a very short period. They have offices in Puerto Rico and in Baltimore, Maryland.
4. INVID has been in operation since 2003, developing custom software to improve processes, provide online experiences, manage and automate processes, and gain accurate insights. They serve customers in Puerto Rico, the United States, and Latin America. INVID made Inc. Magazine's 2021 Inc5000 list.
5. OutcomeProject is a company dedicated to Data Science, especially developing a systematic and scalable process to collect and analyze health data. They have been in operation since 2019, creating data management and analytics solutions on web-based platforms. They have been assisting several Puerto Rican municipalities providing contact tracing during the COVID-19 pandemic.
6. Overactive is an IT service company that provides digital modernization services for corporations, capitalizing on the nearshore business model. They work with Microsoft and open-source technologies, and with Microsoft, Google, and Amazon cloud providers. The company started in PR in 2008 and later opened offices in Uruguay, Colombia, Argentina, Chile, and the US. They offer services in Puerto Rico, the United States, and across Latin America.
7. Sirena Patterns is a woman-owned company, which was born out of the desire to bring to market Puerto Rican designed sewing patterns based on the owner's 20 years of experience in the fashion industry. Their physical products are distributed in Puerto Rico, the United States, and England. Sirena Patterns sells its online products in more than 49 countries. They also created an online sewing academy, offering online courses reaching over 20 countries. Through their online platform, customers can make purchases, download patterns, and instructions. They are the only Puerto Rican purveyor of custom sewing patterns.
8. Strain went into business in 2019 with a mobile app and marketing, sales, and retention platform connecting to the point of sale (POS) platform of cannabis dispensaries. Their technology maximizes the operation, expand the marketing network, increase sales, and helps retain cannabis dispensaries' customers. Strain's solution is comprised of a mobile application and web platform serving more than 500 cannabis dispensary locations and 350,000 patients in Puerto Rico, United States, and Canada.
9. TrackIt TrackIt is a Geographical Information Systems (GIS) services company with current geo data banks for Puerto Rico and the Caribbean. It is dedicated to intelligent geolocation services, and it is one of the leading GIS analysis firms on the Island, in operations since 1994. The company has a proven track record implementing sophisticated technologies and procedures to achieve clients' goals through the incorporation of geographic information systems into their workflows, database design, system architecture, project planning, project definition, collaborative project management and web mapping integration, field data validation, photogrammetry, and LIDAR data interpolation, among others. Their offering includes several GIS

proprietary products and custom services. This is a woman owned company and it has been recognized by internationally respected GIS organizations such as the Canadian Institute of Geomatics, URISA, and the GIS Certification Institute.

10. Wovenware was created in 2003 to provide digital transformation consulting and technical services through service design, software development, and emerging technologies such as artificial intelligence. They patented a method to create synthetic data and have been rated by Forrester as a leading company in Deep Learning. They have offices in PR and the US, and serve customers in PR, the US, and Europe.

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