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Review Article

Examining the San Diego Venture Ecosystem

John Michael York^{*1}, Jin Cho², Subbu Iyler³¹Orfalea College of Business, California Polytechnic State University, San Luis Obispo, USA²Qualcomm, San Diego, CA³ICW Group, San Diego, CA

***Corresponding author:** John Michael York, Pharm.D., M.B.A. Orfalea College of Business, California Polytechnic State University, San Luis Obispo, USA. Tel: +18052382485; Email: joyork@calpoly.edu

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Abstract

In the recent decade, San Diego, California has become a hub for startup activity in multiple sectors including biotechnology, cybertech, defense, energy, technology, and telecommunications. Ranked as one of the top places to launch a startup, it is the home to startup success including Acadia Pharmaceutical, Amylin, Gen-Probe, Illumina, ProFlowers, and Qualcomm. To understand the dynamics within this entrepreneurial community, the paper provides an overview of its venture ecosystem, defined as a mix of capabilities to support startup activity. It examines the research conducted to identify and discuss the key components within the community. These include major facilitators including trade organizations, accelerator/incubator programs, academia, private research institutes, city and state government, and key corporations. Then this paper will cover requisite support services including accounting, legal, insurance, human resources, and marketing, followed by a discussion of the real estate and financial capabilities to address the startup community needs. Afterwards, it will examine relationships within the community, strengths and weaknesses, and synergies. This review includes a comparison of San Diego's ecosystem characteristics with that of the San Francisco/Silicon Valley and Los Angeles/Orange County regions. The paper closes with an assessment of ecosystem and prospects for the future.

Keywords: Angel, Community capabilities, Entrepreneurship, San Diego, Startup, Venture capital, Venture ecosystem

Introduction/Background

When one thinks about San Diego, what comes to mind? To many, it is about surf, sun, Shamu, and Sea World. To others, it is about the San Diego Zoo, the Hotel Del, Petco Park, and Del Mar Racetrack. In business circles, most individuals do not think much about San Diego. To some, San Diego is a city trying to shake off its Navy town and tourist reputation. To most business people, they think of the convention center and the Gas Lamp District. Over the last twenty years, San Diego has evolved. It has moved from a military and tourist town to a tech town. Since the 1990s, San Diego has become a more diverse business community. Following the lead of Silicon Valley and the Bay area, San Diego has embraced innovation and entrepreneurial activity. In fact, in Tom Post's

Forbes Magazine 2014 article, he ranked San Diego as the best place to launch a startup [1]. San Diego has enjoyed the success of its first-generation of startups in its telecommunications, software, technology, and life sciences businesses. It is home to many dynamic firms (Table 1). The success of several first-generation startups has established now a foundation in San Diego for the next generation. Blockbuster successes, such as Qualcomm, have transformed the communications and tech scene. Life sciences successes, such as Agouron, Amylin, IDEC, Illumina, ISIS, and Thermo Fisher Scientific, have led some to rename San Diego as "biotech beach." The emergence of such players in this space has drawn outside corporations into the community. Today, AT&T, Verizon, Samsung, Huawei, Pfizer, and Novartis maintain some commercial or research presence.

Table 1: Examples of Companies Headquartered in San Diego

Apparel	Biotechnology
Reef sandals	Abgent
Tribal Gear	Acadia Pharmaceuticals
Bad Boy (brand)	Accelrys
Computer Software	Aethlon Medical
	Allerca
Aonix	AMN Healthcare
Axure	Amylin Pharmaceuticals Inc.
BackBone	Apricus Biosciences
DivX	Arena Pharmaceuticals
ESET, NA	Cytori Therapeutics
FutureWave (acquired by Macromedia)	Gen-Probe
Mitchell International	Genesee Scientific
Semantic Research	Genomics Institute of the Novartis Research Foundation
Silicon Beach (acquired by Aldus)	Halozyme Therapeutics
SweetLabs	Illumina
Peregrine Systems (acquired by Hewlett-Packard)	InvivoGen
ServiceNow	Nereus Pharmaceuticals
Websense	Neurocrine Biosciences
Teradata	NuVasive
Consumer Goods	ResMed
	The Scripps Research Institute
Dr. Bronner's Magic Soaps	Salk Institute for Biological Studies

Consumer Goods Continued	Biotechnology Continued
HD Supply	Sanford-Burnham Medical Research Institute
ProFlowers	Sequenom
WD-40 Company	Quidel Corporation
Underground Toys, LLC	Electronics
Defense Contracting	
Cubic	e.Digital Corporation
General Atomics	Mad Catz, Inc.
Energy	Chassis Plans
Envision Solar	Entertainment
Maxwell Technologies	Daybreak Game Company
Sempra Energy	Nautilus Entertainment Design
San Diego Gas & Electric	Food and Drink
Solar Turbines	
MobileOne	AleSmith Brewing
Events	Ballast Point Brewing Company
	Chicken of the Sea
The Allstar Group	Hash House a go go
Finance and Insurance	Karl Strauss Brewing
	Jack in the Box
California Bank and Trust	Rubio's Fresh Mexican Grill
Commonwealth Financial Network	Souplantation
Encore Capital Group	Stone Brewing

Finance and Insurance Continued	Food and Drink Continued
LPL Financial	Modern Times
Health	Sports
Arcturus Therapeutics	BMC USA
CareFusion	Ellsworth Handcrafted Bicycles
Dexcom	Sector 9
NuVasive	Bike Bandit
Scripps Health	Score Stream
Sharp HealthCare	Telecommunications
Internet	Cricket Communications
Satellite Internet	Continuous Computing
MindTouch	Jump Mobile
Veoh	Leap Wireless
SwoopThat.com	Next Wave Wireless
Ignite Visibility	Nokia UMT
Media	Novatel Wireless, Inc.
	Qualcomm
KSDY-LD	Skyriver
McKinnon Broadcasting	Transportation and Logistics
Mission Times Courier	
San Diego Business Journal	National Steel and Shipbuilding
Media Continued	Transportation and Logistics Continued

San Diego City Beat	Ryan Aeronautical
San Diego Jewish Journal	Other
San Diego Magazine	
San Diego Reader	Anacomp
Times of San Diego	Bridgepoint Education
U-T San Diego	Champion Ballroom Academy
Retail	Kyocera
	Nth Generation
PETCO	Peregrine Semiconductor
Price Smart	Quality Assurance International
Le Travel Store	The Allen Group

Considering the emergence of San Diego as a hub for entrepreneurial activity, this paper will explore this community’s venture ecosystem. First, this piece will outline our research into several of core elements that comprise the ecosystem: (1) facilitators; (2) services; (3) real estate; (4) workforce; and (5) financial. Second, it will examine relationships within the ecosystem, strengths and weaknesses, and comparisons to other ecosystems within California. Finally, the paper closes with several observations related the community’s future as a startup community for entrepreneurs to consider.

Elements of The Ecosystem

Facilitators

The cornerstone of a robust ecosystem is the number of facilitators that support entrepreneurs through the startup journey. These organizations have helped startups from inception to initial development to seed-stage funding to growth-stage funding. We can segment facilitators into several groups and will examine and before further in this section. The major groups that function as facilitators are summarized in (Table 2) include trade organizations, incubators/accelerators, the academic community, private research institutes, government (city and state), and corporations.

Table 2: Facilitators in the San Diego Ecosystem.

SECTOR	ORGANIZATION(S)	
Trade Organizations	CommNexus	
	San Diego Business & Entrepreneurs Exchange	
	San Diego Entrepreneurial Center & Startup Society	
	San Diego Intellectual Property Law Association	
Incubators/ Accelerators/ School Programs	Accelerators	Incubators
	Analytics Ventures	EvoNexus
	Connect Springboard	Moxie Center (UCSD)
	CyberHive	StartR (UCSD)
	Hera Labs	Von Liebig Center (UCSD)
	Janssen Labs	Wireless Health Hub
	Plug and Play San Diego	West Health Incubator
	Qualcomm Institute (UCSD)	Zahn Innovation Center (SDSU)
	Qualcomm Robotics Accelerator	Lavin Center for Entrepreneurship (SDSU)
Universities	University of California San Diego (UCSD)	
	San Diego State University (SDSU)	
	University of San Diego (USD)	
	California State University San Marcos (CSUSM)	
	Coleman College	
	Ashford University	
	California International Business University (CIBU)	
Private Research Institutes	Sanford-Burnham Prys Medical Research Institute	
	Salk Institute	
	Scripps Research Institute	
	Scripps Institute of Oceanography	
	Space and Naval Warfare Systems Command	
City of San Diego	Business Expansion Attraction and Retention Team	
	Government Incentives Team	
	San Diego Business and Industry Incentive Program	

	Offices/Programs	Tax Credits/Incentives
State of California	Innovation and Entrepreneurial Unit of the Governor’s Business and Economic Development Department (GO-Biz)	New Employment Credit California Competes State of California Board of Equalization Partial Sales Tax Exemption
	California Innovation Hub (i-Hub) San Diego	
Key Corporations	Qualcomm	
	Huawei	
	Janssen Labs	
	Irvine Company	

Trade Organization

As San Diego developed as a hub for telecommunications (e.g., Qualcomm, AT&T, and Verizon), CommNexus San Diego (formerly the San Diego Telecom Council) became a significant force and bridged a vast telecommunications community in the region. This non-profit organization pulled together companies from the telecommunications business, defense industry, service providers, professional trade organizations, and local government. Corporate partners, such as Qualcomm and Huawei, have supported CommNexus and hosted many CommNexus events.

CommNexus

CommNexus has brought an educational and strategic focus to the community and beyond. It positioned San Diego as a world center for innovation in technology and introduced San Diego technologies to national and international markets. Its annual activities have included over 50 events (networking and technical) and assistance (funding and business development) to over a hundred local startups. As the San Diego tech scene expanded beyond telecommunications, CommNexus developed twenty different special interest groups to support the diversity of new businesses within the community. Additionally, its efforts

spun out the CONNECT accelerator and the EvoNexus incubator programs.

Other Trade Organizations

Several organizations have played a role in this ecosystem. These include: 1) the San Diego Business and Entrepreneurs Exchange (SDEE) [3]; 2) San Diego Entrepreneurial Center and Startup Society (SDEC) [4]; and 3) the San Diego Intellectual Property Law Association (SDIPLA) [5]. SDEE is another non-profit run by local entrepreneurs. This organization supports interests in the life sciences, mobile health, diagnostics, medical devices, clean tech, biofuels and alternative energy space. It is a community for networking, and for locating resources. The organization appears to be more life science oriented in its support. SDEC is another community for networking and has over 2000 entrepreneur members. It sets up live networking and education events (mainly meetups), plus facilitates dialogue among its members via its web portal. SDIPLA [5] is another facilitator of intellectual property is critical to all technology industries. This organization offers a forum for members to exchange ideas and engage in stimulating discussions concerning the current intellectual property (IP) issues and network. This organization is influential, as many of attorneys in the city have built an extensive system of successful startup executives and investors. Additionally, the legal community is a critical service provider in helping startups from incorporating, to handling employment law, to managing term-sheet negotiation, and, of course, to securing various types of IP protection, particularly in the form of utility patents.

Incubators/Accelerators

Over the last decade, organizations have established several support systems for startups. The first type is an incubator (a support program for early-stage startups to run up to a year with defined milestones to get the venture up and to obtain funding). The second is an accelerator (a support program for growth-stage startups to run for several months with set goals to gain capital in later stages of funding). Notable programs in San Diego include the EvoNexus tech incubator [6]; the CONNECT Springboard [7]; and Plug and Play San Diego [8].

EvoNexus

CommNexus developed EvoNexus as a pro-bono, community supported technology incubator. It evolved to become the center of the San Diego (and the Orange County) tech universe, with locations in downtown San Diego, University City (between LaJolla and Sorrento Valley), and Irvine (next to the University of California, Irvine). EvoNexus has focused on helping startups grow from developing a proof of concept to creating a product and business plan that attracts customers, strategic partners, and capital. The founders established his incubator around networking,

education, incubation, and acceleration. EvoNexus provides a full array of services to startups accepted into the program. These are free of charge, and with no financial or IP related obligations to the entrepreneurs because the Irvine Company provides this space and mentors, while providers offer services pro bono. The supplier community provides donations and sponsor functions, and volunteers furnish a variety of support services. This incubator furnishes a startup fully furnished office space, mentoring, strategic and capital introductions, community visibility and credibility, and free access to over 75 programs/events each year at no cost. These services are geared to help a startup achieve sustainability. For entrepreneurs accepted into the incubator, EvoNexus starts with EvoStart during the first four months, followed by eight more months (and up to twenty more) of incubation support, provided that the participant hits critical metrics. As the center of tech startup activity, EvoNexus has been the hub for the StartUp San Diego week for several years [9].

Connect Springboard

The CONNECT Springboard program is a competitive, accelerator initiative for innovative companies [7]. This three-to-four-month accelerator helps startups prove their business model and develop a compelling commercialization strategy. The program assigns business advisors to coach the entrepreneur throughout the process. The program provides startups commercialization, financial, legal, and marketing advice, along with industry executive feedback (primarily from CommNexus). It offers startups opportunities to participate in investor forums, capital road shows to San Francisco and Silicon Valley, and deal network receptions. The program provides a platform for entrepreneurs to test out presentations and pitches. By the time a startup completes Springboard, the company should be ready for investment (angel, venture capital, corporate). It can then move on to participate in the Springboard Capital Competition and potentially become a part of the CONNECT Portfolio.

Plug and Play San Diego: Silicon Valley in a Box

Startup Circle and Inter west Capital formed Plug and Play San Diego to accelerate San Diego startups by increasing access to Silicon Valley and San Diego resources to enhance a Startup's chances of commercial success. This five-month program bridges San Diego startups with the resources and leadership of Silicon Valley. It pulls in technology leaders intending to co-invest in early high-tech companies, accelerate growth, and provide a direct route to success.

Entry involves a competitive "pitch off" each April. Selected startups receive an investment of \$25,000 (for a 5% equity stake). Participants travel to Silicon Valley for the three-month Startup Camp program and receive free space and mentorship at Plug and Play Tech Center in Sunnyvale, followed by time in the firm's San Diego center, and a final

EXPO event where entrepreneurs pitch to over 200 investors.

Other Noteworthy Accelerators, Incubators, and Education Programs

In the academic space, the University of California, San Diego (UCSD, in LaJolla) is home to the Institute for the Global Entrepreneur (formerly von Liebig Entrepreneurism Center (IGE) [11] and StartR at the Rady School of Business [12]. San Diego State University (SDSU) supports the Zahn Innovation Center and the Lavin Center for Entrepreneurship [13]. One private educational development program in the city is the Founders Institute [14]. It claims to be the world's most extensive entrepreneur training and startup launch program. Other organizations of interest include: (1) AnalyticsVentures [15] (tied with a local venture capital group); (2) Hera Labs [16] (an accelerator for women entrepreneurs); (3) Janssen Labs (a LaJolla-based life sciences innovation center for biotechnology) [17]; (4) CyberHive (for cybersecurity) [18]; (5) the Wireless Health Hub (for entrepreneurs and investors in the biomedical industries focusing upon web and wireless technologies) [19]; and (6) West Health Incubator [20] (for more cost-effective healthcare product and service solutions).

Academic Community

San Diego is home to several major educational institutions. The most notable in the community include the University of California, San Diego (UCSD, in LaJolla), San Diego State University (SDSU), and the University of San Diego (USD).

UCSD

UCSD has been a significant player in life sciences and technology sectors due to its robust science orientation and research focus. The institution has been one of the leading research centers from technology to biotechnology and the #17 ranked medical school according to US News World and Report [21-23]. In fact, the University is one of the most prolific in the University of California system for US patents [24]. It has a nationally recognized medical school and engineering program. In 2001, the University added the Rady School of Management, which has bought a robust entrepreneurial orientation. In recent years, UCSD has stepped up its entrepreneurial focus. This move follows the lead of University of California President, Janet Napolitano, to make a significant move to transfer basic research into the community as startups to stimulate economic development and royalties back to the University [25]. UCSD Chancellor Pradeep K. Khosla has placed a tremendous emphasis on entrepreneurship within the University [26].

Facilitated out of UCSD are several entrepreneurial programs and incubators at the Jacobs School of Engineering, [10] #7 engineering program for public schools and #12 for all engineering schools, which was named after Qualcomm's co-founder and

former UCSD professor Irwin M. Jacobs. Von Liebig [11] focuses on mentoring faculty and student inventors/entrepreneurs through proof-of-concept and provides commercialization support to bridge innovative ideas with market needs. It services the schools of engineering, medicine, pharmacy, and biosciences and the local science community. The Center runs a mentoring program that helps students and faculty with their ideas. The programs and initiatives at the von Liebig Center have been incorporated into the Institute for the Global Entrepreneur (IGE), which is a formal collaboration between the Jacobs School of Engineering and Rady School of Management. This collaboration allows engineering students to have access to resources in both schools in the areas of entrepreneurial education, training and translation of research ideas to market. Students are paired with industry mentors and strategic partners who help advance their ideas and validate their technical advantages and business prospects. As an official NSF I-Corps site, IGE conducts customer-centric entrepreneurial education using Lean Startup methods and since its inception has fostered over 100 startup teams. In 2016, IGE launched a Technology Accelerator, which helped teams build near-market ready prototypes for field testing with potential customers and industry partners. This year, IGE is launching a companion Business Accelerator, for UCSD students, alumni and affiliated companies, focused on helping startups scale their business. Over the past year, IGE has successfully established working relationships and collaborations with the Office of Innovation and Commercialization, plus additional research and entrepreneurial programs in other schools and departments across campus, bringing together industry mentorship and resources to strengthen the UCSD startup community.

Another piece in the UCSD community is StartR [12], a non-profit accelerator program for Rady School of Management students and alumni. Rady designed this program to provide entrepreneurs the tools needed to start and grow their businesses. Founded by a group of Rady students in 2013, this free six-month program acceleration program held on the Rady School campus accepts up to six teams per cohort. The program includes workshops, mentoring, advice, and access to other resources for early-stage companies. At the conclusion of the program, the groups present their pitches at Demo Day, attended by investors, industry experts, and the San Diego community.

Recent additions to the UCSD startup support system include an incubator supported by Qualcomm Institute Innovation Space [27] and the UCSD Basement [28]. The Qualcomm Institute is the UCSD division of the California Institute for Telecommunications and Information Technology (Calit2) [27]. The Qualcomm incubator program facilitates close collaboration with the local tech industry community. This arrangement allows for UCSD faculty and students to access resources from both the University and the company. The Basement [28] functions as a hub where student entrepreneurs can connect, develop, and grow companies and

social ventures, and with alumni support and leadership. It is open to all students regardless of college affiliation within the University. Already, the program has engaged 200 students, set up 21 teams, and raised \$80 thousand in capital contributions this past spring [28].

SDSU

SDSU has been home to one of region's most established business school and Masters of Business Administration (MBA) programs. Innovation and entrepreneurship have been at the heart of the SDSU program. Forbes has ranked SDSU as the 18th top entrepreneurial university in the United States [29]. It is home to the Lavin Center for Entrepreneurship for business students and faculty [30]. Also, the SDSU Zahn Innovation Center is a commercial and social incubator within the school of engineering to support the SDSU community [30].

USD

USD has been a long-standing Jesuit school with an active business program and home to the region's most established law school. It was ranked #3 in the top 10 global MBA programs for entrepreneurship by the Financial Times [31]. The school of business hosts a campus-wide entrepreneurship competition, V2, in which potential investors vet the venture and the entrepreneur [32]. Also, USD is home to USD Legacy Entrepreneurship Conference [33]. A final note is that its Law School runs a clinic in entrepreneurial law to serve the community.

Other Academic Institutions

Finally, California State University, San Marcos (CSUSM), Coleman College, Ashford University, and California International Business University (CIBU) round out the academic community. Each institution has a focus on supporting San Diego's growing entrepreneurial community. CSUSM services predominately the growing North County (Carlsbad, Oceanside, Vista, Escondido, and Rancho Bernardo) business community. Ashford is an entirely online program and is home to the Forbes School of Business. Coleman is a private school with a robust entrepreneurial following. Finally, CIBU is worth mentioning further due to its international focus, work across the border in Tijuana, proximity to several essential incubators and workspace locations and plans to host the first academic-sponsored incubator within the city's downtown area.

Private Research Institute Community

In addition to the academic community, San Diego also is home to several recognized private research institutes.

Life Sciences

The life sciences space includes: (1) the Sanford-Burnham Prys (SBP) Medical Research Institute [34]; (2) the Salk Institute; [35]; and (3) the Scripps Research Institute [36]. All these institutes

are based in LaJolla. SPB [34] is a significant player in driving basic research in a variety of areas, such as cancer, immunology, inflammation, neuroscience, metabolic disease, and pediatrics. Similarly, the Salk Institute [35]; focuses upon biologic research in aging, Alzheimer's, cancer, diabetes, and infectious diseases. Scripps [36] connected with the prestigious Scripps Clinic, focuses its efforts on a broader array of illnesses in basic, translational, and clinical research. These three institutions, along with UCSD's biotechnology program and medical school, which have created a significant hub for the San Diego biotech/life science community.

Defense

In the defense space is Space and Naval Warfare Systems Command (SPAWAR) [37]. Based in Point Loma, SPAWAR is Navy's principal research, development, test, and evaluation laboratory for command, control, communications, computers, intelligence, surveillance, and reconnaissance.

Government

For entrepreneurs in San Diego, significant governmental supports and incentives exist. The most notable is through the city of San Diego and the State of California.

City Government of San Diego

The City of San Diego's government has established itself as a business-friendly partner to entrepreneurs, a purveyor of good governmental practices, and a facilitator of specific economic development programs. The City has focused on saving businesses money through reduced fees and requirements, saving businesses time by cutting red tape, providing regulatory relief, and making information accessible [38]. Additionally, it has worked to maintain an attractive environment and robust infrastructure, which is a support to the business community. In all, the government has positioned the City as a community to provide startups (and established companies) an environment to gain a competitive edge and prosper.

Government leadership has driven the City's attitude. The mayor and city council during the late-1990s and early 2000s inspired the direction for business growth [39]. Kevin Faulconer, the current mayor, who has spoken to attendees of Startup San Diego on multiple occasions, came from this thriving business community. His leadership has helped to ensure that the City continues to offer incentives and benefits to various businesses including startups. As a result, San Diego has provided the lowest business license fees of the nine largest cities in California and charges no utility users taxes. Additionally, the mayor's office has developed a proactive Business Expansion Attraction and Retention and Government Incentives teams to advance specific economic development programs [40]. Both groups work to create a business-friendly environment, facilitate new investment, and work with targeted industries to create and retain jobs and taxable investment in the City.

The City's plan for economic growth includes the attraction, retention, and expansion of businesses, maintenance of a business-friendly environment, ensure competitive in emerging markets (e.g., CleanTech, Cybertech), foster development in economically distress communities, and increase international trade activities. San Diego's Business and Industry Incentive Program (SDBIIP) [41] serves as the City's platform for economic development. SDBIIP combines its incentives with those from the Office of Small Business and other incentives offered through the City's Redevelopment Agency. The City offers these incentives to business that: (1) provide significant revenues and jobs; (2) promote the growth of City taxes and revenues; (3) develop in older parts of the city; and (4) are being induced by other communities to relocate from the City. San Diego's city government has created other supports for startup and scaled up companies. These include specialty locations within the city for economic development as enterprise zones, foreign-trade zones, recycling market development zones, and redevelopment project areas [42]. Additionally, the City has developed a program offering small business loans for small- to mid-size business owners with expanding businesses that require capital but are unable to meet traditional bank requirements [43].

State of California

The government of the State of California offers several different supports to businesses and startups. These include the California Innovation Hub (i-Hub) Program [44], and various tax incentives [45-48].

California Innovation Hub (i-Hub) Program

The Innovation and Entrepreneurship Unit within Governor's Business and Economic Development Department (GO-Biz) has established a wide range of collaborations with partners (e.g., regional economic development authorities, local governments, private organizations, incubators, venture capital sources, and the higher education systems) to develop infrastructure and support for entrepreneurs [49]. The State established the i-Hub program [45] as a critical component and designated San Diego as one of the twelve i-Hubs [44].

Tax Incentives:

Under Governor Edmund G. (Gerry) Brown, the State of California created several meaningful incentives to develop new business, attract new firms, and maintain existing companies within the state. These included the New Employment Credit (NEC), the California Competes Tax Credit, and the Partial Sales Tax Exemption Program [45-48]. The State created NEC [45] to offer businesses and startups the opportunity to capture valuable tax credits against their annual State income taxes. This program allows firms to gain up to \$56,000 in tax credits (per qualified employee) for hiring individuals for challenging to employ categories (e.g., discharged veterans, ex-offenders, long-term unemployed, and public assistance recipients). Also,

the State government provides hiring credits for businesses in areas with the highest unemployment rates in the State. The State designed California Competes [46] a flexible tax credit program. Administered by GoBIZ. It was put forth to promote job creation, business attraction, retention, and expansion. The State has provided the opportunity to companies across California to compete for significant quarterly allocations of State tax credits based on the number of jobs created and retained and wages paid.

The State of California Board of Equalization developed the Partial Sales Tax Exemption program to offer businesses a 4.19% state sales tax exemption, an immediate and direct cost benefit, for qualifying manufacturing equipment purchases statewide [47]. This incentive was slated for all manufacturing equipment and research and development equipment purchases for biotech and manufacturing companies to promote growth in these industries.

Corporations

San Diego has become a hub for the telecommunications, tech, and life sciences industries. Several major corporations have established either a headquarters, a research facility, or a business office within the community (Table 1). Several have become significant facilitators of the startup community. A few of the most significant corporations to have a presence in San Diego include Qualcomm, Huawei, Johnson & Johnson (Janssen Labs), and the Irvine Company [17, 50-52].

Qualcomm

Qualcomm, the global semiconductor company that designs and markets wireless telecommunications products and services, has been a significant player in San Diego's telecommunications and tech scene. Based in Sorrento Valley, this global giant has been intimately involved with the Ictinus, and the entrepreneurial community. Qualcomm has been an active sponsor of CommNexus by providing a variety financial, volunteer, and meeting facility support. Also, it has been a significant sponsor during StartUp San Diego week, during which the company has held in the past an entrepreneur track at its headquarters. The company has supported a number local incubators and accelerators. First, it sponsors at UCSD the Qualcomm Institute, a division of the California Institute for Telecommunications and Information Technology [27]. This Institute recently launched an incubator program (i.e., innovation space) for UCSD faculty and students to access resources from both the University and the company. Second, the company created the Qualcomm Robotics Accelerator, as a four-month mentored startup program to accelerate the development of the next generation of robotics and intelligent machines [53]. Finally, Qualcomm supports startups through its ex-employees, as many have moved on to start up their ventures.

Huawei

Huawei ("wa-way") Technologies, a Chinese company

in the telecommunications sector, has been a global leader in the information and communications technology space. It has generated \$1 billion of annual business in the US by providing network equipment for phone companies and accessories, such as wireless modems for laptops [54]. It also has established a path in the mobile phone space since 2010. The company has become a significant supporter of the startup community. It is involved with CommNexus and EvoNexus in many ways including hosting events on the company's campus in Sorrento Valley. In collaboration with EvoNexus, Huawei has put forth to the startup community a program called Marketlink [55]. Huawei and EvoNexus created Marketlink to provide entrepreneurs in the information and communications technology space the opportunity to initiate and build strategic relationships with leading multi-national companies through a variety of business and social engagement in the US and China. This competitive application-based program has focused upon connecting selected entrepreneurs with Huawei's executives and other executives from other multi-national corporations concentrate on new technologies.

Janssen Labs

Over the last twenty years, several life sciences companies have established a base in San Diego County. Several large pharmaceutical companies, such as GlaxoSmithKline, Johnson & Johnson (Janssen Labs), Novartis, and Pfizer, have set up research facilities to work with UCSD and the various medical research institutes that exist in the LaJolla area. Janssen Labs, a part of Johnson & Johnson's external research and development program, has developed a no strings attached, open-innovation model incubator as part of its WestCoast Research Center in LaJolla [17]. It has stood out within the life sciences startup community. Janssen developed this incubator to provide a capital-efficient, resource-rich environment for emerging companies to help advance their scientific discoveries into actual healthcare products. Janssen offers to startups a variety of space options including core research labs with specialized capital equipment, administrative areas, and own bench, wet lab, and office modules. Startups can lease needed space on a short-term basis and can quickly expand based on their resources and needs. Also, Janssen provides an operations team, so its companies to focus on the science and a business team for access to education, experts, and funding partners. What is excellent about the Janssen incubator is that the company does not ask for any equity in a startup or require any future affiliation with Johnson & Johnson.

The Irvine Company

The Irvine Company has been a private real estate development company, primarily involved with the development of master planned communities within Southern California [52, 53]. The company was instrumental in the development of the Irvine Spectrum complex in the 1990s, which led to a tremendous influx of technology, life science, and design companies, along with investment firms in the southern portion of Orange County. Part of the Irvine Company's holdings has included multiple office buildings. In San Diego, the Irvine Company has been the leading landlord of high-rise office buildings in downtown San Diego, with 2.8 million square feet. These holdings include six high-rise buildings: (1) 750 B Street; (2) 401 B Street; (3) 225 Broadway; (4) 101 West Broadway; (5) 501 West Broadway; and (6) 600 West Broadway [57]. Considering this investment in real estate, it is no surprise that the Irvine Company has been a vital supporter of the tech startup community in San Diego and Orange County. Notable has been its commitment to building working communities for entrepreneurs through the Vine [58]. Presently, there are three Vine locations: (1) downtown San Diego at 101 Broadway (next to Horton Plaza); (2) University Town Center (LaJolla); and (3) Irvine (next to University of California, Irvine). It provides these workspaces and resources for startups at a low cost to the entrepreneur. In addition to the Vine in San Diego, the Irvine Company offers a full floor of space to the EvoNexus incubator at no charge. Finally, the Irvine Company has been an active financial supporter of various entrepreneurial events in San Diego, including StartUp San Diego.

Services

It is essential to for startups to collaborate with service providers to address the support functions to focus on its core competency. For many of the Startups, this means outsourcing to or working with companies that provide services in the accounting, legal, human resources, marketing, insurance, and human resource areas. In San Diego, there are quite a few companies that work closely with Startups and small businesses and having access to these services local helps the entrepreneurial firms tremendously. They bring services and helpful advice in managing startups based on their experience working with other startups. The major groups summarized in (Table 3) include accounting, legal, insurance, human resource, and marketing.

Table 3: Services in the San Diego Ecosystem.

SECTOR	ORGANIZATION(S)
Accounting	Ernest & Young (national with an office in San Diego, CA)
	PricewaterhouseCoopers (national with an office in San Diego, CA)
	Deloitte (national with an office in San Diego, CA)
	KPMG (national with an office in San Diego, CA)
	T.W. Taxes (regional with a headquarter in San Diego, CA)
	Profit wise Accounting (local with an office in San Diego, CA)
Legal	Stubbs Alderton, and Markiles, LLP (local with offices in Los Angeles and Santa Monica, CA)
	Stradling Yocca, Carlson, and Rauth (regional with an office in San Diego, CA)
	Cooley LLP (national with an office in San Diego, CA)
	Latham & Watkins LLP (national with an office in San Diego, CA)
	Procopio (regional with a headquarter in San Diego, CA)
	Pillsbury (international with an office in San Diego, CA)
	SoCal IP Law Group (local with offices in Santa Barbara and Westlake Village, CA)
	Shimokaji & Associates, P.C. (local with an office in Irvine, CA)
Insurance	Barney and Barney Insurance Services (regional with headquarters in San Diego, CA)
	Vanorsdale (local with an office in San Diego, CA)
	Pacific Unified Insurance Agency (local with an office in Lawndale, CA)
SECTOR	ORGANIZATION(S)
Human Resources	TriNet (national with an office in San Diego, CA)
	San Diego HR Consulting (local with an office in Carlsbad, CA)
	Angel.co (online, national with a dedicated webpage for San Diego, CA)

Marketing	Gerson and Associates (local with an office in San Diego, CA)
	Digithrive (local with an office in San Diego, CA)
	Red Door Interactive (local with an office in San Diego, CA)

Accounting

In San Diego, both large and small accounting firms service startups as their clients. Of course, there are several significant, well-known firms in the area including Ernst & Young, PricewaterhouseCoopers, Deloitte, and KPMG. These firms offer their expertise to help startups manage rapid growth, as well as to prepare for audits, tax returns, and other internal controls to continue the growth of these new companies. While these firms bring tremendous knowledge, the fees for such firms may be more than what most startups can afford, so entrepreneurs usually do not engage them during the startup’s early phases. Only when startup has scaled and has established a strong financial base that it would hire a major accounting firm. While there are many accountants and firms within San Diego County, a few stand out concerning the needs of startups. T.W. Taxes [59] works with early-stage and emerging companies to establish a solid foundation to build their businesses. This firm helps startups determine whether the company should be sole proprietor versus a partnership versus a corporation, what type of corporation (C versus S versus LLC), and where to incorporate (California versus Delaware versus Nevada). It also provides counsel to startups on capital needs and when to bring in investment money. Perhaps most important of all, the firm assesses whether a startup’s current business proposal will generate positive cash flow by reviewing proposed financials. Another local accounting firm that specializes in small businesses is Profitwise Accounting [60]. This firm offers startups services in bookkeeping, QuickBooks accounting, taxes, payroll, and retirement planning. It also provides training for small business owners or bookkeepers on tax savings, business strategy, and QuickBooks.

Law

There are two types of legal services startups need. The first area involves business law. Firms such as Stubbs Alderton, and Markiles, LLP [61] and Stradling Yocca, Carlson, and Rauth [62] help their clients with incorporation, contracts, confidentiality agreements, employment law, term sheets for investment, mergers, and acquisitions, intellectual property, and business litigation practices. There are other national and international companies, such as Cooley LLP [63] and Latham & Watkins, LLP [64]. They offer expertise in international law. The second type of legal services focuses on IP, such as patents (utility and design), trademarks, and copyrights, serving multiple industries. Local firms, such as Procopio [65], Pillsbury [66], SoCal IP Law Group, Inc. [67], and Shimokaji & Associates, P.C [68], furnish similar

services. Procopio [65], one of the largest business law firms in California with 140 attorneys in San Diego, has a group that specializes in assisting startups and emerging growth companies in various fields, including life science, telecommunications, and information technology. Procopio works with startups in the areas of angel and venture capital funding, mergers and acquisition, intellectual properties with an understanding of how start-ups and emerging growth companies operate. Eric Bernsen, an intellectual property attorney at Procopio, shared that while these larger firms are expensive (e.g., \$400 to \$1000/hour), they can be invaluable to the entrepreneur [69]. He added that not only do such firms have the depth of experience in a variety of specialty areas; they tend to be well networked within the community. He also noted that these firms maintain close ties to other leading service providers, large corporations, banking institutions, venture capitalists, wealth managers, and investors. For entrepreneurs who cannot afford expensive legal advice and are looking for free legal assistance, both the USD and Thomas Jefferson Schools of Law offer legal clinics where companies receive legal advice on structuring the business, financing regulations, drafting of investment, employment agreements, and IP protection [70]. Funds for these clinics come from the University of San Diego and, in part, through grants from the State Bar of California and US Department of Treasury [70].

Insurance

Startups may overlook insurance at first, but they need coverage to ensure the protection of both personal and corporate assets. In San Diego, firms such as Barney and Barney Insurance Services [71] and Vanorsdale [72] work with startups and small businesses to provide a well thought out business plan based on thorough risk analysis. It is essential for startups to invest the time into on-going communication and update with their insurance company to keep the coverage up to date. Both firms provide property insurance (e.g., buildings and other capital assets), general liabilities (e.g., products, premises operation, contractors, etc.), workers' compensation, employment practices liability, and business vehicle insurances. Pacific Unified Insurance Agency [73] is another insurance broker in San Diego who works with startups and early stage technology companies with cost-effective insurance and risk management programs. As these companies grow, their insurance needs change, and Pacific United provides help them implement competitive employee benefits for retention and recruiting of employees with various coverages. As an insurance broker based in San Diego, the agency has experience with educating and assisting companies to evaluate their insurance plans to comply with California Workers Compensation so they can lower the cost of providing coverages for their employees by getting multiple quotes and informing them of the best policies for individual needs. In many ways, members of the insurance community, along with other service providers, have become extremely active in supporting the startup community. Many

sponsor sessions during the StartUp San Diego Week and at EvoNexus. A number offer their services on a volunteer or pro bono basis and lecture at EvoNexus. One example of someone from the insurance community who is committed is Nick Tait [74], a principal in Barney and Barney and a specialist in strategic risk management. He volunteers his time to help startups in San Diego area and is active in a variety of incubator and venture capital programs.

Human Resources (HR)

Startups are always in need of good people who can come in to help out on a permanent or temporary basis. Human resource service providers, such as Trinet, provide a vast array of services including hiring, employee benefits and insurance [75]. Their consultants have in extensive experience working with startups. San Diego HR Consulting is another company who works with startups in recruiting, audits, transitions (layoff and mergers), and claims [76]. Trinet [75] is an industry leading HR firm with more than twenty years of experience based in Leandro, CA. The company assists the startup, and emerging companies grow and efficiently scale through providing best-in-class HR infrastructure and benefits packages for their employers for the cost of a monthly administration fee. In addition to providing standard services, such as online performance management, recruiting, payroll, benefits, and insurance, Trinet assists companies with cross-border capabilities with knowledge in laws and tax rules in other states and countries when a company expands and needs to hire employees in remote locations [77]. Another source for employment support includes job sites. When looking for contractor help, entrepreneurs can look to Angel.co/San Diego [78], an excellent resource to list and seek jobs. At any given time, the website contains anywhere from 150 to 200 openings in San Diego area, meaning that qualified candidates will search for opportunities on this site.

Marketing

Marketing and advertisement is another area where startups need help. Several firms, including Gerson and Associates [79], Digithrive [80], and Red Door Interactive [81], have had extensive experience working with startups. Gerson & Associates specialize in optimizing startup messaging for customer acquisition and retention, product launches, and lead generation [79]. Randy Gerson and Chris d'Eon bring startups tremendous "real world" marketing insights, accumulated experience, and knowledge in direct marketing, areas that are startups often lack. Both Gerson and d'Eon have been active in the startup community in San Diego with presentations at StartUp San Diego Week and their monthly program titled Marketing Mondays at the San Diego and Irvine EvoNexus Incubators [82, 83]. Digithrive is a website development firm in San Diego with 16 years of experience in making websites for various companies [80]. In 2014, Digithrive participated in the City of San Diego Website Redesign Initiative, as part of the

Code of America Program, where it has helped small businesses design easy-to-use and accessible websites for best-in-class user experience [84]. Also, Digithrive assists businesses to implement a more straightforward shopping cart process for their sites, so that companies with limited IT expertise can efficiently manage this activity. Red Door Interactive, headquartered in San Diego, maintains offices in Denver, CO, and Carlsbad, CA [81]. Red Door helps their clients grow business through structured processes and techniques centered on customer research and insights, business intelligence, strategic planning and disciplined creative and technical execution. Red Door has also been active in the San Diego startup community, as many of its staff have served in multiple CommNexus and EvoNexus events as speakers, moderators, and panelists in digital media special interest group events.

Financial Institutions

The San Diego finance scene involves several key players including angel investors, local and outside venture capital, and banks focused upon startups (Table 4). One can characterize the funding environment in San Diego as a healthy, but somewhat conservative community.

Table 4: Examples of Financial Institutions in the San Diego Ecosystem.

SECTOR	ORGANIZATION(S)
Angels	Tech Coast Angels (regional with a chapter in San Diego, CA)
	SeedSanDiego (local with an office in San Diego, CA)
	Angels List (local with an office in San Diego, CA)
Local Venture Capital	Analytics Ventures (local with an office in San Diego, CA)
	San Diego Venture Group (SDVG) (local with an office in San Diego, CA)
	Avalon Ventures (AVA) (regional with an office in La Jolla, CA)
	Domain Associates (regional with an office in San Diego, CA)
	Triton Tech Fund (local, UC San Diego)
	Qualcomm Ventures (international with North America office in San Diego)
	TVC Capital (local with an office in San Diego)
Outside Venture Capital	Foundation Medical Partners (headquartered in Boston, MA)
	Cambia Health Solutions (headquartered in Portland, OR)

Banks	Silicon Valley Bank (international with an office in San Diego, CA)
	Square 1 (regional with an office in San Diego, CA)

Angels

The angel community appears to be a critical investor in startups, especially in early-stage and ventures. The most prominent angel group in the region has been Tech Coast Angels (TCA), a group consisting of five chapters that span from San Diego to San Luis Obispo [85]. Currently, there are about 1,343 startups in San Diego with an average valuation of \$4.4 million and around 11,810 angel investors, with 461 residing in San Diego [86]. According to Neal Bloom, entrepreneur and publisher of the San Diego Investment Newsletter, local funding is available for under \$2 million. He added that more substantial investment capital requires entrepreneurs to venture to the Bay area (San Francisco and the Silicon Valley), New York, Boston, and Los Angeles, where there are more experienced and less risk-averse investors [87].

In comparing San Diego with the US venture industry, San Diego companies received 5% of all venture capital dollars during the past decade [88]. During the recession, San Diego was hit harder regarding total venture dollars channeled into the region. In the years leading up to the Great Recession, which officially began in 2007, venture investments in San Diego amounted to about 6% of the US total [88]. This figure dropped to just 3% of the nationwide total over the next three years. Venture funding levels began to recover in 2010 and returned to six percent of the US total in 2013. One observation relative to venture capital is that San Diego has been the third most lucrative region for biotech venture capital funding in the nation [89]. San Diego investments have concentrated heavily in the biopharma sector. Venture funding for biopharmaceutical startups accounts for the lion's share of venture capital deals in San Diego.

Tech Coast Angels

Tech Coast Angels, based out of Southern California, is one of the largest angel investment groups in the US [85,86]. It has been a predominant player within the San Diego investor community. The group comprises over 300 angels with experience in almost every industry (not just technology) in five networks that encompass Southern California (Los Angeles, Orange County, San Diego, Santa Barbara/Westlake Village, and the Inland Empire). TCA is the leader in providing funding, guidance, mentorship and leadership experience to early-stage, high-growth, exciting companies in Southern California. Since 1997, Tech Coast Angels have invested over \$169 million in more than 275 companies and have helped attract more than \$1.5 billion in additional capital/

follow-on rounds, mostly from venture capital firms [89]. These investments were in a wide range of industries including biotech, consumer products, social/mobile, IT, life sciences, media, software, environmental, and tech startups. On July 21, 2015, TCA announced that the group invested a total of \$4,546,338 in 17 total deals in the second quarter of 2015, making it the most active second quarter since the network's inception in 1997 [90]. In 2014, TCA invested record numbers (over \$16 million in 61 deals), and CB Insights ranked TCA ahead of all other angel groups as one of the most active networks in the country [3,91]. Tech Coast Angels San Diego (TCA SD) is the most significant chapter of Tech Coast Angels, the second-biggest angel investing organization in the United States. The San Diego Chapter announced that its 2014 investments reached a record total [92]. The group led funding rounds totaling \$8.3 million for 16 companies, up from \$7.3 million in 2013 with the San Diego chapter, accounting for half of all the investments made by the entire five-chapter network [92]. In a recent interview, Eric Gasser, a Board Member of TCA SD, highlighted some chapter's investment activities [93]. He noted that TCA SD was #3 of all angel investors last year for dollars and deals. Gasser added that the chapter on average had vetted 600 ideas/year, has reviewed 10 to 15 applications/month, and funded 14 deals (four new and ten follow-ons) for \$8.2 million in 2014. He also explained that TCA SD conducts two tracks for investment: (1) a traditional track that funds between \$200 thousand and \$1 million per deal; and (2) a seed track that funds between \$100 thousand and \$200 thousand for high risk profile ideas (these are usually supported faster [14 days] to compete with Kickstarter and OurCrowd) [93]. For investments over \$1 million, he continued on that, TCA SD would bring in other TCA chapters as follow-on investors to the San Diego Chapter's lead. Finally, Gasser explained that TCA SD meets monthly and is open only to accredited investors and TCA's analysts due to the new rules around angel investing [93]. He added that these meetings have 40 to 50 members but may accommodate as many as 60 to 80 attendees when considering candidates and analysts. He also commented that TCA SD was not as active in the life science space, as compared with its investment in the tech space.

Seed San Diego (SSD)

Eric Gasser co-started SSD a year to a year and a half ago [93]. He explained that SSD is a bridging group for companies that they invested in to get these startups through the valley of death and positioned to go to Series A or B [93]. The main reason Gasser started this group was that of a gap that existed within the ecosystem for smarter money and for companies that needed management and operations experience to move the tech company forward with a jump-start. In many ways, SSD is a partnering model. The rationale for this strategy is because such companies do not know what to do next. So SSD provides mentors and taskforce pool to go into the companies to offer a step by step support to move these companies

forward over a six-month period. According to Gasser, SSD makes its money through: (1) the return on the capital invested; and (2) additional percentage more than the valuation in exchange to pay for the task force members working in the companies they support. Seed San Diego was involved with almost half of the all tech deals in San Diego; it concluded six in 2015 [93].

Angels List

Angels List was started by angel investors who oversee a \$300 million venture fund backed by small angels and segmented by specific markets (e.g., tech, biotech) [95]. Gasser noted in his interview that he vetted early-stage tech startups to identify the most promising of firms and technologies for this group [93].

San Diego Venture Capitalists

Venture capital investors - which can include university foundations, government pension funds, and wealthy individuals - sign up with venture capital firms in hopes of making more money. Venture capital firms then search for entrepreneurs and companies that appear poised for success. They are looking for startups that might go public or be future acquisition targets.

Analytics Ventures (AV)

One such local venture capital firm is AV, a San Diego based venture capital firm that creates and invests in local technology companies [15]. It brings entrepreneurs a keen understanding of technology, marketing, sales, capital, and early stage growth. It actively helps companies with financing strategy, business development, customer introductions, and management team development. AV's mission is to invest at the earliest stages of a company to leverage our domain expertise to help companies get quickly on the path toward sales, growth, and profitability. This firm leverages its network of top industry professionals, angel investors, early-stage funds, and venture capital firms to meet the funding needs of our portfolio companies and helps ensure their success.

San Diego Venture Group (SDVG)

SDVG is a non-profit business association with a mission to support and promote the venture capital and startup company ecosystem in the San Diego region [96]. Founded in 1986, the SDVG is a non-profit organization designed to bring together people in San Diego who are interested in new enterprise and the process of creating it. SDVG's mission is to provide a networking forum for entrepreneurs, venture capitalists, and advisors in an informal atmosphere where human expertise can foster new ventures.

Avalon Ventures (AVA)

AVA is a venture capital firm that has founded and funded more than 100 information technology and life sciences companies [97]. The firm is passionate about backing talented entrepreneurs seeking to build market-leading companies. Throughout the firm's

30-year tenure, AVA's long-standing and successful focus has been on seed and early-stage companies. All Avalon partners are seasoned entrepreneurs with experience in company formation, operations, and value creation in the life science and tech sectors. A hallmark of Avalon is working closely with our companies on all aspects of its development, ranging from team building to strategy and operations to customer development.

Domain Associates

Founded in 1985, Domain was one of the first venture capital firms to invest exclusively in the life sciences sector. Domain has helped form over 250 companies [98]. Today, with more than \$2.7 billion in capital raised, Domain is a proven healthcare venture capital leader with solid investment returns from companies built to advance human health.

Triton Tech Fund

Tied with UCSD and the von Liebig Center has been the \$8 million Triton Technology Fund, unveiled in spring of 2014 [99]. The investment partner in San Francisco designed the fund to bridge the gap for early-stage companies tied to the university. The investment group intended Triton to bring connections, knowledge, and mentoring to bold early-stage entrepreneurs with game-changing ideas. Its focus has been in the software, communications, electronics, materials, and medical device/ instrument space. The fund is part of a \$40 million vertical ventures fund [100]. The Fund tapped David Schwab, a seasoned venture capitalist, UCSD alumnus, and managing director at Sierra Ventures, to oversee the fund. UCSD has tasked the von Liebig Center to provide business and commercialization mentoring to support innovators interested in working with the Triton Technology Fund.

Qualcomm Ventures (QV)

Another way that Qualcomm facilitates startup companies is through its own internal venture capital group, QV [101]. This inner investment arm functions not only as an investor, but also as a partner to overcome obstacles and to create value. It brings to the entrepreneur in-house resources, access to the company's current R&D technologies, contact with crucial wireless and tech sector executives, and financing (primary and follow-on). The Ventures group maintains in a variety of local and international companies in its portfolio. Also, the ventures group supports healthcare startups via its Qualcomm Life Fund, a 100 million dollar health care fund it has created with Novartis and is ranked the most active strategic investor in digital health/health information technology [102, 103]. Noteworthy is the QPrize™, Qualcomm Ventures' seed investment competition [104]. Qualcomm Ventures designed this competition to provide entrepreneurs their first level of funding. This support can then help these startups launch their ideas into a successful startup business. The competition seeks bright, energetic and resourceful entrepreneurs with a passion for bringing

new technologies and services to market. QV's goal is to have the QPrize™ function as a catalyst for its winners. This way the prize provides for initial capital to launch the entrepreneur's idea and bridge the startup to its first institutional funding round.

Outside Venture Capital

San Diego Venture Group's Venture Link program connects venture capital firms with local businesses to encourage investments within San Diego [105]. Through this program, venture capitalists provide a "shopping list." After soliciting companies and reviewing applications, the San Diego Venture Group then select four or five qualified companies to present in front of a venture capitalist for a one-hour meeting. Because of this program, venture capitalists, such as Foundation Medical Partners (now Flare Capital Partners), [106], Cambia Health Solutions [107], and TVC Capital [108], have been able to invest in San Diego. Flare Capital invests in innovation that meets the future needs of providers, payers, employers, and patients [106]. It focuses on technologies and services that enable value-based healthcare and leverage wireless, data and analytics technologies. Cambia Health Solutions invests in companies that change the way people experience the health care system [107]. Cambia looks to transform health care to be more economically sustainable, and people focused. TVC Capital is a growth equity firm focused on investments in and acquisitions of software companies and software-enabled service firms [108]. It targets a broad spectrum of software sectors and industry verticals poised for growth and consolidation. TVCs average investment target has been between \$7 million and \$8 million; it can go as low as \$4 million or put together rounds up to \$20 million [109].

Banks

Entrepreneurship development is a concept concerned with the formation, financing, growth and expansion of business enterprises, with the objective of achieving economic growth and development. Financial institutions, most especially the banks play essential in the development and financing of entrepreneurship in the country. Funding is one of the necessary prerequisites for a startup's development. The lack of capital represents a significant obstacle to their growth and development. In San Diego, two noteworthy banks have helped startups move their ideas forward faster: (1) Silicon Valley Bank; and (2) Square 1 [110, 111].

Silicon Valley Bank (SVB)

For more than 30 years, SVB has helped startups and their investors move bold ideas forward in a rapid fashion [110]. SVB provides targeted financial services and expertise through its offices in innovation centers around the world. With commercial, international and private banking services, SVB has helped to address the unique needs of innovators. Forbes named SVB one of America's best banks (2015) [112] and one of America's best-managed companies (2014) [113].

Square 1

In 2005, Richard Casey and colleagues created a new, full-service venture bank, Square 1 [111]. Casey and company formed this bank to provide financial services to entrepreneurs and venture capitalists. It helps growing companies and their investors navigate financial obstacles by providing access to funds and expertise. The bank offers customized product offerings, along with an unrivaled team of banking specialists provides a unique banking experience. After successfully closing a record-breaking \$105 million private placement, Square 1 opened the doors of six offices across the country [114]. Today this specialty bank maintains locations in Austin, Boston, Boulder, Durham, Los Angeles, McLean, New York metro, Palo Alto, San Diego, and Seattle.

Discussion

The final part of this review of the San Diego ecosystem is to take a closer look at: (1) its strengths; (2) its weakness; and (3) how the ecosystem compares with other major Californian communities, most notably the Bay Area (i.e., San Francisco, Silicon Valley) and the Los Angeles/Orange County metroplex.

Strengths

San Diego possesses many desirable attributes as a startup city: (1) well-established firms in telecom; (2) tech and biotech; (3) supportive entrepreneurship community; (4) strong academic institutions; (5) rich talent pool; (6) proximity to the Mexican border; and (7) inherent synergies.

Established Businesses and Successes- Telecom, Tech, and Biotech

San Diego is home to many successful businesses in the telecom, tech and biotech industry. There are over 100 medium to large size corporations (Table 1) that have their headquarters in San Diego [115]. Several companies, such as AT&T, General Dynamics, Kaiser Permanente, Northrop Grumman and Tyco Health Care, maintain offices in San Diego or in the San Diego county employing more than 1,000 people [116]. Moreover, San Diego has become the home to numerous communications firms, attracting talents from all over the world. Qualcomm and Huawei are two companies highlighted previously reviewed in this paper [50, 51]. Headquartered in San Diego, Qualcomm is a technology powerhouse, developing mobile chipsets and licensing its wireless technology to telecommunications-equipment manufacturers and cell-phone makers across the globe [50]. The company was founded in 1985 and has grown from a small start-up with an idea to provide quality communication that has evolved into one of the industry's most significant start-up success stories. Huawei is a Chinese telecom firm, which has expanded from their vast home market to become a global player. The company provides telecom equipment to network operators, such as AT&T, Verizon,

Vodafone and Deutsche telecoms [51]. Also, several other significant telecommunication companies in the area maintain a presence, including AT&T, Hughes Network, Novatel Wireless, Verizon, and LG. The life sciences industry has become another significant driver of the innovation economy in San Diego, with more than 600 life science companies and more than 80 research institutions [117]. San Diego is consistently ranked within the top four in life sciences in the US and is particularly prominent in genomics with companies, such as Illumina and Thermo Fisher Scientific (previously Life Technologies) [118]. Per the San Diego Regional Economic Development Corporation, more than 42,000 employees work in local life science, biotech, and pharmaceutical companies, making San Diego one of the top cities for anyone in the life sciences industry [119].

Supportive Community

There are many networking communities available for entrepreneurs in San Diego. Listings are available at the EvoNexus, SDEE, SDEC&SS, SDVG, and angel.co websites [3, 4, 6, 78, 120]. In any given week, there are several gatherings of various sizes at different venues to discuss topics ranging from concept generation, product development, legal advice, etc. Organizations, such as EvoNexus and Tech Coast Angels, sponsor or host events to connect entrepreneurs with investors. Companies, such as Qualcomm and Huawei, hold events for startups to showcase their ideas. Also, EvoNexus and other organizations organize numerous gatherings through an online tool such as Meetup. For example, San Diego Tech Coffee is a gathering that attracts many entrepreneurs to get together, exchange ideas, and expand their network [121].

Attractive Place to Live

San Diego, home to the San Diego Zoo and SeaWorld, is a great place to live. Anyone would be hard-pressed to find another place with a better climate, where the average daily temperature is around 70 degrees Fahrenheit. Along with the great weather, there are a plethora of activities available for its residents all year, ranging from festivals, conventions, outdoor events, and amusement/theme parks. Also, it is only a short distance away from Los Angeles and Irvine. However, unlike Los Angeles, Orange County, and the Bay area, San Diego has less traffic. When compared to these other communities concerning the cost of living, many find San Diego a less expensive region to live than the San Francisco Bay area. Given the environment, San Diego attracts quality talent from all over the world, including entrepreneurs.

Strong UCSD and Research Institute Presence

Most notable has been the presence of a major research university, UCSD. This institution has nationally renowned programs in engineering and medicine, both of which have grown immensely in stature [21-23]. Also, there are world-class

research institutions, especially in the biological and medical research. The Jacobs School's affiliated research centers and institutes collaborate with companies on leading-edge science and technology. They also license the university's IP to individuals interested in commercializing such assets. The UCSD Technology Office [122] partners with individuals and companies who are interested in licensing the school's IP to create viable products and services. On an annual basis, the technology office receives about 300 new disclosures from UCSD students and faculty members. Many of these are filed for patents or copyrights [122]. It helps researchers to secure funding from the licensees and arranged for the licensees to collaborate with the research on and provide an employment opportunity for graduate students who are involved in this work. Historically, the school grants more than a third of its licenses to the San Diego based companies. The Moxie Incubator [10] provides aspiring student entrepreneurs with workspace, tools, and equipment in two lab facilities. In addition to access to facilities, the program offers advisors for counseling them about corporate and intellectual property law, marketing, manufacturing and design, and engineering. The program helps students develop their business plans and find business partners or investors.

Also, the Moxie Incubator encourages UCSD students to develop their ideas into products and services while they are in school. Also, the Sanford-Burnham Prysby Institute [34], the Scripps Research Institute [35], the Salk Institute [36], and the Scripps Institute of Oceanography [123] maintain a robust scientific research focus. Sanford Burnham Prysby [34] conducts world-class collaborative research on tumor initiation and maintenance, degenerate diseases, cell death and survival networks, immunity and pathogenesis and human genetics to improve quality of life. The Institute focuses on educating and training the next-generation of scientists and creating a legacy for its employees, partners, donors, and community. Internationally recognized as one of the leading research center in immunology, molecular and cellular biology, neuroscience, and infectious disease, the Scripps Research Institute has approximately 2,650 scientists and staff in the LaJolla campus [35]. Widely known for its leadership in the study of the basic structure and design of biological molecules, the center is among the world leaders in its field. The campus offers a top-ranked graduate program in the biologic and chemical sciences. It has many corporate partnership activities including strategic alliances with industry, spin-out company formation, patent licensing and corporate-sponsored research. The Scripps Institute of Oceanography is one of the oldest and largest research centers in the world [123]. The scientific focus of this institution is on the ocean, the earth, and the atmosphere. Recently, it developed a novel technology for studying and characterizing a nanoparticle technology called MANTRA (multi-sizing advanced nanoparticle tracking analysis) [124]. As a result, a new company was formed in San Diego by a collaborative effort among Scripps researchers,

the Triton Technology fund, and Evonex. This new technology has applications in multiple disciplines including medicine and pharmacology, environmental sciences and various consumer industry including cosmetics, inks, coatings, and food [124].

A Military Hub Providing Tech and Telecom Opportunities

Responsible for more than 300,000 jobs in the region and contributing more than \$20 billion to the regional economy, San Diego is home to the one of largest concentration of military-related employment in the world [125]. Total employment accounts for one of every five jobs in San Diego, including active duty, defense contracting and civilian employment, and related support employment. As one of three major Department of Navy acquisition commands, Space and Naval Warfare Systems Command (SPAWAR) develops communications and information system for warfighter for real-time connection across the globe [37]. A team of more than 9,500 active duty military and civil service professionals are involved in the research, engineering, and acquisition. Their goal is to provide and sustain fleet capabilities for Navy, Marine, joint force, federal agencies and international allies, and San Diego's SPAWAR Center Pacific (SSC Pacific) accounts for about 4,500 people [37]. SSC Pacific works with local defense and information technology companies through contracts, collaboration, and technology transfer. Among the most significant employee-owned companies in the US, with approximately 15,000 employees worldwide, Science Applications International Corporation (SAIC), which is headquartered in Reston, VA, is a top scientific and technology contractor for the US government and specializes in communications, logistics, and information technology [126]. Between SAIC [126] and Leidos [127], which was spun out from SAIC, there are about 2,700 employees in San Diego [126]. SAIC provides big data and analytics service, cloud computing solutions, cybersecurity, information technology management, network and communications, and software and mobility services. Through its small business program, SAIC engages with local businesses for subcontract services and help them grow their business; hence, the rationale for the CyberHive incubator [18]. Aside from SSC Pacific, SAIC and Leidos, other major defense contractors (e.g., BAE Systems, General Dynamics, Level-3 Communications, Raytheon, Northrop Grumman, etc.) and small businesses are in San Diego to provide engineering, construction, shipbuilding, healthcare, research and other support services.

Proximity to the Border

A final factor involves San Diego's proximity to Mexico, most notably Tijuana. Because of the North American Free Trade Agreement (NAFTA), established during the 1990s, both American and international firms have seen San Diego as the American base tied to Mexican locations in which these firms have relocated

their manufacturing facilities [128, 129]. As a result, San Diego's proximity to Mexico has facilitated significant cross-border trade and manufacturing activity. For startups that require access to lower cost manufacturing, being close to Mexico offers a definite advantage. Tijuana's low labor cost and skilled manufacturing workforce, coupled with low unionization and low freight cost, helps startups stretch their precious seed money to the maximum extent possible. In the recent years, voluntary employee turnover in Tijuana has decreased to an average of about 3.5%, from about 5% in 2008. With more than 60 industrial parks, Tijuana provides Startups with ample choices for contract services (e.g., Manufacturing) [130].

Inherent Synergies

When considering the diverse and robust capabilities of this ecosystem, one important consideration is the inherent synergies that exist. The most notable starts with the academic segment. The strong emphasis of UCSD in the sciences and its ability to generate a significant amount of intellectual property sets the foundation for transferring innovative technology, supporting new startups in the tech and life science spaces, provide faculty expertise, and develop talent to fill essential scientific and commercial capabilities for such firms. Hence, because of the role of the University in these spaces, the LaJolla, Carmel Valley, Del Mar, and Mira Mesa area, and North County have become home to many of these types of startups and the associated support community. For example, Qualcomm's headquarters is a short drive to the University and provided strong support to the Jacob's School of Engineering.

Another example involves the concentration of life sciences firms, along with and the Salk Institute, the Sanford-Burnham Prysby Institute, the Scripps Research Institute, and Janssen Labs, are within five minutes of the University's campus. The University also has supported several incubators and provided capitalization for the development of firms to transfer its technology into the community to establish newer startups.

Another synergy involves the military presence within the community. As home to the Pacific Fleet, there are many tech and defense firms based in the region. Because of the concentration of research, engineering, and commercial talent in the area between the military and civilian research and supplier firms, the region provides a stable base of labor and specialty technical talent for supporting more firms in this space. This dynamic exists within the telecommunications industry. For years, San Diego has been a hub for this business sector, dating back to the 1970s where firms such as Bell Labs maintained research groups within the community. This presence might be related again to the presence of the military and its needs, and due to San Diego's geolocation proximity to doing business with partners within the Asia-Pacific region. Also, with interest in cybersecurity, the community boasts CyberHive as an incubator to support such needs as well. Furthermore, this

relationship exists within the life sciences community. UCSD's scientific expertise in biotechnology, biomedical engineering, medicine, and pharmacy has led to the development of a significant biomedical community in the device, diagnostic, and therapeutics space. The University and established firms within the community have led to a vibrant and talented workforce and the cross-fertilization between the University, research institutes, and commercial firms, such as Illumina, Thermo Fisher Scientific, Pfizer, and Janssen, to develop and transfer innovations and technologies and support.

Because of the established business sectors in the community, San Diego has attracted many of the critical supports in the service community. Today, the region is home to the legal, accounting, insurance, and marketing expertise to support these firms. Furthermore, significant commercial real estate companies have invested in the ecosystem to ensure adequate office and laboratory space to help this growing entrepreneurial community. Also, numerous co-working sites have set up within the community to provide office and meeting space, technology support, educational events, and community of other entrepreneurs to aid startups through their early development phases. To this end, the area possesses financial support capabilities. It is home to one of the most extensive angel networks, TCA SD. However, it maintains healthy banking and venture supports that bring robust experience with startups. Then there is the multitude of resources geared to the startup community. Starting with the Connect Program, there is a diverse array of incubators and accelerators, including EvoNexus and J Labs. Through the Startup San Diego Week every June, the community fosters collaboration, education, and networking to promote growth within the community. Furthermore, the academic community, including the Lavin Entrepreneurship Center at SDSU, USD with its Legacy Conference, and UCSD with its multiple centers, provide a vast variety of support resources to startups coming out of the academic community.

Finally, the community has tremendous support from the city and county government. These players provide essential incentives and ease the regulatory burden to allow for growth. Along with the government support, the community brings established military industrial relationships, academic-commercial relationships, support community, and strategic geolocation related to the Mexico and the Asia-Pacific region. Together these pieces of the ecosystem can leverage talent, expertise, and resources that have made the greater San Diego metroplex attractive in the starting and maintenance of business headquarters within the region.

Limitations

Growing Entrepreneurial Community

In general, most of the limitations observed in the San Diego venture ecosystem is because San Diego is still much in a growth

stage. Relative to the Bay area, San Diego's venture ecosystem is significantly smaller in size and possesses a shorter history. It appears that San Diego's startup community predominantly consists of first-time entrepreneurs. Contrast this observation with that seen the Bay area in which serial entrepreneurs with a proven record of accomplishment appear to be ubiquitous. Also, according to Neal Bloom, due to the need for investment rounds more than \$2 million, it seems to be that many successful startups in San Diego are likely to migrate to the Bay area, and most likely if their investors are in Silicon Valley or San Francisco [87]. However, as the community matures and establishes a stronger network between entrepreneurs and investors, San Diego will grow into a significant player in the venture space.

No Other Major Research-Intensive Schools Outside of UCSD Providing Capital Support

Other than UCSD, with its Triton VC fund, there are no schools with active research programs to have such funding set up to help students and faculty to take their first steps as entrepreneurs. The von Liebig Center (part of UCSD Jacobs School of Engineering), provides mentoring, legal assistance and proof-of-concept grants to faculty and students once they enter to the program. Recently, the Center was awarded \$300 thousand from the National Science Foundation (NSF) when it became an NSF Innovation Corps (I-Corps™) site [131]. With this funding, it plans to incubate 30 programs annually, where each program has a chance to earn a \$50 thousand NSF I-Corps™ award through this program. Unfortunately, no other school in the area offers similar investment opportunities. On the funding side, the state of California does not have matching grants for entrepreneurs receiving awards from venture capital funds, based upon the rationale that there is sufficient amount of private funding available in the state already.

Angel Funding in San Diego

There are differing opinions on the availability of angel funding availability in San Diego. On the pessimistic side Quinn Lin, vice president of Qualcomm Ventures, and Rosibel Ochoa, past director of von Liebig Center, indicated there were only a handful of angel investors in the San Diego area [132, 133]. As previously discussed, TCA SD has been by far the most active in the area, and they focus on the early stage investment (i.e., less than \$1 million) [85]. In 2014, TCA funded 14 deals (four new, ten follow-ons) for \$8.2 million. It operates five chapters throughout Southern California (i.e., Los Angeles, Orange County, San Diego), and on an annual basis, TCA members typically invest in about ten new deals and an equal number of follow-on rounds, with each investment for its members a minimum of \$25,000 per series [134]. However, other than TCA, angel investments are limited because, in general, investors in this area are conservative, as compared with angel investors from the Bay area. Per Quinn Lin, there used to be more investors in San Diego, and they were more aggressive

in their investments [132]. He added that unfortunately because many of the startups were unsuccessful in securing funding, resulting in to number migrating to the Bay area, these investors became more selective in their startup investments since then. In contrast, Eric Gasser, of TCA SD and SSD, observed during one of our interviews that the apparent lack of local investment capital in San Diego is a misconception [93]. He indicated that success is a matter of connecting great ideas with willing investors. He added that San Diego is about 20 years behind the Silicon Valley relative to history and maturity in the startup world. Eric commented further that there are other angel groups in the area. As previously mentioned, he noted that he was a co-founder of SSD, a group that investment companies that are poised to take the next step (series A or B) [93]. He started the group when he recognized a gap in the ecosystem: tech startups that need management and operations experience to move forward. SSD provides mentors and a taskforce pool to go into the companies and provide systematic support for a six-month period. According to Gasser, SSD engaged in nearly half of all tech deals in San Diego: six in 2014 [93].

Many Companies Bought Out and Transferred to Other Cities

One of the goals for many startups in San Diego is to be acquired. To have the maximum visibility, some have had to move to the Bay area. This decision to relocate is not always their own. In many cases, initial investors will encourage the startup to move to the Bay area to secure additional funding or to connect with people who can help them to be acquired. This movement is especially real for life science startups, whose burn rate is exceptionally high, and for established companies. For example, over the last fifteen years, several major San Diego biotech or pharmaceutical companies started in the community were acquired and relocated, including (1) Agouron (by Warner-Lambert, now part of Pfizer in New York) [135]; (2) IDEC (by Biogen in Boston) [136]; (3) Amylin (by Lilly in Indianapolis) [137]; and (4) Santaurus (by Salix in Research Triangle Park, NC) [138].

Comparing San Diego with Other California Venture Ecosystems

To make a robust comparison of the San Diego venture ecosystem versus other California communities would involve a detailed analysis that would serve as the basis for another paper. Our most notable comparisons include the Bay area (San Francisco/Silicon Valley) and the greater Los Angeles/Orange County metroplex. The most notable for this comparison involves the relative maturity of the ecosystems, the depth of financial community, and the depth of the academic/research communities. San Diego is a robust and developing community for startups. Post's 2014 article listed it as the top place for entrepreneurs [1]. Investor Eric Gasser, at TCA San Diego, indicates that San Diego is hot and feels there are misperceptions regarding the local investor community [92].

An Evolving Community

On balance, San Diego is a community that is still evolving. Its growth in the telecom, tech, and life sciences sectors have only been over the last twenty to twenty-five years. For many years, San Diego was a military town and the next major industry was aerospace. In contrast, the Bay area has had a robust tech ecosystem since the 1970s and life science community since the 1980s. Los Angeles has had strong startup growth since the 1950s and Orange County since the 1980s in various areas spanning from aerospace, tech, lifestyle apparel, to life sciences and entertainment.

Smaller Investment Community Size

The advantage these communities maintain has been a robust investment sector. San Francisco and Silicon Valley are home to approximately 40% of the top venture capital firms investing in an early-stage startup in the US [139]. Also, significant investment/banking institutions, such as Wells Fargo, Transamerica, and Silicon Valley Bank are all located in the Bay area. Los Angeles, according to PricewaterhouseCoopers, is second in venture dollars to the Bay area in the state of California [140]. Finally, Orange County is home to MacArthur Boulevard in Newport Beach, the investment hub for Orange County and home to notable firms such as Pimco. Additionally, these investment communities have been well established for many generations. They also have been home to serial entrepreneurs. According to Neal Bloom of the San Diego Investment Newsletter, these second and third generation entrepreneurs possess a broader capital base and a higher tolerance of risk, leading a willingness to invest more capital (e.g., over \$1 million) into more risky propositions [87].

Relative Strength of Academic Centers

Another area of comparison is the academic presence within these communities. San Diego is home to UCSD, a major technology-based research institution, which has the honor of holding the most patents in the University of California system [24]. The Bay area, in contrast, is the home to the University of California, Berkeley and Stanford University, both of which possess top-tier engineering, business, and law programs [141, 142]. Also, the University of California, San Francisco and Stanford University maintain two of the top-10 medical schools in the US [23] and both have National Cancer Institute (NCI) designated Comprehensive Cancer Centers [143]. Finally, the bay area is the home to the Lawrence Livermore National Laboratories in Livermore, CA [144]. In examining Los Angeles and Orange County, one finds that this metropolplex is home to several nationally top-ranked universities. The University of California, Los Angeles (UCLA) and University of Southern California (USC) maintain top-ranked programs in engineering, medicine, business, and law [145, 146]. The University of California, Irvine (UCI) has developed strong academic efforts in medicine and business. It also

possesses a recently established law school. On the tech side are the renowned California Institute of Technology in Pasadena [147] and California Polytechnic State University, Pomona [148], both institutions add to the strength of the tech and engineering base in the greater Los Angeles area. In addition to these institutions are four NCI-designated comprehensive cancer centers (UCLA, UCI, USC, and City of Hope Cancer Center) and the NASA JetPropulsion Laboratory in Alta Dena, CA [143].

Other Considerations

Other areas can include the critical mass of successful industries, such as tech and biotech in the Bay area and entertainment, medical devices, shipping, apparel, automotive design, and aerospace industries within Los Angeles and Orange County. The Bay area is the home to success including Google, Facebook, Hewlett-Packard, Intel, Gilead, Genentech, Oracle, Salesforce.com, Sun Microsystems, and Tesla. The Los Angeles/Orange County basin is the home to Amgen, Allergan, Abraxas, Broadcom, Disney, Honeywell, Lockheed, Microsemi, and Hyundai. Both these ecosystems bring a greater diversity of industries and large talent pools. Connected with the mature and robust industrial base within these communities involve a healthy base of support services in law, accounting, consulting, marketing/advertising, and public relations. Between the established industry base, startup communities, support firms, and academic communities, these communities have a diverse and robust workforce on which a startup can draw. It is not unusual to hear about individuals in the bay area having circulated through multiple startups; the same is true in Los Angeles and Orange County.

Conclusions

The San Diego ecosystem is a community that is evolving with a group of successful first-generation entrepreneurs and companies. It is a community on the rise, with many young entrepreneurs, particularly in the tech space. Between CommNexus and EvoNexus, San Diego is bursting with entrepreneurial energy and supports. While the North County (LaJolla/Del Mar/Sorrento Valley/Carlsbad) has been the center for startup development, much of which is due to the influence of UCSD. Now downtown San Diego is becoming the focal point for startups, particularly in the tech space. San Diego is a community that is growing and evolving. Its most significant limitation is the investor community, which palls relative to the concentration of investors, dollars invested, and risk tolerance seen in the Silicon Valley and San Francisco region, New York City, Boston, and even the Los Angeles and Orange County region. The investor community has to become more comfortable with risk, as seen within Northern California. This behavior may evolve, as more second- and third-generation entrepreneurs become part of the investor community. If not, San Diego startup entrepreneurs will continue to flock up north to the

Bay area for B and C rounds and venture capital. In essence, San Diego may be a great place to initiate a venture, but may have a limited scale for growing the concern further. Another limitation is that there is a single national academic program that feeds out technologies in contrast to other centers (e.g., SF, Boston, NY, and LA), which have multiple top-tier schools, which have established research reputations. Nonetheless, these are pieces within San Diego that are coming together, as seen in the telecommunications and biotech businesses. San Diego may still be a little behind in comparison to the other communities concerning the areas touched upon in this discussion. However, with that said, it rated as the #10 region related to venture capital investment [149]. As the San Diego startup community continues to see more successes within the tech, telecommunications, and life sciences industries, the ecosystem will continue mature. Present forces in the area, including government, academia, local sectors, and angel investors, are focused upon supporting future startups so that the San Diego economic base will continue to grow, diversify, and rival those of Los Angeles, Orange County, and the bay area in the future.

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