ENHANCING S&T-BASED ENTREPRENEURSHIP: THE ROLE OF INCUBATORS AND PUBLIC POLICY

Kavita Surana • Anuraag Singh • Ambuj D. Sagar

DST Centre for Policy Research
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डॉ. हर्ष वर्धन
DR. HARSH VARDHAN

सत्यमेव जयते

मंत्री
विज्ञान और प्रौद्योगिकी एवं पृथ्वी विज्ञान ;
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SCIENCE & TECHNOLOGY AND EARTH SCIENCES ;
ENVIRONMENT, FOREST AND CLIMATE CHANGE
GOVERNMENT OF INDIA
NEW DELHI - 110001

MESSAGE

It is now well established that technological entrepreneurship accelerates economic growth. One of the chief means to accelerate entrepreneurship is through the establishment of incubators. Thus, incubators are a key policy tool for S & T innovation and entrepreneurship. During the past three decades over 140 publicly funded incubators have been established in India, and several more are being launched through the 'Startup India' programme. More recently, the private sector has also become active in setting up new incubators/accelerators.

However, India still remains low on most innovation and entrepreneurship rankings. Gaps still exist in channelling S&T innovation for startups. Therefore, it is essential for us to take a broad and systematic look at how the incubators that have been established so far have fared, re-examine the key determinants that make the difference between success and failure, identify the gaps that need to be plugged, and enumerate the lessons that can be learnt to strengthen the ecosystem as a whole. This would lead towards redefining our S&T policy in the light of changing circumstances and newer challenges and strengthen the ecosystem of innovation in the country.

The current study entitled ***Enhancing S&T-based Entrepreneurship: The Role of Incubators and Public Policy*** is an exercise in this very direction. Undertaken by the DST Centre for Policy Research (DST-CPR) at the Indian Institute of Technology, Delhi (IITD)-supported by the Department of Science & Technology (DST),

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Government of India – the report provides an analysis of the historical experience and current landscape of publicly-funded incubation for S&T driven entrepreneurship in India. It takes both a broad look at this landscape as well as deeper look at a few selected incubators. Through this, the report analyses what make incubators effective and what are the key barriers to stronger innovation. Finally it presents a set of clear recommendations to policy makers, programme managers as well as the incubators themselves.

I would like to congratulate the experts at the DST-CPR at IITD for having undertaken this valuable and timely study. I am sure it will be instrumental in articulating a new set of policy changes necessary to inject a new energy to our incubators and through them India's landscape of innovation and entrepreneurship.

(Dr Harsh Vardhan)

सत्यमेव जयते

प्रो. आशुतोष शर्मा
Prof. Ashutosh Sharma

स्वच्छ भारत
एक कदम स्वच्छता की ओर

सचिव
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Secretary
Government of India
Ministry of Science and Technology
Department of Science and Technology

3rd May, 2018

MESSAGE

The Department of Science & Technology (DST), Government of India has established five DST Centres for Policy Research (DST-CPRs) in various academic institutions across the country. One of these centres is at the Indian Institute of Technology Delhi (IITD), one of India's premier educational institutions. The focal areas of CPR at IITD are assessing the current landscape and status of the Indian innovation system and devising policies and approaches to improve its performance; devising policies to leverage innovation to meet sustainability and inclusivity challenges, and to exploit opportunities for leveraging science, technology, and innovation to promote economic and human development in the country.

The present report entitled ***Enhancing S&T-based Entrepreneurship: The Role of Incubators and Public Policy*** broadly explores the current incubator landscape, and provides detailed insights into selected ones. It also critically examines the strengths, weaknesses and barriers to success and provides well thought out recommendations.

DST *per se* has established incubators in public/private academic as well as research institutes through various schemes. Scientists and engineers have been encouraged to explore S&T based entrepreneurship by nurturing the startups in the incubator space. The thorough analysis of incubation space within the country by IIT Delhi team has led to implementable recommendations which include requirement of skilled manpower; alignment of strategy, design and activities of incubator with local need and resources; need of constant financial and infrastructural support to validate high risk ideas of societal relevance and strong networking, coordination and data management etc for visible impact on country's innovation ecosystem.

I would like to convey my appreciation to all those involved in this study at IIT Delhi for the rigor, quality, hard work and dedication. The Department would carefully look into the recommendations made through this report to examine what needs to be done to further improve the innovation ecosystem relating to technology incubators.

(Ashutosh Sharma)

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Kavita worked at the French Atomic and Alternative Energies Commission (CEA) during her Ph.D. in Materials Science and Engineering from the Institut Polytechnique de Grenoble (INP-Grenoble), France. She was an Erasmus Mundus scholar at Paul Sabatier University, Toulouse, France and holds a B.Sc. in Physics from St. Stephen's College, Delhi University, India.

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Ambuj Sagar is the Vipula and Mahesh Chaturvedi Professor of Policy Studies and the founding Head of the School of Public Policy at the Indian Institute of Technology Delhi. Ambuj's interests broadly lie at the intersection of technology and development. His recent work has focused on innovation policy for meeting sustainability and inclusivity challenges, energy innovation policy and strategies (in areas such as bio-fuels, clean cookstoves, coal power, automobiles, and institutional mechanisms such as climate innovation centers), climate change policy and politics, capacity development, and higher education policy.

Ambuj did his undergraduate studies in Mechanical Engineering at IIT Delhi. He subsequently received an M.S. in Aerospace Engineering from the University of Michigan and then an M.S. in Materials Science, a Ph.D. in Polymer Science, and an M.S. in Technology and Policy from the Massachusetts Institute of Technology.

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

S&T-based entrepreneurship is likely to play an increasingly important role in India's innovation landscape, given the increasing focus on this in public policy, the evolution of the country's innovation ecosystem, and the burgeoning interest among scientists and engineers to explore this pathway. In the past three decades, incubators have been the most prominent public policy tool used by the Government of India to promote S&T-driven entrepreneurship. These incubators act as intermediary agents designed to nurture startups with innovative, risky ideas into marketable products by providing infrastructure and support services, and by providing rich linkages to other actors of the innovation system. Yet, despite three decades of experiences with incubators, the impacts of public policy interventions for promoting S&T-driven entrepreneurship have been mixed. Policymakers' recently renewed efforts to strengthen innovative S&T- and knowledge-based startups—such as Startup India and the *Atal Innovation Mission* announced in 2014-2015—will double the existing number of incubators. While these initiatives will take a few years to pay off, a systematic analysis of the rich experiences from various incubator programs is imperative for making existing and new policy efforts more effective.

This report provides a detailed analysis of the historical experience and current landscape of publicly-funded incubation for S&T-driven entrepreneurship in India. The most prominent actors include, among others, incubator program managers from different government departments, incubator managers, and incubatees. The analysis builds on insights from semi-structured interviews and a workshop with participation from various incubators across the country, desk research (from policy documents, public and private reports, and newspaper articles), collated data on publicly-funded incubators, and detailed case studies (of incubators seen as prominent in meeting their individual goals and contributing to building the entrepreneurial ecosystem).

The report finds that public policy goals for incubation and S&T-based startups evolved over the past three decades, even though publicly-funded incubators continue to share several characteristics. The initial public policy focus on promoting self-employment changed to prioritizing academia-industry linkages, promoting technology transfer, and eventually to focusing on creating innovative enterprises. Most incubators continue to be not-for-profit entities with a host partner that is often a public or private academic (or research) institute, established primarily through programs run by the Department of Science and Technology (DST) and to a lesser extent from Department of Biotechnology (DBT). The majority of incubators are located in clusters around metropolitan Tier I cities of Hyderabad, Chennai, Bangaluru, Delhi, and Ahmedabad, albeit with a few exceptions. Incubators receive public financial support for their operations from multiple government departments; however, the most prominent support comes for an initial five years from the DST after which incubators are expected to sustain their own business. These publicly-funded incubators also facilitate financing for incubatees through several public funding channels. Since 2010, new public-private models have emerged increasing private sector financing and industry linkages for these incubators. Overall two sectors—i.e., information technology (IT) and life sciences (or biotechnology)—dominate in terms of policy priorities for sector-specific innovation and incubation.

Insights from case studies indicate the following characteristics common to generating effective, successful outcomes from existing publicly-funded incubators:

- investing time and resources in building, identifying, and attracting good ideas—for example, by training students and researchers to innovate, by identifying research with commercialization potential, or by attracting talented innovators to the incubator
- operating on business models that reflect an understanding of markets (in one or more sectors) and with clear goals to purposefully target specific market demands that may not be fully addressed by the private sector
- facilitating investments for startups—especially early-stage investments—by administering funding for startups from government bodies, by managing their own seed funds or venture capital funds, or by helping attract external investment.
- creating business models that ensure long-term financial sustainability and a secure flow of income for the incubator beyond the five-year period of initial public financing
- providing startups access to multi-faceted networks for knowledge (technical, strategic, operational, and market knowledge), mentorship, finance, and private sector markets
- being led by dynamic, entrepreneurial incubator managers (and incubator founders or trustees) who bring experience beyond academia, or have the skills to actively leverage different actors beyond academia

The report recommends actionable steps for policy-makers, incubator managers, and other actors to address four key aspects that can strengthen publicly-funded incubators and S&T-based entrepreneurship (Table ES.1).

1. Broadening and deepening the pipeline of S&T talent can bolster human capacity for incubatees in the form of S&T-based startups.
2. Purposefully aligning strategy, design, and operations of the incubator with the context of the incubator (geographical location, sectoral scope, market opportunities, etc.) can create more favorable outcomes for incubators and incubatees.
3. Incubators addressing specific market failures (such as those related to areas with high societal benefits but low commercial returns) can help S&T-based startups connect to financial markets or other services.
4. System-level coordination and assessment can exploit synergies/ benefits between individual incubators/ programs activities that are not undertaken by any single entity to provide a larger, 'systems-level' perspective.

Table ES. 1: Recommendations to address different gaps and barriers related to incubators and S&T-driven entrepreneurship in India (for policymakers and program managers in white boxes, and for incubators in light blue boxes)

1 PIPELINE OF S&T TALENT
Students lack skills in S&T driven entrepreneurship and innovation
Fund the development of new courses to build the ability to apply S&T skills to market needs: • courses on innovation based on specific problems including those that fulfill social needs—for example energy services, sanitation, rural areas, etc.—where students first analyze the problem context and then apply theoretical, experiential, and practical knowledge to find S&T-driven solutions

- courses on interdisciplinary subjects—combining medicine and engineering, technology and society, etc. to improve understanding of market needs while generating ideas

Expand faculty-training programs on S&T-driven innovation and entrepreneurship to generate faculty who can design and teach relevant courses for students in different specializations

- Develop entrepreneur-in-residence programs with university campuses to bring in S&T entrepreneurs with real world experiences of creating and managing challenges associated with product-based S&T startups
- Offer students internships, projects, and other opportunities to engage more deeply with startups and incubators that are co-located with their university

Faculty have limited knowledge of industry and have few incentives to launch startups

Revise HR policies and UGC rules to incentivize faculty engagement in innovation and entrepreneurship:

- flexible hiring and promotion policies where entrepreneurial activities are valued along with academic publications and research projects
- revising UGC rules for sabbaticals or 'study leave' to include external employment in the "problem environment" so faculty can interact with end-users such as healthcare institutions, rural workers, etc.; revising UGC rules to support and fund sabbaticals for launching startups

Faculty and students have poor perception of entrepreneurship

Increase the visibility of scientists in startups through the following to ease risk perceptions about careers in S&T-driven startups and increase interactions with university S&T researchers

- offering awards for startup scientists to encourage research with commercialization focus
- creating forum for startup scientists to share their experiences on university campuses

Revise external- and self-evaluation criteria of university success by including both corporate placements and student-launched startups to encourage students to consider entrepreneurship and commercialization of ideas in the same light as taking up salaried employment

2 INCUBATOR STRATEGY, MANAGEMENT, & OPERATIONS

Incubator activities are misaligned with poorly-defined incubator goals

Require incubators to define goals, along with preliminary activities and self-evaluation metrics as part of the application procedure. These goals could include a combination of—sectoral development, geographical development, co-location with academia, startup stage (i.e., idea stage, early stage, or growth stage) etc.

Offer periodic guidance to incubators in articulating and adapting goals and activities to the changing context of innovation and market needs

Mandate regular self-evaluation exercises based on metrics designed to evaluate performance in relation to goals
Incubatees lack skills in entrepreneurship
Create competitive cohort programs for incubatees on regular intervals—e.g., sector-based accelerators—to build community, strengthen networks with industry or investors, and provide mentoring in a more targeted manner
Offer incubatees training on a range of skills useful for entrepreneurs—e.g., startup business models, writing business proposals, applying for grants, developing communication skills, etc.
Incubator management can be weak
Identify, invite, and train experienced professionals with business, market, and S&T experience in incubation management to make S&T innovation-based incubation market-driven rather than champion-driven
Incentivize talented professionals (or academics) to take up incubation management as a career and to alleviate perceived risks, particularly in universities—for example by showcasing career paths of prominent managers from other incubators, integrating incubator managers in university management, etc.
Hire experienced (or well-trained) incubator managers (or CEOs) with an ability to connect business, markets, and S&T-innovation, strong skills in leadership and marketing, and passion for S&T-innovation Offer continued support for the entire incubator management team (and not just managers) through systematic training, access to advisors, etc. relevant for the incubator's local context
Incubator funding from government sources may be insufficient
Offer flexible incubator financing (based on well-defined region- or sector-based goals and performance indicators) instead of fixed, five-year financing through the following: • expanding well-performing incubators and strengthening their linkages with other incubators • offering long-term performance-based support to incubators that meet performance requirements or have sectors with longer innovation and development cycles • phasing out funding to incubators that fail
Initiate and incentivize public-private models for incubator financing • supporting incubator managers in leveraging local industry or other networks to use CSR funding for entrepreneurship • using competitive tendering processes by public sector to select private partners for setting up joint incubators

3 MARKET FAILURES

Startups / incubatees lack support services to validate S&T-based ideas
Create mechanisms for testing and validation of new technologies that are developed in startups but have no established standards or mechanisms for validation
Establish centralized support services—i.e., technical services, legal and patenting services, market research, etc.—by pooling resources to benefit regional, sectoral startup clusters (e.g., Hyderabad and Bengaluru with life sciences / biotech)
Facilitate connections between publicly-funded startups and public sector (central and local) to secure advanced market commitments including provisions for public procurement of technologies
Private sector underinvests in sectors with high societal benefits
Create a larger seed fund to support the needs of S&T-driven innovation by leveraging public funding seed money and inviting private investments
Provide tax breaks to corporate firms for investing in incubators to increase private investments by replacing (or complementing) CSR funding for incubators that has so far been perceived by corporates as an additional tax
Partner with local bodies that work on societal issues and draw S&T-driven entrepreneurs to address problems related to public goods or areas with high societal benefits but low commercial returns where private sector will not invest, or is less likely to invest
Extend incubator network resources in regions with less developed innovation ecosystems by partnering with local industry associations or with other industry networks to compensate for insufficient private capital or linkages with markets
Leverage alumni networks to create venture funds for supporting startups in areas of expertise of the university or of the incubator

4 SYSTEM-LEVEL COORDINATION AND ASSESSMENT

Actors involved with incubation have weak coordination and no formal networks
Organize meetings for different actors in publicly-funded incubators to strengthen coordination: • annual conference for all incubatees to promote community building, share experiences, and strengthen networks • periodic meetings between incubator managers and program managers to enhance systematic knowledge sharing and coordination • meetups between sector-specific incubator and incubatee meetups through “networks of incubators” for sharing resources, best practices, and for generating new ideas

Maintain (and update) a centralized registry of all incubators that receive public-sector funding to improve accountability of incubator performance, help government departments coordinate incubator support efforts, and increase visibility of incubators for potential incubatees
Create open repositories of projects and problems to strengthen linkages between innovators and markets: • database of research projects from knowledge networks can promote collaboration for new entrepreneurial ideas, find potential applications, or find potential customers • database of problems identified with private companies, foundations, government departments, etc. can attract potential innovators to find solutions
Build and maintain centralized online databases of support services and partners for startups and facilitate startup engagements with these services: • support services (testing and validation services, legal support for intellectual property and patenting, technical infrastructures, etc.) • industry and finance partners willing to work with startups
Build regional innovation ecosystems outside of metropolitan cities by mandating incubators to include experts from regional companies or industry associations in their management
Government-led incubator programs lack systematic data or analysis on incubator activities
Develop (and regularly evaluate) sectoral and regional innovation maps to identify the landscape of actors, their linkages, and the dynamics of innovation and to help incubators define their goals, strategies, and activities
Conduct systematic, annual assessment of incubators and incubatees to assess performance, to improve accountability, and to assess the long-term effectiveness of incubation programs: • Develop a new set of indicators to analyze incubator and incubatee performance based on innovation inputs, outputs, and outcomes and be designed to reflect the goals of the incubator (e.g., regional development, sector-specific, etc.) • Use a common template with indicators to collect information on incubators and incubatees
Increase the understanding of different incubator business models used in publicly funded incubators under different contexts and goals—i.e., differences in incubator management (public- or private-sector managed), technology or startup stages (idea to early stage, early stage to growth stage, growth to expansion stage); other goals (sector-specific, sector-agnostic, regional development, etc.) • Conduct a detailed assessment of different incubator business models used in publicly funded incubators • Make the assessment available to incubator managers and use it to advise existing and new incubators on modifying their business models

1 Introduction

The Government of India announced in the period 2014-2016 a set of ambitious national- and state-level initiatives to promote innovation-driven entrepreneurship through startups. At the national level, *Startup India* (launched in 2016), primarily targeted the practical barriers to innovation through: (i) easing of complex, lengthy regulatory processes for startups, (ii) providing high-risk funding and tax incentives to startups (with a total budget of INR 10,000 crores to be distributed by 2020), and (iii) promoting industry-academia linkages including through 70 new incubators, startup centers, and research parks. Also at the national level, the *Atal Innovation Mission* (AIM, launched in 2015), aimed to address socio-economic issues through innovation by: (i) building the capacity to innovate in middle- and high-school students through 500 new maker-spaces known as Atal Tinkering Labs, (ii) creating 100 new sector- or technology-specific incubators, and (iii) extending support for existing incubators. At the state-level, 15 state governments introduced specifically designed startup policies between 2014 and 2016.

While recent policy initiatives acted as a much-needed catalyst to build the Indian startup ecosystem and to strengthen the broader innovation system, the government's association with startups is not new. Public policy support for innovation- and science and technology (S&T)-based startup creation extends to over three decades, formally initiated through the establishment of the National Science and Technology Entrepreneurship Development Board (NSTEDB) in 1982. The involvement of government in stimulating startup activity has been motivated by multiple public policy goals that include generating economic growth, creating employment opportunities, and supporting regional development.

Incubators have been central to public-policy engagement with S&T startups in India. Between 1985 and 2014, over 140 incubators were established across India with public funding[1]. These incubators were established to act as intermediary agents that reinforce the innovation system and link its interrelated groups of actors, i.e., governments, universities, and firms, operating under an institutional context (where institutions refer to policies, cultural norms, etc.). Incubators therefore operate with the aim of providing a conducive environment to help convert innovative, risky ideas into enterprises.

The outcomes of three decades of public-policy interventions to support S&T driven innovation and entrepreneurship in India have been mixed. On the one hand, despite the public sector support for incubators, it is the private sector that has produced an exponential rise in the number of startups in recent years. Estimates on the number of pri-

[1]Author calculations with incubator data from DST, NSTEDB, DeitY, DBT, DSIR, and MoMSME.

vate sector incubators and accelerators indicate a 37.5% increase from 80 in 2014 to 110 in 2015 while estimates on the number of startups indicate a 71% increase from 700 in 2013 to 1200 in 2015 (NASSCOM, 2015). On the other hand, while India has the third largest number of startups in the world, as per estimates from NASSCOM, India lags behind in several indicators of innovation and in linking innovation to markets. For example, the business and innovation environment in India is generally poor demonstrated by the relatively weak ranking on the ease of doing business index (130/189) and on the global innovation index (66/128) (Cornell University et al., 2016; World Bank, 2016).

As policymakers renew goals for promoting innovative S&T- and knowledge-based enterprises—including by nearly doubling the number of publicly-funded incubators—a systematic analysis of three decades of incubation experiences can offer useful lessons. This report on publicly funded incubators in Indiaaims to (1) understand the factors that effectively contributed to building and strengthening the startup ecosystem and innovation system, and (2) provide evidence-based recommendations to strengthen incubator activities for S&T-based innovation and entrepreneurship. This report analyzes how incubator activities evolved over time under different policy objectives, drawing on a number of semi-structured interviews with a range of experts and practitioners (see Appendix A, page 51), six detailed case studies (see Appendix E) on different incubators, the authors own analysis, and insights from a workshop with representatives from a number of incubators. Through this, we specifically aim to address the following questions: (a) How have the goals and activities of policymakers and other actors evolved in the context of incubation and startup creation? (b) How have the outcomes and determinants of success of incubators been shaped by goals and activities of different actors?

The rest of this report is structured as follows. Chapter 2 describes the methodology. Chapter 3 offers a detailed review of the scholarly literature on the role of public policy in supporting innovation and entrepreneurship through incubators. Chapter 4 provides the landscape of policies, the most relevant actors, and their activities and how these have evolved over time for promoting S&T-based innovation and entrepreneurship in the Indian context. Chapter 5 discusses the findings from case studies of six publicly-funded incubators in India and identifies factors that contribute to successful incubation outcomes. Chapter 6 discusses the most pressing gaps for incubators and provides concrete, actionable recommendations for policymakers and for incubators to strengthen S&T-driven innovation, incubation, and entrepreneurship. Chapter 7 concludes.

2 Methodology

This report on analyzing and strengthening publicly funded incubators for S&T-based entrepreneurship is based on the following six steps drawing on desk research, semi-structured interviews, and case studies. First, we conducted high-level interviews to understand key priorities, challenges, and needs related to publicly-funded incubators and S&T driven entrepreneurship in India (see Appendix A for list of interviewees). Second, we conducted a detailed review of public policy involvement inincubators and incubation programs in countries around the world, and on how these programs are designed and analyzed. Third, we assessed the current and historical landscape of S&T driven entrepreneurship, innovation, and incubation in India using policy documents, public and private reports, and high-level interviews. Fourth, with the help of experts, we identified six incubators that exhibit particularly favorable incubation outcomes.We conducted detailed case studies on these incubators using semi-structured interviews with a variety of personnel involved with these incubators (i.e., incubator managers, incubatees, members of the management team, etc.). Fifth, we identified common factors from these six incubators that determine successful incubator outcomes. Sixth, based on our insights from interviews and case studies, we developed recommendations to strengthen S&T driven innovation and incubation in India. We further refined these recommendations based on consultations with various incubator representatives in a workshop that discussed the findings of this report.

There is no formal (and regularly maintained) database of incubators making it difficult to systematically assess over time all incubators, their interactions with government and other actors, or their changing goals, priorities, outputs, outcomes etc. We address this issue in three ways. First, we created our own database of all publicly funded incubators and analyzed the different channels of public funding from 1985-2014. Second, because the focus of this report is on incubators, our interactions with other actors of the innovation system—i.e., funding agencies, incubatees and startups, investors, universities, national and state-level policymakers, etc.—were aimed at developing a broad perspective on incubators (see Appendix A). Third, while our interviews and six case studies are by no means an exhaustive representation of incubation activities in India, they represent incubators with access to different types of resources (e.g., location in metropolitan Tier 1 city vs. location in a Tier III city), different sector-related priorities (e.g., biotech vs. information technology), and different university partners (e.g., engineering school vs. business school).

3 Innovation, Entrepreneurship, and Economic Development

Before exploring the state of incubators and S&T-driven entrepreneurship in India, we review (i) key literature on the importance of innovation and entrepreneurship for economic development, (ii) why and how public policy plays a role in shaping these, (iii) what incubators do and why incubators are a commonly used policy tool for innovation, and (iv) how incubators have been used by policymakers in the rest of the world to promote innovation.

Background

In this report, the term 'innovation' encompasses the creation or adaptation of new technologies, products, processes, and business ideas and their translation into practical application. Effective innovation is a product of a well-developed innovation system—aset of actors (e.g., governments, universities, and firms) that collaborate and interact under an institutional context (where institutions include policies, social and cultural norms).

The interactions between innovation, entrepreneurship, and economic development are well documented (OECD, 2013a; Szirmai et al., 2011). As actors central to the innovation system, entrepreneurs contribute to innovation by creating new enterprises (or startups) that commercialize new technologies, bring new technologies to market, or create new ways of using existing knowledge. Entrepreneurs discover and exploit opportunities, transfer resources towards more productive uses and increase efficiency, thus creating and adding economic value (Acs and Storey, 2004; Audretsch et al., 2007; Shane and Venkataraman, 2000). The coupling of innovation and entrepreneurship through startups can create new opportunities for employment and increase industrial competitiveness, thus driving regional economic development and growth. To this end, efforts to replicate the Silicon Valley model have emerged around the world.

Box 1: What is a startup?

While there is no single definition of the world "startup", the term startups has been used broadly to new enterprises that are associated with a combination of market impact (high-growth, job creation, gazelles), innovation content (innovation from research and development, new processes, etc.) (OECD, 2013). Startups are formed after the initial idea or seed stage, followed by growth, and expansion. The government of India defines starts-up as follows (Ministry of Commerce and Industry, Government of India, 2016):

> *A startup is an entity, incorporated or registered in India not prior to five years, with annual turnover not exceeding INR 25 crore in any preceding financial year, working towards innovation, development, deployment or commercialization of new products, processes or services driven by technology or intellectual property.*

Globally, innovation-driven economic growth is widely accepted as an underpinning foundation to meet socio-economic development challenges (e.g., (Audretsch et al., 2007; OECD, 2013a, 2013b). Technological innovation and technological change have been instrumental in meeting human development goals while simultaneously supporting sustainable growth and shaping current societies. The synergies between innovative startups and economic growth are widely declared by policymakers, investors, and academics as an engine for innovation-led growth in developing countries.

However, while many countries and regions associate entrepreneurship with innovation and they design policies to facilitate one or the other in hopes of achieving economic growth, not all entrepreneurs innovate (Audretsch et al., 2007; Autio et al., 2014). A recent study on 60 countries indicates that the share of innovative ventures among new enterprises varies from 20% to 30%, and in certain cases, high entrepreneurial activity may even accompany lower innovation (Kelley et al., n.d.). Spurring innovation based enterprise creation therefore requires policymakers to consider "not whether entrepreneurs innovate, but rather, when and where they do so" (Autio et al., 2014). This means consideration and manipulation of the context that may have key differences between industry sectors and regions.

The emergence of innovative startups therefore requires favorable conditions reflected in the strength and quality of the innovation system. In developing countries—where the potential to benefit from innovative startups is particularly high—institutions and markets are often underdeveloped and unpredictable, in what is known as "institutional voids" (Khanna and Palepu, 1997). The immature innovation system in developing countries often means that startups face barriers related to limited human and financial resources, have poor infrastructures, and have limited access to markets where they can sell their products.

The role of public policy

The role of the government and public policy is key in strengthening the innovation system and in creating enabling conditions favorable to startups for innovation-led economic growth. However, S&T-driven startups have a particularly high likelihood of failure because of their inherently risky ideas that require human resources with strong S&T foundations, a business-friendly environment, often a focus on physical products whose development, manufacture, and sales require a large supporting cast of characters, and access to high-risk financial capital. The combination of these factors exacerbates barriers for S&T innovators who may not be well connected with business- and market-related aspects of their startups. For example, the S&T innovator or entrepreneur is often familiar with the limits of technology while the investor is better connected with markets and customers; innovators who get grants or seed funding from the public sector at the idea stage need a well-developed financial sector that can support the startup through different stages for expansion and growth; innovators often lack the business or entrepreneurial skills to convert their invention into an innovative product through an effective business plan. The success of startups therefore depends in significant part on the quality of the innovation system and the strength of its networks and linkages between different actors.

Creating enabling conditions for startups by policymakers therefore requires building an innovation system that allows the development of new knowledge and technologies or their integration into markets and offers sufficient opportunities for smooth knowledge flows between different actors. This requires a mix of policies that depend on the country- and region-specific context and conditions, as there is no "one size fits all" solution.

Across the world, public-policy instruments and governments have supported startups through different stages, in particular at the earliest stage.

Direct government-driven initiatives for startups include programs for university-based startups and technology-based economic development (e.g., incubators, accelerators, science parks, etc.) and formal programs for direct financing or grants such as the Small Business Innovation Research (SBIR) in the US (Grimaldi et al., 2011). Under the right mix of policies, government participation can help to absorb risks associated with early-stage startups while sending signals to the private sector to invest as these startups grow. Indirect government-driven activities that underlie successful startups include building capacity and human resources through universities, technology transfer offices, and provision of entrepreneurial training. More broadly, governments manage the regulatory framework and business environment under which startups operate and can greatly facilitate startup investments by creating supportive conditions for angel investors and venture capitalists. Overall, public policy plays a central role in directly or indirectly strengthening the linkages between startups and other actors of the innovation system.

Incubation as a policy instrument

Incubation is a long standing policy tool used worldwide to create favorable conditions for promoting innovation-based startups. Incubators are formally organized entities that support the conversion of individual ideas from early stage innovation to marketable enterprises and they facilitate startup activity by strengthening the context (or ecosystem) under which startups operate. They also act as intermediaries that link startups with other actors of the innovation system—i.e., entrepreneurs, universities, researchers, government officials, policymakers, investors, etc.—with the aim of correcting market failures where the private sector fails to provide investment (or other support) to expand new ideas (Dutt et al., 2015).

Incubators provide a combination of support services for startups that includes infrastructure (working space and associated basic physical infrastructure, workshops), finance, business capability (mentoring, training, consulting), and access to networks. (Amezcua et al., 2013; Cohen, 2013; Dee et al., 2011; Dutt et al., 2015; Hackett and Dilts, 2004).

Incubators can be linked to several related configurations that include science parks, business parks, innovation centers, accelerators, etc. (Table 1). Incubators provide long duration support for new enterprises (up to five years) and often generate revenues by renting out space; in comparison accelerators are primarily driven by investments and returns, they support enterprises in batches with intervals of three months, and are inherently more competitive (Cohen, 2013).

Table 1: Characteristics of incubators, accelerators, and hybrids (based on Cohen, 2013; Hathaway, 2016)

Characteristics	Incubators	Accelerators	Hybrids
Duration	1 year – 5 years	3 months – 6 months	3 months – 2 years
Cohorts	No	Yes	No
Business model	Non-profit	Investment; can be non-profit	Investment; can be non-profit
Selection	Non competitive	Competitive; cyclical	Competitive; ongoing
Venture stage	Early or late stage	Early	Early
Mentorship	Minimal	Intense	Staff expert support; Moderate mentoring
Location	On-site	Off-site (virtual incubation)	On-site Off-site; (virtual incubation)

Although typically incubators are not-for-profit and often receive varying levels of assistance from public funding bodies (Cohen, 2013; Dee et al., 2011; Hackett and Dilts, 2004), in recent years there also has been a rise of commercial incubators.

While incubators provide specific support services for startups, effective incubation has three requirements. *First*, incubators require access to human resources that have the capacity to innovate, engage in entrepreneurial activity, and create startups. To this end, incubators often have close linkages with universities and research centers, often in regional hubs. Universities provide incubators access to knowledge-based assets—such as technically-trained students and faculty—and incubators thus benefit from localized knowledge spillovers (e.g., Jaffe et al., 1993; Rothaermel and Thursby, 2005a). Linkages with universities are found to help in startup survival (Rothaermel and Thursby, 2005b) and with developing networks (McAdam and McAdam, 2008). Furthermore, the concentration of startups in a region can promote entrepreneurial culture, information sharing, and knowledge spillovers within and across firms and academia, thus resulting in additional innovations (Saxenian, 1996). Second, incubators require the ability to provide exit mechanisms for their startups to graduate and make way for new startups. Startups can graduate through several exit mechanisms—i.e., startups may receive additional financing from investors, startups experience other forms of validation from markets, or they can declare bankruptcy and close down—and incubators must be able to help startups in identifying and managing the right exit opportunity. Third, incubators require the capacity to manage activities that support startups. Once a startup enters the incubator, it benefits from services in the form of infrastructures (i.e., space, power and internet, technical equipment, financing, etc.) and business capabilities (mentors, training, etc.). Effective incubators therefore require managerial staff with the capacity to provide adequate business and technical mentoring to startups, build their linkages with markets, while simultaneously managing incubator finances.

Besides assessing the three key requirements of incubators listed above, ananalysis of incubator activities requires an understanding of the underlying goals under which a particular incubator was set up (Bergek and Norrman, 2008). These goals may be, among others, to promote a particular technological sector, build a regional technological cluster, transform research to innovative products, generate employment opportunities, or contribute to development of a suburban area. The activities and outcomes of incubators have been subject to extensive scrutiny worldwide with the aim to understand best practices. Much of the extant analysis on incubators focuses on their formation and functioning, their performance outputs and outcomes, and on their linkages with public and private actors (Bergek and Norrman, 2008; Dee et al., 2011; Hackett and Dilts, 2004; Phan et al., 2005).

Innovation, startups, and incubation around the world

Developed countries like Switzerland, Finland, Israel, and USA rank high in various indicators of innovation as they invest more heavily in human capital and research, have stronger institutions and markets, and have greater outputs in terms of knowledge, technology, and creativity (Figure 1) (Cornell University et al., 2016). In contrast, with the notable exception of China, emerging economics rank low in innovation, with low budgets for research, few R&D personnel to innovate or to develop new technologies, less developed infrastructures, and less sophisticated markets. India, while seen as an 'achiever,' scores particularly low in terms of institutions (i.e., political, regulatory, and business environment), human capital and research (i.e., education and R&D), and creative outputs (i.e., intangible assets, creative goods and services, online creativity).

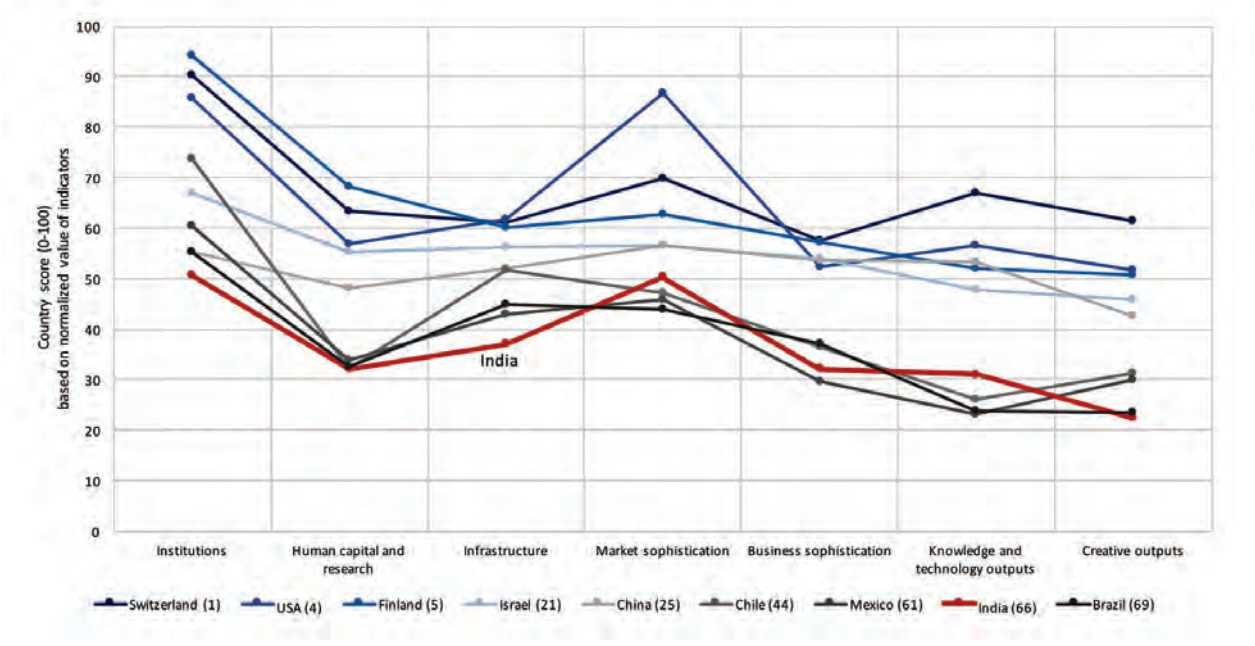

Figure 1: India scores low in various indicators of innovation compared with other major industrialized and developing countries. Brackets next to countries show country ranking in the Global Innovation Index, 2016. (Cornell University et al., 2016).

Many of these countries have used incubators as a policy instrument for creating an enabling environment for startups. Appendix B illustrates how incubation has been used as a policy instrument for around the world, with examples from Brazil, Chile, China, Mexico, Finland, Israel, and the United States..

4 Incubation and S&T Innovation-based Entrepreneurship in India

Barriers to innovation and consequences for startups

The most pressing social and economic barriers for Indian S&T innovators—and consequently for S&T-innovation-based entrepreneurship among students and academics—are (1) the lack of capacity to innovate in academia, (2) low support for failure, (3) underdeveloped markets, and (4) bureaucratic and regulatory barriers (Cornell University et al., 2016; GIZ, 2012; GoI, 2012; LeBlanc, 2012, Interviews).

First, S&T students and researchers often lack the capacity to innovate. The prioritization of theoretical knowledge in higher education offers limited practical knowhow to students. While research is often not on the cutting-edge in a majority of universities outside of the few high ranking institutions, researchers also have had few interactions with industry or markets. This means that research outcomes rarely translate to marketable products or services.

Second, support mechanisms for engaging in high risk activities or for managing failure are weak—and risk and failure together are characteristic of S&T-driven innovation. Social and institutional support for failure in India is low while cultural aversion to risk is high. This translates to limited innovation-based entrepreneurial activity in high-risk S&T sectors. Often, incentives for students and researchers to engage in innovation-based activity are misaligned with the priorities of the university. For example, students' or researchers' activities that focus on innovation—and thus divert from 'traditional' productive activities—are perceived as a waste of time and may be associated with failure. Similarly, university success is primarily measured through student placements with little consideration of startup activity; universities therefore rarely encourage graduating students to engage in innovation for creating risky startups. Furthermore, S&T students—widely acknowledged as key innovators in countries across the globe—are hesitant to give up salaried jobs in favor of launching their own startups, for example over concerns on their ability to repay student loans or because replacing high salaries for equity shares in a start-up is uncommon in India (although this has changed somewhat in recent years). This means that innovators who do start their own ventures are unfamiliar with the challenges of startups and often lack experience from previous failures. The reluctance of students to engage in S&T innovation-based entrepreneurship is further exacerbated by the lack of role model innovators or startup success stories, with few startups actually reaching an IPO stage outside the IT sector.

Third, markets in India are underdeveloped and do not support the discovery of new products or the diffusion of innovation. Under developed markets affect innovators who need stronger linkages with the innovation system for locating mentors, inves-

tors, or customers, or for finding a form of market validation for their idea (for example, additional rounds of financing, IPOs, university spinoffs, etc.). Regions outside of major metropolitan cities (or Tier I cities) face the greatest obstacles. In the largest metropolitan cities, the private sector is relatively mature with large availability of customers, investors, and mentors for startups. However, suburban areas or smaller towns (or Tier II and Tier III cities) may suffer from a lack of potential investors or buyers, particularly in sectors outside of IT. Underdeveloped markets there fore particularly restrict innovation for non-IT or product-based startups (more than service-based startups) where scaling up technology, receiving financing, and connecting to markets is difficult. Scaling up technology is particularly challenging for non-IT startups that have no established supply chain to bring in parts and no established avenues for validation of their products (i.e., no quality assessment or testing opportunities). Similarly, the availability of financing is exacerbated for non-IT sectors due to a combination factors. On the one hand, traditional actors in India with a high appetite for risk—i.e., venture capital networks, high net worth individuals, etc.—prefer investing in low-risk fast-growth startups with late stage deals. Most startups are therefore associated with the IT sector outside of which there is a shortage of early stage capital and few high profile exits of new S&T-based enterprises. On the other hand, banks unlikely to lend to small, new S&T-based enterprises because of the high-risks involved. Innovators also prefer financing from venture capital rather than banks because high transaction costs with banks make them less attractive for those who require small amounts of capital (GIZ, 2012).

Fourth, in the event of actual innovation with commercialization potential, complex bureaucratic procedures and paperwork involved in patenting, procurement, starting or closing a company etc.put additional pressures for time and resources on innovators and innovation-based startups (NITI Aayog, 2015). The times required to start or to close a business—i.e., 29 days to start and over 4 years to close a failing business (World Bank, 2016)—illustrate long regulatory delays faced by innovators and startups already strapped for resources. The costs and lengthy procedures associated with shutting down a business mean that many entrepreneurs keep their defunct businesses alive on paper.

Box 2: Examples of challenges for startups in non-IT sectors

Hardware products or non-IT innovations face a lack of testing or validation mechanisms before they go to market. The usual validation and quality control mechanisms (e.g., ISI marks of the Bureau of Indian Standards) fail as there are no standards or precedents for new technologies and there is little capacity to test these new technologies. In a culture that is already risk-averse, lack of product testing and validation mechanisms further limits linkages to a potential market, resulting in a lack of buyers.

Three anecdotal examples illustrate this issue (authors' interview with Harkesh Mittal, 2015). First, a with "startup" developed a super-specialty wire that met highly specific requirements of the Indian Railways. Before being used in the market, the wires needed to comply with 15,000 hours of initial product testing. With no facilities available for accelerated testing, the startup waited for two years (and 15,000 hours) before commercializing the product. Second, an innovator created a portable diagnostic lab in a briefcase that could perform multiple medical tests at a nominal cost. Despite commercialization potential, the innovator could not find customers for the untested technology up until he donated five portable labs following a natural disaster and demonstrated the effectiveness of this product. Third, a serial entrepreneur installed five cameras on a van to gather data, monitor, and categorize condition of roads, visibility of billboards etc. The public sector was a potential market for the product. Yet, public sector enterprises were unwilling to buy a new untested technology that had not been validated elsewhere.

The biotechnology sector, albeit better developed, still faces issues on testing and validation. For example, startups and incubatees hosted at IKP moved abroad, citing difficulties in conducting trials, the lack of understanding of life sciences in the venture community in India, and the consequent lack of funding.

Similarly, the weak intellectual property regime and the long-wait to process a patent application discourages researchers from valorizing their innovation—it takes seven years or more to process a patent application in India compared to two years in the United States (NITI Aayog, 2015). Furthermore, laws and regulations on foreign capital flows, foreign ownership, and equity investment are often restrictive, limiting financing opportunities for startups. The business environment is unfavorable for startups as India ranks 130 of 189 countries (and the lowest among BRIC countries) on the ease of doing business index (World Bank, 2016). However, despite these challenges, it is important to note that new regulations announced in 2016 are expected to reduce procedural barriers to innovation—for example, a new bankruptcy law will allow entrepreneurs to easily close down defunct businesses.

Landscape of S&T-based innovation and incubation

Indian public officials were pioneers in the developing world in using incubation as a policy tool as much of public policy efforts in enabling S&T-innovation in startups were channeled through incubators. Since the early 1980s, government has been involved inincubator-building activities primarily through the National Science and Technology Entrepreneurship Development Board (NSTEDB). Between 1985 and 2014, over 140 incubators were established with public funding from different sources (see Table 2 for different estimates on the number of incubators). The NSTEDB provided INR 200 crores in funding for incubators, evolving from around INR 20 lakhs for each incubator in the late 1980s, to an average of INR 3 crores by 2015 (personal interview with Anita Gupta, 2015). Public policy support for incubation resulted in an increase in private sector activities, too. Between 2010 and 2014, over 40 privately funded incubators were established. Between 2014 and 2016, government programs specifically targetedstartup creation and innovation—Startup India, National Entrepreneurship Policy, Make in India, Atal Innovation Mission, etc. While recent efforts will take a few years to pay off, India performed poorly in the context of linking innovation to new enterprises and markets despite three decades of experiences with incubators. In this context, we examine how incubators in India can be strengthened to bring S&T-based innovation to market with the help of startups.

Table 2: Key outcomes of incubators reflected in different reports. In addition to the data in this table, NASSCOM reports 110 incubators in India with 4200 startups in 2015. Our calculations show 146 publicly funded incubators (including those with MoMSME) with at least 2000 startups from 1982 through 2014 (DST, 2014, 2009; NITI Aayog, 2015).

Description	Niti Aayog 2015	TBI 2014	TBI 2009
Incubators	120	54 reported	36 reported (full or partial data)
Employment generated	40,000	32,000+	13,400+
Startups	800+ (graduated since 1982) 500 supported annually	2000+ (incubated) 950 +(graduated)	1170+ (incubated) 486+ (graduated)
Total turnover	INR 4000+ crore turnover of graduates and incubatees; INR 1500 crore (total value)	INR 1500+ crore turnover by incubatee and graduate companies in 2012-2013	INR 1100+ crore by incubatee and graduate companies
Other outcomes		450 patents/copyrights	

Evolution of incubation from a policy perspective

Public policy goals for incubation and S&T-based startups evolved over the past three decades from promoting self-employment to strengthening academia-industry linkages, promoting technology transfer, and creating innovative enterprises (see Table 3).

Table 3: Evolution of public policy goals for S&T-based entrepreneurship and incubators in India. Source: Authors' compilation from FYP reports and other sources

Year	Public policy goals	Announced plans, policies, and events	Source
1980 1981 1982 1983 1984		NSTEDB established First STEP established	Sixth Five Year Plan
1985 1986 1987 1988 1989	Employment generation / self-employment for S&T students and personnel	DBT set up Three pilot incubators with UN Fund for S&T	Seventh Five Year Plan
1990			Annual Plan
1991		Economic reforms	Annual Plan
1992 1993 1994 1995 1996	Employment generation / self-employment for S&T students and personnel; STEPs; Entrepreneurship training to for biotech; Commercializing indigenous technology		Eighth Five Year Plan
1997 1998 1999 2000 2001	Regional development; Entrepreneurship training	TBI established	Ninth Five Year Plan
2002 2003 2004 2005 2006	Academia, R&D, industry interfaces; Training in IT for remote, rural populations for entrepreneurship/ self-employment; grassroots innovation; Biotech: creation of venture capital fund, commercialization of technologies, incubators and science parks	ISBA- Incubator Association; TDB seed fund	Tenth Five Year Plan

2007 2008 2009 2010 2011	Technology- and knowledge-based entrepreneurship; Academia-industry linkages; Incubators for commercializing technology developed at universities; Biotech: incubators, parks, and clusters through PPPs; Venture funding and tax incentives; Attracting talent through flexible salaries, startup grants	Service tax exempt for NSTEDB incubators and incubatees (turnover less than INR 50 lakhs); TIDE scheme for electronics, ICT	Eleventh Five Year Plan
2012 2013 2014 2015 2016	Building an inclusive innovation ecosystem across sectors for entrepreneurship, growth; Biotech: incubators, parks, and clusters to technology transfer and management; Funding schemes through PPP, BIRAC	SME exchange BIRAC as a Section-25 not-for-profit company; BIG program launched; DST, MoMSME incubators qualify for CSR; Science, Technology, and Innovation Policy; Revision of bankruptcy laws; Support for venture capital, angel investors; State governments' startup policy Atal Innovation Mission Startup India Action Plan	Twelfth Five Year Plan; Public reports

In the early 1980s, policymakers considered incubation and entrepreneurship as tools to create employment in individuals with S&T backgrounds (i.e., students and academics) and to counter large-scale unemployment. Over time, policymakers' goals for incubation shifted towards building academia-industry linkages, encouraging technology transfer and commercialization, building public-private linkages, creating entrepreneurial activity in the biotech sector, and most recently towards building an innovation system and inclusive innovation.

Indian support for entrepreneurship and innovation started in 1982 after the formation of the NSTEDB. The evolution of public policy goals—reflected in different five year plans—influenced incubator activities. The first incubators were set up as Science and Technology Entrepreneurs Parks—or STEP—for generating employment in S&T-trained personnel. While 16 STEPs were established between 1984 and 1995—in a period where the economy was closed and high technology was difficult to import—it is regular enterprises (and not startups) that primarily benefitted from STEPs (Mittal, 2015). STEPs attracted new enterprises by offering access to infrastructures (e.g., an improved supply of water and electricity). However, incubated firms faced financial restraints and did not contribute to STEP revenues—by 2001, only 6 of 16 STEPs demonstrated promising results and financial sustainability. Many STEPs engaged in

offering training and skill development workshops as a source of revenue. Such capacity building activities generated awareness on the benefits of entrepreneurship, however the outcomes were primarily new brick-and-mortar enterprises and not technology-driven startups (Mittal, 2015). These enterprises—with access to good infrastructures—were reluctant to vacate the STEP premises and graduate as incubatees.

In 2001, policymakers initiated a shift from STEPs to Technology Business Incubators (or TBI) for high technology ventures. This shift was a product of multiple factors, including learning from past incubator experiences and broader economic factors. Besides the experience with STEPs, during 1987-1990, three pilot TBIs had been established with support from the UN Fund for Science and Technology. However, government financial support proved to be insufficient and the incubators failed despite making progress in providing business plans, training, and workspace to incubatees (Lalkaka, 2002). Furthermore, liberalization reforms after 1991 improved the availability of technology while the dot-com bubble of the late 1990s-2000 led to return of IT-talent from outside India (Mittal, 2015). Policy priorities shifted towards building academia-industry linkages, encouraging technology- and knowledge-based enterprise or startup creation. In 2004, following a global conference with infoDev, the Technology Development Board (TDB) set up a seed fund to provide grants to startups. An incubator association was created to build networks for incubators and to share best practices (Ministry of Science and Technology, 2004).

New incentives to create incubators for entrepreneurial and startup activities emerged after 2007. In 2007, publicly funded incubators and their tenant incubatees became exempt from service tax. In 2013, corporate expenditure on publicly-funded incubators was recognized under the Corporate Social Responsibility (or CSR) program. The CSR program required corporate companies with high net worth and profits to spend 2 percent of their profits on social issues (Companies Act). CSR funding provided new opportunities for incubators to generate additional income and strengthen industry linkages.

Most of the publicly funded incubators were set up with academic partners as not-for-profit entities. Between 1985 and 2014, over 140 incubators were established. Private sector participation in incubators grew only after 2010 with over 40 privately funded incubators and with emergence of new public-private models.

Policymakers primarily promoted two sectors for innovation-based startups—information technology (IT) and life sciences (or biotechnology). The Department of Electronics and Information Technology (DeitY) launched the Technology Incubation and Development of Entrepreneurs (TIDE) scheme in 2008 for promoting electronics and ICT. The Department of Biotechnology's goals of building public-private partnerships in biotechnology, supporting entrepreneurs, and building an innovation system, culminated in the creation of the Biotechnology Industry Research Assistance Council (BIRAC) in 2012. Within a year, BIRAC had awarded 21 grants (Biotechnology Ignition Grant) and set up 5 incubators (BIRAC).

Between 2014-2015, specific programs targeted enterprise creation and innovation – Make in India, Startup India, and the National Entrepreneurship Policy.

Incubators and other actors in the innovation system

Incubators are part of the innovation system where they interact with other actors, including different government departments, incubatees (i.e., entrepreneurs, innovators, startup founders), academic institutions, private sector industry, etc.

Government departments

The dual needs to promote S&T-based enterprises and to generate employment drive government involvement in incubation in India. The Department

of Science and Technology (DST), through the National Science and Technology Entrepreneurship Development Board (NSTEDB), is the primary support body for incubators. At the national level, at least four more departments of the central government besides the DST are involved in implementing policies to facilitate innovative startups through incubators(Appendix D). Of these, only the DST's NSTEDB and the Department of Biotechnology's (DBT) Biotechnology Industry Research Assistance Council (BIRAC) set up new incubators. Other government departments support established incubators with specific mandates for promoting a particular sector (e.g., IT) or a particular agenda (e.g., promotion of micro, small, and medium enterprises or MSMEs).

Public policy support for entrepreneurs extends beyond incubation to provide incubatees with financing at different stages of innovation for taking ideas to market especially because the private sector that should fulfill this function is underdeveloped and inefficient in bringing the most viable of innovations to market[2]. This direct government financing for startups—through grants, low interest loans, or equity shares—is administered through publicly-funded incubators. Government financing for innovation-based startups targets project survival until the demonstration or prototype stage so that startups can get external validation from the private sector and expand into the market.

a) Department of Science and Technology (DST)

The DST is the most prominent government department that actively promotes S&T-based startup creation through the NSTEDB[3] . In the last three decades, the NSTEDB funded over 86 Technology Business Incubators (TBI) and Science and Technology Entrepreneurs Parks (STEP) (DST, 2014). The primary goals of NSTEDB include the creation of S&T-based startups and enabling of technology transfer.

NSTEDB supports incubators with a partner institute (i.e., an academic, technical, or R&D center). In its approval process for new incubators, NSTEDB evaluates applications from potential hosts based on, among others, the strength of the regional innovation system, demands of the geographic location, experience of managers, incubation business model, resources offered by the host partner etc. (NSTEDB, 2012a). Once approved, the NSTEDB provides initial five years of financial support for setting up and managing the incubator. In addition, DST provides funding for startups located in its incubators through the Technology Development Board (TDB) and the Seed Funding Scheme (SSS) that provide financial assistance—through debt, equity share, or a share of royalties—to technology-focused startups physically located in government-approved incubators (NSTEDB, 2012b).

b) Department of Biotechnology (DBT)

The DBT supports innovation through BIRAC, its public sector enterprise. BIRAC's mandate specifically targets creating biotechnology-based startups and converting research into products. BIRAC implements several policy instruments relevant for creating linkages between innovation and markets. Of direct relevance for incubators is the Bio-incubators Support Scheme (BISS) that strengthens existing and established incubators with proven infrastructures and business development capabilities. BISS aims to create new incubators that can provide necessary

[2] Additionally, the laws and regulations on foreign capital flows, foreign ownership, and equity investment are considered restrictive, and there are restrictions on blended capital (GIZ, 2012).

[3] The DST also oversees the National Innovation Foundation (NIF), which unlike the NSTEDB, prioritizes the informal sector, focusing on grassroots technological innovations with societal benefits. In addition, it also provides funding for technology commercialization projects through the Micro Venture Innovation Fund (MVIF).

equipment and support for academic-industry linkages and technology transfer. BIRAC also provides financial support for entrepreneurial activity through several funding mechanisms—from the Biotechnology Ignition Grant (BIG) for developing early stage proof-of-concepts to the Small Business Innovation Research Initiative (SBIRI) for validation of early stage ideas and for helping them grow.

Outreach cum Cluster Innovation Centers—implement the PRISM program and are responsible for evaluating, monitoring, and coordination of grants for startups, in addition to providing mentoring support(DSIR). The PRISM program provides funding to individual innovators for creating early stage prototypes, technology transfer, and for late stage for scaling up of innovation and startup creation.

Box 3: Biotechnology Industry Research Assistance Council (BIRAC)

BIRAC is a Section-25 Not-for-Profit company setup by the DBT to function as an industry-academia interface. BIRAC administers the Biotechnology Ignition Grant (BIG) that aims to bridge the gap between discovery and invention by spurring commercialization of research. BIG provides very early stage grants to scientist entrepreneurs from research institutes, academia, and start-ups. To prevent misuse of funds, BIG requires applicants to be an incubatee in an eligible DBT incubator or to have a registered company with a functional R&D laboratory. BIG innovators receive up to INR 50 lakh (approximately $100K) for their research projects with commercialization potential for up to 18 months.

DBT incubator interventions (through BIRAC) differ from DST activities due to the unique challenges of the life sciences and biotech industry, including (i) long gestation period of startups (about five years) requiring longer-term incubation compared to other sectors such as IT; (ii) high capital intensity of startup technologies; (iii) need for highly-skilled, trained manpower to operate technical equipment; and (iv) lack of business models with proven financial sustainability of biotech incubators. The startups that DBT incubators manage, coordinate, and often host receive funding from BIRAC. Over three years between 2012 and 2015, BIRAC supported approximately 186 startups and individual entrepreneurs either directly (as resident incubatees) or indirectly (as virtual incubatees or grantees) through 12 incubators (BIRAC, 2015).

c) Department of Scientific and Industrial Research (DSIR)

The Department of Scientific and Industrial Research (DSIR) prioritizes industry-centric research and innovation. DSIR manages a grants funding program for incubators—Promoting Innovations in Individuals, Startups and MSMEs, or PRISM. DSIR-financed incubation centers with experience in technology-based innovation—i.e., TOCICs, originally known as TePP

d) Department of Electronics and Information Technology (DeitY)

The Electronics and IT Department (DeitY) focuses on its goals to build electronics and IT-related industries and digital services). While DeitY does not engage in setting up of new incubators, it offers financial support to existing incubators (or their host academic partners) by offering new financing opportunities and low interest loans for incubatees (through the TIDE scheme). DeitY aims to generate product-oriented growth and enhance startup linkages with markets.

e) Ministry of Micro Small and Medium Enterprises (MoMSME)

The Ministry of Micro Small and Medium Enterprises (MoMSME) has broad goals of generating self-employment, entrepreneurship, and employment through SMEs (or startups), executing strategic plans for developing clusters, and strengthening manufacturing competitiveness. These goals underpin MoMSME's involvement with S&T-based incubators. Since 2008, like the DST, the MoMSME collaborated with host institutes (academic, technical, or R&D) to designate incubator-like entities that encourage early-stage ideas in a range of sectors (biotechnology, nanotechnology, fruit processing, ceramics, surgical

instruments, etc.) (MoMSME, 2010). The MoMSME also provides small amount of funding for the incubator host in addition to small grants for innovative ideas; MoMSME grants operate in a public-private-partnership (PPP) model that expects a partial share of funding to come from the SME.

Many other incubators receive support from other central government departments (such as the Ministry of New and Renewable Energy) and more notably through state governments as well. Other government departments—for example, the Department of Industrial Policy & Promotion (DIPP) of the Ministry of Commerce and Industry—are responsible for industrial policy and new initiatives like Startup India.

Incubators

The objectives of incubators supported by different government departments converge on S&T-driven innovation, startup creation, and linking innovation to markets. Incubators therefore provide a range of facilities that support market infrastructure development (basic infrastructures, finance, and space), build business capabilities (mentoring and networks), and provide technology infrastructures (laboratory facilities and hardware).

Most incubators are funded through the NSTEDB. The NSTEDB has provided funding for 86 Technology Business Incubators (TBI) and Science and Technology Entrepreneurs Parks (STEP)(DST, 2014), out of 146 incubators (or entities that function as incubators) that receive public funding through different central government agencies (See Appendix C).

Publicly-funded incubators share several characteristics.. First, incubators operate as a not-for-profit entity (as a registered society), or as a Section-25 company that is required to reuse profits or income, and cannot provide any dividends to shareholders. Second, all incubators are set up with a host partner that is often an academic institute or a R&D lab. Together with the hosts, incubators can provide some of the technology infrastructures relevant for S&T-based innovation in different sectors along with space and basic facilities. Third, incubators facilitate financing for incubatees through several public funding channels that prioritize startups located in government-approved incubators; incubators also strengthen networks with private investors, angel investors, venture capital, etc. Fourth, incubators receive five years of financial support from the DST, after which they are expected to sustain their own business (DST, 2014). DeitY, MoMSME, DSIR and DBT also have some provisions for incubators to manage their expenses (Appendix D, Figure 2). Most incubators generate revenues by renting out infrastructures and providing services to tenant enterprises. And fifth, all incubators are eligible for tax incentives—incubators and incubatees with net profits lower than INR 50 lakhs, are exempt from paying service tax.

The majority of incubators are located in clusters around metropolitan Tier I cities of Hyderabad, Chennai, Bangalore, Delhi, and Ahmedabad, albeit with a few exceptions. The presence in clusters stresses the importance of networksin cities where industrial partners may be present and more active. Outside of these clusters, incubators are expected to contribute to regional development while generating S&T-innovation based startups. However, even though incubators partner with universities or research institutes, supporting in stitutions may not be regionally inclusive, as some regions may have a more developed innovation system.

The role of the manager is particularly central as they are responsible for sustaining the incubator and generating its own income beyond a period of five years. Once the incubator is sanctioned by the NSTEDB, managers choose their own business models and manage seed funds provided to incubatees. The managerial staff is expected to oversee everyday operations, mentor early-stage startups, and administer funds provided to the incubator through different schemes designed to deliver early-stage financial assistance to enterprises.

Incubator partners

Nearly all incubators partner with academia, laboratories, or R&D host institutes—among the NSTEDB incubators alone, 84 percent of incubators have such a partner, and 50 percent of partner hosts come from the private sector, including private universities (DST, 2014). Therefore, while publicly-funded incubators remain strongly connected to academia, private sector academic bodies and R&D centers are active in supporting incubation. Furthermore, besides formally recognized incubators, many academic institutes have entrepreneurship cells that fulfill a similar purpose as that of an incubator. Incubator hosts are expected to provide a supply of innovators or incubatees by building an entrepreneurial spirit and innovation capacity among academics and students, and to provide a channel for technology transfer of ideas that have been developed.

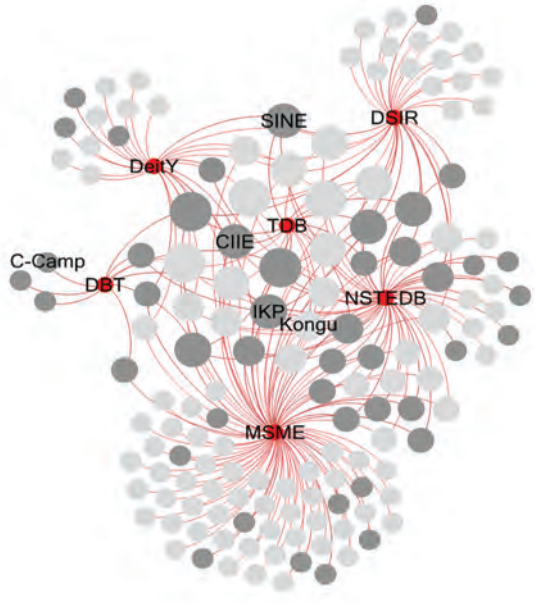

Figure 2: Network of publicly funded in incubators in India with circles representing government or incubators and lines representing the linkages between them. Red dots represent government funding, dark grey dots represent incubators in Tier-I cities (Delhi NCR, Hyderabad, Bangalore, Mumbai, Kolkata, Ahmedabad, Pune), light grey dots represent incubators in other cities or towns. The size of the dots reflects different sources of funding for incubators – bigger dots represent funding from more sources.

Incubators in close proximity to academia expect access to good incubatees—i.e., entrepreneurs with good ideas through S&T trained students and faculty. However, most incubators welcome external incubatees and do not limit tenancy to their academic affiliates or alumni. Furthermore, the quality of incubatees or of their innovative ideas remains a cause for concern, given the risk-averse nature of students, academics, and society at large. While recent public policy initiatives intend to improve the quality of incubatees—for example under the Kerala Startup Policy, universities would build the capacity and enthusiasm for innovation and entrepreneurship—such initiatives are few and need more comprehensive assessment of outcomes.

The unavailability of consistent data (Table 2) prevents a more rigorous assessment on incubators

and their incubatees—i.e., who are the innovators, to what extent are they linked with the host partner that the incubator represents, etc.

External partners and networks

Incubators are designed to act as intermediaries to connect new technology innovations with markets and industry. However, few incubators are actually associated with the industry, or have direct linkages.

Efforts have been made to improve private sector industry involvement in incubation. For example, corporate expenditure on publicly-funded incubators was recognized to meet CSR requirements since 2013, providing opportunities for incubators to generate additional income, and to strengthen industry linkages[4] . However, in the absence of alignment between corporate priorities and government priorities, publicly-funded incubators did not immediately benefit from CSR financial flows. Most corporates may prefer to finance with CSR other, more popular, social values in support of government initiatives, and are unaware of the benefits of incubators. There have been few exceptions—for example, the Manipal Institutes accessed close to INR 20 lakhs from local industries (personal interview with Anita Gupta, 2015).

Incubators leverage private sector industry typically through large multinational corporates, and not through Indian PSUs or other smaller domestic firms. International companies that support domestic incubators are often interested in developing domestic technologies for strengthening their supply chain networks. Examples of private sector support for incubators includes Intel (business plan competition); Boeing (workshops for strengthening supply chain); Reliance and Economic Times (Power of Ideas competition); GE, and Alstom (PPP model). Additionally, investing in entrepreneurial ventures is part of the business activities of companies like Reliance and Mahindra (personal interview with Anita Gupta, 2015). Public-private partnerships are prominent particularly among DBT programs that foster industry linkages (Aggarwal and Chawla, 2013).

Incubators also benefit from linkages with other incubators and their extended networks. For example, a majority of DST incubators are part of the Indian STEPs & Business Incubators Association (ISBA).

[4]Since 2012, corporate companies with high net worth and profits are mandated to spend 2 percent of their profits as part of the Corporate Social Responsibility Program [Section 135, Companies Act].

5 Insights from Case Studies: Factors for Favorable Incubator Outcomes

With the help of interviews with experts, we identified six incubators—out of 146 publicly-funded incubators—that were seen as prominent in meeting their individual goals and contributing to building the entrepreneurial ecosystem and the innovation system. We conducted detailed case studies on these incubators using semi-structured interviews (see Appendix A: List of interviewees for list of interviewees). These incubators (listed in Table 4) representa spectrum of goals, locations, and partners—for example, incubators in well-connected business schools in entrepreneurial clusters (i.e., CIIE), incubators with sector-specific goals (i.e., IKP), incubators outside of metropolitan cities (i.e., TBI@KEC) (see Appendix Efor detailed case studies). Building on insights from interviews and case studies, the following sections outline six major factors that determine favorable incubator outcomes.

Table 4: Incubator case studies

Incubator	Location	Host or partner
Center for Innovation Incubation and Entrepreneurship (CIIE)	Ahmedabad	Indian Institute of Management, Ahmedabad (IIMA)
Centre for Cellular and Molecular Platforms (C-CAMP)	Bangalore	Bangalore Biotech Cluster
Incubator at IKP Knowledge Park (IKP)	Hyderabad	IKP Foundation
Technology Business Incubator- Kongu Engineering College (TBI@KEC)	Perundurai, Erode	Kongu Engineering College (KEC)
Society for Innovation & Entrepreneurship (SINE)	Mumbai	Indian Institute of Technology, Bombay (IITB)
Startup Village (SV)	Kochi	MobME

Identifying and attracting good ideas

Investing time and resources in building, identifying, and attracting good ideas—for example, by training students and researchers to innovate, by identifying research with commercialization potential, or by attracting talented innovators to the incubator—isa key priority common to all six incubators. All six incubators recognize that efforts to attract and nurture good incubatees—i.e., good innovators and good entrepreneurs—increase the likelihood of success

of the incubator. These incubators therefore engage in activities to strengthen innovation capacity in the short-term while ensuring flow of good talent andideas in the long-term.

For incubators with sector-specific focus or strengths—e.g., IKP and C-CAMP in the life sciences (biotechnology or pharmaceutical sectors)—the proximity to research and industry clusters with innovative S&T ideas ensures access to scientific innovation and S&T-based entrepreneurs. IKP and C-CAMP further reinforce their access to entrepreneurial talent by managing and distributing grants for innovative early-stage ideason behalf of the government or other foundations where grantees also often become incubatees in these incubators. For example, IKP and C-CAMP both manage the Biotechnology Ignition Grant (BIG) Scheme of the DBT and distribute grants; IKP also partners with the Bill & Melinda Gates Foundation to manage Grand Challenges Exploration, an initiative that supports and funds innovative ideas to address global health challenges.

Other incubators build their pool of S&T ideas and innovators with help of resources of their host engineering institutes and local industry—for example, SINE at IITB and TBI@KEC at Kongu Engineering College. SINE—the incubator at IITB—has access to top engineering students, researchers, and alumni networks along with strong financial, investor, and mentor networks in metropolitan Mumbai. SINE provides affiliates of IITB a platform for commercialization of technology created at IITB prioritizing ideas with a strong technology component and a potential to generate intellectual property. SINE ensures a flow of good ideas and good entrepreneurs through rigorous screening of incubatee applications by domain experts, industry, and more experienced entrepreneurs. In contrast, TBI@KEC, a regional engineering college in the small town of Perundurai—has less prominent S&T resources and limited investor or mentor networks. TBI@KEC supports long-term, market-driven ideas by organizing workshops for students and researchers to strengthen skills in specific IT areas (e.g., VLSI design, embedded technologies, wireless DSP, etc.) while providing training in entrepreneurship. TBI@KEC compensates for its location away from a metropolitan area by actively leveraging local industry associations near Perundurai and participating in industry specific events, such as trade fairs, that provide visibility to the incubator and help TBI@KEC attract new talent.

Incubators with strengths in business and markets—like CII Eat the business school, IIMA—use their knowledge of markets rather than in S&T to bring new ideas and entrepreneurs. CIIE attracts entrepreneurs not only from within IIMA but also from the rest of the country. Within IIMA, CIIE creates conditions for students to develop their ideas and engage in entrepreneurship. For example, CIIE allows IIMA students to intern at the incubator and experience entrepreneurship as a profession. To ease student concerns about paying off education loans under the uncertainty of entrepreneurship, CIIE provides a fellowship and prototype grant for entrepreneurs. CIIE and IIMA also offer courses and trainings—e.g., mock fund management, technology and design, etc.—to build innovation capacity among students. CIIE attracts ideas from outside IIMA and from different parts of the country by hosting competitive programs—for example, Power of Ideas—or by managing sector-based accelerator programs that address market-specific needs.

Incubators also prioritize the long-term flow of ideas by building innovation capacity. For example, Startup Village (SV), Kochi partnered with the Kerala state government to formulate the Kerala Innovation Policy that makes building innovation capacity a priority for the state. Under the innovation policy, the Kerala Technology University incentivizes students to explore innovative ideasby providing 'grace marks' for students who engage in entrepreneurship during college. Furthermore, SV recognizes that the absence of practical technical training in schools and universities results in few product-based ideas or

startups; SV distributed Arduino kits for to school children to encourage them to experiment with electronics and coding and to build products.

Strategic choice of incubator model

All six incubators reflect in their business models an understanding of markets (in one or more sectors) and have clear goals to purposefully target specific market demands that maynot be fully addressed by the private sector.

Sector-focused incubators in the life sciences—i.e., C-CAMP and IKP—recognize the need for sector-specific requirements and business models. Life science innovations may need special laboratory facilities or may need a longer time horizon to demonstrate market potential compared to IT innovations. Furthermore, most innovators in the life sciences have limited industry or business experience. Both incubators therefore offer mentoring, equipment, technical expertise, and industry linkages to address specific challenges for life sciences startups.

Incubators that target regional development and operate in regions without existing high-technology sectors benefit from identifying specific market demands and building capabilities to address these demands. For example, TBI@KEC built expertise on electronics and information technologies (including VLSI design, embedded systems, digital signal processing, etc.) to prioritize product-driven startups over service-driven startups or apps.

In sector-agnostic incubators like CIIE, identifying the viability of new products in underdeveloped sectors is more critical than focusing on developing S&T aspects. Through its various accelerator programs, CIIE uses its deep understanding of business, markets, and market failures, to build depth across sectors with high societal impacts—including agriculture, water, and clean energy. These accelerator programs bring in innovators with products or prototypes that have already been built, and help find a product-market fit through validation by potential stakeholders, customers, or investors.

Addressing investment gaps for startups

All six incubators facilitate investment in startups—especially early-stage investments—by administering funding for startups from government bodies, by managing their own seed funds or venture capital funds, and also by helping attract external investment because of their high profile and activities.

Some incubators—e.g., IKP and CIIE that are registered investors with SEBI—directly invest in incubatee startups to support them in their early stages. This investment makes incubators more deeply engaged in startup success, makes incubators more sensitive to sector-specific demands, and sends positive signals to potential late-stage investors. For example, the CIIE runs its own seed fund where over 80 percent of the incubatees have received follow-on financing from venture capital or angel investors within two years of incubation. As of 2015, for every rupee invested by CIIE, its portfolio ventures had raised on an average INR 14 from other investors. CIIE also runs its own venture capital fund, Infuse Ventures, to provide early stage funding for clean energy startups. Similarly, IKP collaborated with NASSCOM to set up the India Innovation Fund for investing in early-stage innovative startups in the life sciences and addressing sector-specific issues, including the longer periods required to develop technology before engaging in business development.

Other incubators provide startup investments through loans, equity, or revenue share or through external financial networks. On the one hand, SINE's location in Mumbai—thefinancial hub of the country—and proximity to the emerging startup cluster in Powai provides easy access to venture capital for startups, with more 50 percent of incubatees with investments from angels, venture capital, and finan-

cial institutions. On the other hand, TBI@KEC only offers loans to startups through the DST and does not take equity.

Incubators in the life sciences—i.e., IKP and C-CAMP—also provide BIRAC grants for incubatees that are early stage-startups (BIG) or other small industries (SBIRI and BIPP).

Focus on sustainable incubator models

All six incubators have business models that ensure long-term financial sustainability and a secure flow of income for the incubator. The sustainability of incubator finances is important because the DST provides financial support for incubators only for the first five years of operations. After the initial five-year period, incubators are expected to generate their own income through different activities including partnerships with the private sector, equity shares in startups that graduate, renting space and equipment, providing training, etc. While other government agencies also occasionally provide some additional financial support to incubators, such programs are scattered with mixed impacts on incubator operations.

Generating revenues within five years is particularly challenging for incubators that support S&T-based ideas beyond service-based IT—early-stage startups are risky by definition and need time to develop their products. Furthermore, equity investment in startups take several years to yield results and most private equities that invest in risky ideas have a ten-year fund, and consequently, a ten-year investment horizon. Consequently, incubators struggle to be financially sustainable after five years, and prioritize short-term revenue-generating activities over incubating risky, innovative ideas.

The six incubators generate revenues in different ways while maintaining the quality of incubatees and of incubator activities. Rather than charging rents, many incubators are transitioning to taking a share of equity or share of revenues as they stand to benefit more from supporting and graduating successful startups. Incubators with their own seed fund (e.g., IKP, CIIE, and SV) charge a management fee from incubatees to ensure sustainable revenue generation. IKP and C-CAMP cross-subsidize expenses on their incubation activities by income generated through other sources. For example, IKP charges a fee from foundations for managing grants and from companies that need technology services or equipment to run tests. Similarly, C-CAMP charges a licensing fee from users of its technology platforms. CIIE and SV manage financing their incubator activities by effectively leveraging private sector investments. For example, CIIE launched one of the first accelerator programs in India—iAccelerator—where financial support from Microsoft complemented CIIE's know-how in incubation.Similarly, SV raised nearly INR 5 crores of investment from the private sector. Incubators like TBI@KEC engage in lean operations—i.e., less staff members with multi-facetted skills—to minimize costs and maximize revenues.

The business models of incubators are most effective in incubators where activities and outcomes are regularly assessed and adjusted. In the absence of formal and standard reporting requirements on incubator performance by DST, some incubators engage in rigorous external evaluations or internal assessments. For example, CIIE holds regular internal reviews and self-assessment that serve as guidelines for changes in its activities in accordance to market needs. DB Trigorously monitors the performance of incubators such as IKP and C-CAMP, resulting in efforts to develop metrics for self-assessment and to find opportunities for improvement.

Access to multi-faceted networks

All six incubators provide startups access to multi-faceted networks for knowledge (including technical, strategic, operational, and market knowledge), mentorship, finance, and private sector markets.

Access to networks is key for startups and incubators provide this access by strengthening their own industry linkages or by organizing events, camps, and forums to foster startup linkages with mentors, investors, and private sector customers. For example, CIIE makes use of IIMA's brand and networks to support incubatees. CIIE's MentorEdge program is particularly useful for first time entrepreneurs who lack the right connections and offers startups access to mentors with expertise in multiple sectors. SINE requires all incubatees to have one mentor on board from their mentor pool. C-CAMP emphasizes on market linkages and exposure to business ideas for its incubatee scientists and academics through mentor forums and events, while IKP connects incubated companies with markets through the India Innovation Fund. Incubators like IKP and CIIE offer access to knowledge networks by supporting business plans, technology licensing, compliance requirements, intellectual property, etc. Incubatees at TBI@KEC benefit from its close linkages with Coimbatore District Small Industries Association (CoDISIA), where a member of CoDISIA serves on the board of the incubator. This incubator-industry association alliance provides visibility to incubatees at TBI@KEC despite its location nearly 300 km away from the closest major metropolitan city. For example, with the help of CoDISIA networks, the first product launched out of the incubator was an industrial vacuum cleaner in partnership with Hacko, Germany.

IKP and CIIE also offer virtual incubator services, where incubatees benefit from mentorship and networks provided by the incubator, but do not need to be physically hosted.

Centrality of leadership

All six incubators have dynamic, entrepreneurial managers (and founders or trustees) that bring experience beyond academia, or have the skills to actively leverage different actors beyond academia. Incubator leadership is critical to incubator success because while incubators manage high-risk startups, incubators managers are often academics or professors with little understanding of risk. Academic incubator managers are particularly common in university-affiliated incubators because incubator salaries are often insufficient to attract managers with startup experience in the private sector. Such academic managers may possess strong technical expertise that is useful for scaling-up or managing technology, but they may lack the business experience that is necessary to connect with markets and may have limited skills to manage high-risk activities.

The managers of the six incubators have established credibility with their past experiences—for example, by working in the private or public sectors or by graduating from a top-ranked school with strong alumni networks—and have a demonstrated capability to work cohesively with different government departments, innovators, academics, and local industries to develop the innovation system. These managers have the vision and salesmanship to invite good ideas and incubatees to help build new incubators; they have the attention to detail and leadership skills necessary to build strong teams and support systems to help sustain incubators; and they have the skills to make connections, strengthen networks, and help the incubator to grow.

6 Lessons Learnt and Recommendations

Broadening and deepening the pipeline of entrepreneurs

S&T-driven entrepreneurship requires strengthening S&T-based innovation capacity and strengthening the innovation system. These in turn require building robust technical foundations among researchers and students—in many cases, through deep expertise in a specific area—as well as through building some appreciation of the innovation process.

While both government-led efforts to build innovation capacity and recent startup success-stories are increasing in India, two key issues remain for broadening and deepening the pipeline of entrepreneurs. First, many public policy initiatives are scattered and do not address systemic issues related to lack of S&T capacity. For example, plans to build 500 Tinkering Labs will cover less than 0.7% of 72,000 senior secondary schools andp lans to build 300 university-affiliated incubators will cover less than 40% of over 770 universities. Furthermore, it is not clear to what extent such activities by themselves actually enhance entrepreneurship. Therefore, while these initiatives represent positive developments for enhancing the pipeline of entrepreneurs, they are still unlikely to benefit a large number of students and researchers. Second, despite the growing number of successful startups and entrepreneurs in India, there is little recognition that not all entrepreneurs innovate. Most commercially-successful Indian startups—for example, Naukri.com, Flipkart, Ola, Snapdeal, Zomato—have used established business ideas with proven international success and adapted them in the Indian market (see Raghavan, 2016). While such startups generate revenues, create employment, and are important for supporting economic growth, they represent business model innovations rather than S&T-based innovation.

Talent emerging from Indian universities is limitedand according to most of our interviewees, there is a relative paucity of innovative, cutting-edge, technical ideas and of startups emerging from academic institutions. India's experience with academic entrepreneurship stands in contrast to that of the US where universities and academic research act as the primary source of talent for new technical ideas creating the largest and most successful S&T-driven entrepreneurship ecosystem. In many cases, Indian students are seen as lacking the training to come up with new technical ideas as they have limited understanding of key issues in particular sectors. Unusually (in comparison to other major entrepreneurial economies) there is a greater generation of startups by undergraduates than post-graduate students or post-doctoral researchers. In other cases, even faculty and doctoral researchers are unequipped or lack the incentives to generate or support market-driven ideas as faculty hiring and promotion is based on UGC guidelines that prioritize degrees and publications, and there are few

institutional channels or programs to inspire or enable innovation (UGC, 2016, 2013)[5] .

Increasing the interactions between incubators, established entrepreneurs, and engineering schools may help create conditions for students and faculty to strengthen the quality of their S&T-driven ideas and to look beyond new business models(see for example, MIT, 2016; Stanford, n.d.)[6] . Such interactions would help students (i) complement theoretical or academic knowledge from universities, (ii) get guidance for their ideas from closer linkages to markets, and (iii) find role models outside of service-based startups that are predominant in India.

Our study of key incubators and our conversations with other experts and practitioners suggest that measures to support innovation, to generate enthusiasm, and to train faculty and students in entrepreneurship have shown favorable outcomes. Examples of such measures that are already in place in individual incubators include provisions for gap years for students to pursue their own ideas, internships for students to work in incubators, designing courses in entrepreneurship, or inviting successful entrepreneurs who act as role models for students. However, these efforts are scattered. Ultimately, strengthening the capacity to innovate will require a paradigm shift in the education system through reforms that target developing skills in S&T, fostering creativity, promoting experimentation to complement theoretical concepts, minimizing rote learning, as well as greatly upgrading the quality of research programs.

Incubator strategy, management, and operations

Incubators—led by managers—that approach the design of the incubator and its activities strategically and purposefully, giving due consideration to the context of the incubator and available market opportunities, obtain more favorable out comes. The context of the incubator includes considerations of geographical location, host institutions, networks of incubator managers and partners, characteristics of the local or regional economy, sector-specific expertise, etc. Market opportunities might include needs of local industry, sectoral possibilities (e.g., energy, health, agriculture, ICTs), or needs of specific user groups (such as the poor or women). For example, the requirements of, and opportunities available to, incubators in metropolitan cities like Delhi, Mumbai, Ahmedabad, etc. are markedly different from those in semi-urban areas, in less developed regions of the country, or in industrial clusters with expertise in specific technologies. Similarly, the requirements of biotech or life science startups will differ from those in clean energy or IT sectors in terms of infrastructure, mentorship, and incubation periods. While an incubation period of less than a year may be sufficient for some IT startups, biotech industries and other high tech enterprises may require more than five years of incubation. Overall, understanding requirements of the local industry and local market conditions, designing incubators to address these specific market gaps and opportunities, and regularly monitoring and evaluating incubator outcomes can greatly improve their performance.

[5]In 2016, UGC guidelines for evaluation or promotion focused on publications and included patents, but did not specify entrepreneurship or startups as favorable indicators of success for faculty evaluation and promotion. Also, UGC rules for 'study leave' mainly support research projects only and do not allow full- or partial- employment with any organization during the study leave period, possible due to potential conflict of interest.

[6]US universities engage in different activities to promote entrepreneurship among students by increasing interactions with successful entrepreneurs. For example, MIT invited successful alumni entrepreneur for one year (entrepreneur-in-residence) to guide students interested in founding startups in the developing world. Another example is the Mayfield Fellows Program at Stanford University that brings undergraduate students to Silicon Valley by offering them courses, mentoring and networking activities, and a paid internship at a startup in Silicon Valley.

The quality of entrepreneur incubatees—and their successes and failures can define incubator outcomes. But as many incubatees may not be trained in business or market-related areas outside of S&T, it is the role of the incubator to provide access to mentoring or training services to develop these skills in incubatees. In this context, sector-specific incubators—rather than those that offer incubation services to all startups—can help in providing targeted mentorship to startups and help address specific market gaps and opportunities. Similarly, accelerator programs can speed up the startup cycle while providing mentoring or training to entrepreneurs in batches or cohorts. Accelerators built on the lines of famous Silicon Valley institutions such as Y-Combinator have increasingly become popular because of the frantic pace of innovation where startups need to get to market quickly or play catch up. These accelerators impart minimum business training to entrepreneurs and help them attain a market fit for their products.

Incubator managers—and their leadership skills and capabilities—are key to successful operations and revenue generation for publicly funded incubators. All successful incubators are led by individuals with strong business and management capabilities that can help connect S&T innovations to markets, provide strong networks and mentorship, and manage operations of the incubators. Efforts to reinforce existing incubators, or create new ones, fundamentally depend on the availability of talented managers.

However, the challenges in finding talented mangers and incubatees are exacerbated for incubators that are unable to sustain their finances due to limited ideas, little market-linked research, or poor ability to connect ideas to market. This is particularly common in incubators located outside major metropolitan areas that operate with regional development goals. The current five-year public funding for incubators endorses a one-size fits all approach even though incubators have different goals and priorities. The five years of financial support provided by the government are therefore insufficient for many publicly-funded incubators to start generating their own revenues, and many incubators make training as their primary activity for revenue generation (which distracts from fundamental incubation objectives). In contrast, private venture capital funds are aware of the risk and timelines associated with startups and operate with a ten-year horizon for investments. While publicly-funded incubators operate as not-for-profit Section-25 Companies (or as Registered Societies) the more successful publicly-funded incubators are able to leverage the private sectorand develop public-private partnerships as a way to strengthen their financial position[7]. Similarly, other resources, such as technical resources, may be leveraged through other networks, for example, through partnerships with academia, government labs, and/or industry.

Overcoming market failures

According to economic theory, in a well-functioning market, goods and services are efficiently allocated through price signals. Thus, private actors have an incentive to invest in goods for which there is a high demand (and therefore, a strong price signal). But in many cases, markets may not work well or by themselves do not fulfill societal goals, leading to what is termed as 'market failures.' These may be in cases where there are barriers to organization of efficient markets, for example, due to lack of information, lack of resources, regulatory hurdles, or unattractive risk/return ratios, which lead to the

[7]Competitive tendering processes have been used to finance public-private incubators. The government of Karnataka (GoK) organized a competitive tendering process to set up the GoK Incubator for Tech Start-ups (GIfTS) with a private partner. in Israel, the government implemented a public-private model for incubators by providing licenses to private equity, venture capital, angel investors, other industry, etc. through a competitive process. These incubator license holders financed 15% of the budget for a startup, and the government provided grants for the remaining 85%.

'institutional voids' mentioned earlier. In other cases, such as public goods (e.g., education and clean environment), the private sector tends to underinvest even with large societal benefits since it cannot appropriately monetize these benefits in the absence of public policy to help do so. And in yet other cases, there may also be under investment in areas where the beneficiaries do not have paying capacity. In many of these areas relating to public goods or other societal benefits (such as sustaining and creating can impede such innovation.

Furthermore, S&T-based entrepreneurship may also face its own particular market challenges. S&T-based startups have livelihoods, S&T-based innovation and entrepreneurship can play a particularly key role and therefore these market failures insufficient resources to connect to the markets, both in terms of finding financing and other necessary services to help them develop their products and take them to market (e.g., testing and validation services for new products, legal support for intellectual property and patenting etc.). There is a growing venture capital investment in startups in India, with $9 billion raised by startups in 2015 alone. This is not surprising since the private sector is better positioned to take on the risk to support and provide follow-on financing to startups. But much of the venture capital investment is primarily in new business ideas that operate with service-based IT or new business models that are already proven or are easier to test, possibly because the private sector perceives the risks associated with S&T-driven startups as too high, or the rewards as too low, even if there are significant societal benefits. Such perceptions exist because S&T-based startups often need longer timescales to create prototypes, to test unproven technologies, and to demonstrate market acceptance[8]; they also have to manage supply chains and physical distribution of the product. All of these factors increase the risks for private investors, especially where the large and growing market still offers substantial options for IT- or business model-based entrepreneurship.

As intermediaries between startups and market or industry, publicly-funded incubators (with the help of public policies) can help overcome these various market failures for S&T-based entrepreneurship. Incubators can help procure early-stage financing in high-risk S&T startups (for example, underway in BIRAC). They can facilitate collaborative relationships between startups and the government to take on some of the initial risk and to provide positive signals to private investors for follow-on financing[9]. Publicly-funded incubators can be particularly useful in linking S&T-driven innovation to markets in areas related to public goods or areas with high societal benefits but low commercial returns (such as energy services, sanitation, rural areas, energy services, water, housing, agriculture, livelihood creation) as they can facilitate collaborations between government bodies or NGOs working with these issues and S&T-driven entrepreneurs[10] . In less developed regional innovation ecosystems, incubators can facilitate linkages between startup incubatees and industry by closely aligning with local industry associations or with other industry networks.

[8]The validation of the technical performance of a new product by a government laboratory could help mitigate the perceived risk of investing in such a technology. For example, the Comprehensive Initiative on Technology Evaluation (CITE) is a USAID-funded program, where researchers at MIT develop consumer reports for new products (e.g., solar lanterns) provided by international aid agencies or private companies, to help consumers make informed choices of their purchases.

[9]Collaborative networks of startups with governmental partners—where government acts as a partner for technology- or market development—have demonstrated positive outcomes in terms of innovation and follow-on financing in the case of cleantech startups in the US (Doblinger, Surana, and Diaz, forthcoming).

[10]For example, the Chicago CleanWeb Challenge hackathon provided city data to innovators and invited them to create technological solutions for environmental issues. In another example, the city government of Helsinki, helped startups by using technologies from cleantech startups including energy efficiency, low emissions public transport, waste management, district heating, water and air quality. Similarly, the local government in Sao Paolo, Brazil eased pre-qualification conditions for procurement tenders in favor of SMEs and startups. Sao Paolo also prioritizes procurement from startups as long as their bids are no higher than 10% of bids from non-startups.

System-level support and coordination

While individual incubators—and programs to support these—can be much helped through a careful approach of incubator design as well as supporting public policy, it is also necessary to pay attention to the larger ecosystem that ultimately links these individual activities and to exploit synergies/benefits that might be available through a larger, 'systems-level' perspective. Of particular interest are activities that will be beneficial for individual incubators/programs but are unlikely to (and sometimes cannot) be undertaken by any single entity. In a sense, therefore, addressing such ecosystem issues could be seen as a 'public good' and therefore particularly appropriate for public policy interventions.

To start with, systematic information-sharing and coordination between different government agencies can greatly help improve the effectiveness of individual programs by minimizing overlaps and maximizing synergies. Exchanging knowledge and experiences between different incubators and programs—through meetings between incubator managers and program managers—would help in learning from success stories and from assessment approaches and contribute to more effective design and management of incubators with different goals and priorities[11]. This coordination between incubator programs is critical as the most successful incubators tap into multiple resources—i.e., DST, DBT, MoMSME, DeitY, etc., and also bring in additional financing from the private sector. Similarly, meetings between all incubatees—or those involved in specific sectors—would not only engender enthusiasm and excitement among like-minded participants, but also provide an opportunity to collaborate and generate new ideas[12].

Expanding local initiatives (programs in academic institutions, building networks with key actors, etc.) across the country is imperative for developing a "pipeline" of innovators and entrepreneurs and enhancing their capacity to innovate – such activities may be more effectively supported jointly than individually by individual incubators or agencies.

Lastly, as with any activity, monitoring and assessment is central to improvement. As the management adage goes "what is not measured is not improved." This is as true for individual incubators as for the incubator programs run by different agencies. Tracking progress is also important for other reasons: it forces the managers (whether of an incubator or the program) to think about the key outcomes that represent and capture their objectives and the metrics through which to measure these. It also sends a signal to the incubatees as to the expectations from them. A systematic approach to examining and assessing incubator programs jointly may also reveal gaps that are not apparent otherwise.

[11]The Indian STEPs & Business Incubators Association (ISBA) already organizes such meetings, but these meetings need expansion and could be formalized to require all managers.

[12]For example, the World Bank's Climate Innovation Centers are present in seven countries around the world and are now establishing a network of incubators to share best practices. Similarly, the Clean Energy Incubators Network in the US aims to highlight best practices on incubation techniques and clean energy technologies through workshops that bring together start-ups, incubators, investors, and industry participants working on clean energy.

Table 5 presents a list of specific recommendations to address the four areas mentioned above.

Table 5: Recommendations to address different gaps and barriers related to S&T-driven entrepreneurship in India (for policymakers and program managers in white boxes, and for incubators in light blue boxes)

1 PIPELINE OF S&T TALENT
Students lack skills in S&T driven entrepreneurship and innovation
Fund the development of new courses to build the ability to apply S&T skills to market needs: • courses on innovation based on specific problems including those that fulfill social needs—for example energy services, sanitation, rural areas, etc.—where students first analyze the problem context and then apply theoretical, experiential, and practical knowledge to find S&T-driven solutions • courses on interdisciplinary subjects—combining medicine and engineering, technology and society, etc.—to improve understanding of market needs while generating ideas
Expand faculty-training programs on S&T-driven innovation and entrepreneurship to generate faculty who can design and teach relevant courses for students in different specializations
Develop entrepreneur-in-residence programs with university campuses to bring in S&T entrepreneurs with real world experiences of creating and managing challenges associated with product-based S&T startups
Offer students internships, projects, and other opportunities to engage more deeply with startups and incubators that are co-located with their university
Faculty have limited knowledge of industry and have few incentives to launch startups
Revise HR policies and UGC rules to incentivize faculty engagement in innovation and entrepreneurship: • flexible hiring and promotion policies where entrepreneurial activities are valued along with academic publications and research projects • revising UGC rules for sabbaticals or 'study leave' to include external employment in the "problem environment" so faculty can interact with end-users such as healthcare institutions, rural workers, etc. • revising UGC rules to support and fund sabbaticals for launching startups
Faculty and students have poor perception of entrepreneurship
Increase the visibility of scientists in startups through the following to ease risk perceptions about careers in S&T-driven startups and increase interactions with university S&T researchers • offering awards for startup scientists to encourage research with commercialization focus • creating forum for startup scientists to share their experiences on university campuses
Revise external- and self-evaluation criteria of university success by including both corporate placements and student-launched startups to encourage students to consider entrepreneurship and commercialization of ideas in the same light as taking up salaried employment

2 INCUBATOR STRATEGY, MANAGEMENT, & OPERATIONS

Incubator activities are misaligned with poorly-defined incubator goals
Require incubators to define goals, along with preliminary activities and self-evaluation metrics as part of the application procedure. These goals could include a combination of—sectoral development, geographical development, co-location with academia, startup stage (i.e., idea stage, early stage, or growth stage) etc.
Offer periodic guidance to incubators in articulating and adapting goals and activities to the changing context of innovation and market needs
Mandate regular self-evaluation exercises based on metrics designed to evaluate performance in relation to goals
Incubatees lack skills in entrepreneurship
Create competitive cohort programs for incubatees on regular intervals—e.g., sector-based accelerators—to build community, strengthen networks with industry or investors, and provide mentoring in a more targeted manner
Offer incubatees training on a range of skills useful for entrepreneurs—e.g., startup business models, writing business proposals, applying for grants, developing communication skills, etc.
Incubator management can be weak
Identify, invite, and train experienced professionals with business, market, and S&T experience in incubation management to make S&T innovation-based incubation market-driven rather than champion-driven
Incentivize talented professionals (or academics) to take up incubation management as a career and to alleviate perceive risks, particularly in universities—for example by showcasing career paths of prominent managers from other incubators, integrating incubator managers in university management, etc.
Hire experienced (or well-trained) incubator managers (or CEOs) with an ability to connect business, markets, and S&T-innovation, strong skills in leadership and marketing, and passion for S&T-innovation
Offer continued support for the entire incubator management team (and not just managers) through systematic training, access to advisors, etc. relevant for the incubator's local context
Incubator funding from government sources may be insufficient
Offer flexible incubator financing (based on well-defined region- or sector-based goals and performance indicators) instead of fixed, five-year financing through the following: • expanding well-performing incubators and strengthening their linkages with other incubators • offering long-term performance-based support to incubators that meet performance requirements or have sectors with longer innovation and development cycles • phasing out funding to incubators that fail

Initiate and incentivize public-private models for incubator financing • supporting incubator managers in leveraging local industry or other networks to use CSR funding for entrepreneurship • using competitive tendering processes by public sector to select private partners for setting up joint incubators

3 MARKET FAILURES

Startups / incubatees lack support services to validate S&T-based ideas
Create mechanisms for testing and validation of new technologies that are developed in startups but have no established standards or mechanisms for validation
Establish centralized support services—i.e., technical services, legal and patenting services, market research, etc.—by pooling resources to benefit regional, sectoral startup clusters (e.g., Hyderabad and Bengaluru with life sciences / biotech)
Facilitate connections between publicly-funded startups and public sector (central and local) to secure advanced market commitments including provisions for public procurement of technologies
Private sector underinvests in sectors with high societal benefits
Create a larger seed fund to support the needs of S&T-driven innovation by leveraging public funding seed money and inviting private investments
Provide tax breaks to corporate firms for investing in incubators to increase private investments by replacing (or complementing) CSR funding for incubators that has so far been perceived by corporates as an additional tax
Partner with local bodies that work on societal issues and draw S&T-driven entrepreneurs to address problems related to public goods or areas with high societal benefits but low commercial returns where private sector will not invest, or is less likely to invest
Extend incubator network resources in regions with less developed innovation ecosystems by partnering with local industry associations or with other industry networks to compensate for insufficient private capital or linkages with markets
Leverage alumni networks to create venture funds for supporting startups in areas of expertise of the university or of the incubator

4 SYSTEM-LEVEL COORDINATION AND ASSESSMENT

Actors involved with incubation have weak coordination and no formal networks

Organize meetings for different actors in publicly-funded incubators to strengthen coordination:

- annual conference for all incubatees in to promote community building, share experiences, and strengthen networks
- periodic meetings between incubator managers and program managers to enhance systematic knowledge sharing and coordination
- meetups between sector-specific incubator and incubatee meetups through "networks of incubators" for sharing resources, best practices, and for generating new ideas

Maintain (and update) a centralized registry of all incubators that receive public-sector funding to improve accountability of incubator performance, help government departments coordinate incubator support efforts, and increase visibility of incubators for potential incubatees

Create open repositories of projects and problems to strengthen linkages between innovators and markets:

- database of research projects from knowledge networks can promote collaboration for new entrepreneurial ideas, find potential applications, or find potential customers
- database of problems identified with private companies, foundations, government departments, etc. can attract potential innovators to find solutions

Build and maintain centralized online databases of support services and partners for startups and facilitate startup engagements with these services:

- support services (testing and validation services, legal support for intellectual property and patenting, technical infrastructures, etc.)
- industry and finance partners willing to work with startups

Build regional innovation ecosystems outside of metropolitan cities by mandating incubators to include experts from regional companies or industry associations in their management

Government-led incubator programs lack systematic data or analysis on incubator activities

Develop (and regularly evaluate) sectoral and regional innovation maps to identify the landscape of actors, their linkages, and the dynamics of innovation and to help incubators define their goals, strategies, and activities

Conduct systematic, annual assessment of incubators and incubatees to assess performance, to improve accountability, and to assess the long-term effectiveness of incubation programs:

- Develop a new set of indicators to analyze incubator and incubatee performance based on innovation inputs, outputs, and outcomes and be designed to reflect the goals of the incubator (e.g., regional development, sector-specific, etc.)
- Use a common template with indicators to collect information on incubators and incubatees

Increase the understanding of different incubator business models used in publicly funded incubators under different contexts and goals—i.e., differences in incubator management (public- or private-sector managed), technology or startup stages (idea to early stage, early stage to growth stage, growth to expansion stage); other goals (sector-specific, sector-agnostic, regional development, etc.)

- Conduct a detailed assessment of different incubator business models used in publicly funded incubators
- Make the assessment available to incubator managers and use it to advise existing and new incubators on modifying their business models

7 Conclusions

S&T-based entrepreneurship is likely to play an increasingly important role in India's innovation landscape, given the increasing focus on this in public policy, the evolution of the country's innovation ecosystem, and the burgeoning interest among scientists and engineers to explore this pathway. Incubators can play a critical role in this process by nurturing startups through provision of infrastructure and support services as well as rich linkages to other actors. Public support for such incubators can help the government both advance its goal to enhance S&T-base entrepreneurship and also allow the achievement of various public goods objectives.

Our research and analysis indicates that there is much that can be done to strengthen publicly-funded incubators through a range of activities. Accordingly, we have a set recommended actionable steps that could be considered by policy-makers, incubator managers, and other actors. But these should be seen only as first step in the long road to strengthen incubation and entrepreneurship in India. There clearly is much more research needed to better understand various aspects of these activities in the country and to use that learning to move even further down this road. But one step at a time.

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APPENDICES

Appendix A: List of interviewees

1. Dr. Harkesh Mittal, Adviser, Member Secretary, National Science & Technology Entrepreneurship Development Board (NSTEDB), Department of Science and Technology (DST), Government of India
2. Dr. Anita Gupta, Associate Head /Scientist-F, National Science & Technology Entrepreneurship Development Board (NSTEDB), Department of Science and Technology (DST), Government of India
3. Dr. Renu Swarup, Managing Director, Biotechnology Industry Research Assistance Council (BIRAC)
4. Rajneesh Kumar, Senior Manager-IP & Technology Management, Biotechnology Industry Research Assistance Council (BIRAC)
5. Dr. Raghunandan Rajamani, Executive Director, Indian STEPs & Business Incubators Association (ISBA)
6. Deepanwita Chattopadhyay, Chairman & CEO, IKP Knowledge Park
7. Dr. Sangita Sen Majee, Head-Life Science Incubator, IKP Knowledge Park
8. Dr. Kiran K Sharma, Director- Platform for Translational Research & Chief Executive Officer- Agribusiness and Innovation Platform, The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
9. S.M. Karuppanchetty, Chief Operating Officer - Innovations and Partnerships Program (INP), Agribusiness and Innovation Platform (AIP), The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
10. Dr. B.S. Ramakrishna, Administrative coordinator, Technology Business Incubator (TBI), University of Hyderabad (UoH)
11. Prof. V. Venkata Ramana, Co-ordinator, TBI-UoH & Professor, School of Management Studies - University of Hyderabad (UoH)
12. Sujil Pokkavayalil, Manager Incubation and Projects, The IIIT Hyderabad Foundation
13. Dr. Taslimarif Saiyed, Director and COO, Centre for Cellular and Molecular Platforms (C-CAMP)
14. Pratibha Boga-Kamat, Project Manager, Centre for Cellular and Molecular Platforms (C-CAMP)
15. Asgar Ahmed, Director, Student Entrepreneurship Development (SED)
16. Kunal Upadhyay, Chief Executive, Centre for Innovation Incubation and Entrepreneurship (CIIE)
17. S. Balamurugan, Executive Director, Technology Business Incubator (TBI), Kongu Engineering College (KEC)
18. P. S. Kannan, Senior Manager, Technology Business Incubator (TBI), Kongu Engineering College (KEC)
19. Poyni Bhatt, Chief Administrative Officer, Society for Innovation and Entrepreneurship (SINE), Indian Institute of Technology- Bombay
20. Sanjay Vijaykumar, Chairman, Startup Village- Kochi
21. Gautham, COO, Entrepreneurship, Sales, Marketing and Product, Startup Village- Kochi
22. Ganapathy Venugopal, CEO, Axilor Ventures
23. Prof. Tarun Khanna, Professor, Harvard Business School

Appendix B: International examples of incubator programs

Brazil: Brazil's innovation policy has several instruments in place to catalyze an enabling environment for startups at the national, state, and local levels. Incubators—primarily affiliated with universities—feature prominently in the support for startups, and Brazil has the third largest number of incubators in the world (following USA and China) following several incubation models (Akçomak, 2009). Brazil's incubators reflect a 'triple-helix' model of synergies between university, industry and government (Etzkowitz, 2002). Many of the incubators in Brazil are set up with support from multiple government partners and the private sector, for example, National Incubation Support Program (PNI) provides financial support to set up new incubators or expand existing ones (Chandra and Fealey, 2009). The number of incubators in Brazil increased from 2 in 1988 to 384 in 2011, and the primary prerequisite for startups to be hosted in these incubators has been innovation. The incubators currently in operation host 2640 companies and generate employment for over 16000 jobs. Over 2500 companies have already graduated that generate revenues of over R$4 billion and support over 16000 jobs ("FAQ - ANPROTEC"). Other examples of public support include the PRIME program of FINEP—a corporation affiliated to the Ministry of Science, Technology, and Innovation—that provides grants co-financed of up to USD 70000 per startup through anchor incubators, and supplements grants with interest free loans (OECD, 2013a). The Startup Brazil program launched in 2013, plans to support 150 startups with a budget of B$150 million (Startup Brasil).

China: Chinese innovation policy makes specific provisions for creating enabling conditions for innovative high-technology enterprises, as demonstrated through the Torch Program (started in 1988) by the government's Ministry of Science and Technology (MOST). The Torch Program invested heavily by providing funds for construction of S&T industrial parks and incubators. Between 1988 and 2012, the Torch Program supported the establishment of 1200 incubators, including 435 incubators at the national level. These incubators hosted over 70,000 startups of which 50,000 graduated and 180 became listed companies. In addition, the Chinese government runs the Innofund—a program to support innovation in the private sector. The Innofund provided grant appropriation for startups ($150-$200k), low interest lows, or equity investments. From 1999 to 2011, the Innofund provided over 19.17 billion RMB (over USD $2 billion) to over 30,000 projects, primarily through grants appropriation, and induced external financing from local governments, private equity, and venture capital of 1:11. Typically, Innofund provides up to 20% of the capital for the investee company (Guo et al., 2014; Mahmood et al., 2015).

Chile: Chile places a growing emphasis on startups, by having a chain of policies in place to create an enabling environment by building finance, management skills, and a legal framework. Between 1992 and 2012, 27 incubators were established in Chile, many with strong university linkages (Chandra, Corfo). CORO has also been key to startup growth an expansion since 1998, financing venture capital funds. The Startup Chile program launched in 2010, through Fondacion Chile and CORFO, provides USD 40000 as seed capital for local and international entrepreneurs and provides them with basic infrastructures for one year, with the aim of creating a critical mass of entrepreneurs. Between 2010 and 2015, with the support of Startup Chile, 1200 startups from 72 countries graduated, raised over $100 million USD and created over 1500 jobs (Chandra and

Silva, 2012; Karsten and West, 2015; OECD, 2013a).

USA: Government support for incubators in the United States is evidenced in the form of funding through government grants, state economic development agencies, or state legislative allocations (Chandra and Fealey, 2009), and programs include the SBIR, Startup America, etc. According to the National Incubator Business Association, the number of incubators increased from 12 in 1980 to 1,250 incubators in 2012 (INBIA).

Israel: Israel's innovation policy has been a catalytic force in creating an enabling environment for the success of high technology startups in Israel, particularly in the life sciences, cleantech and ICT sectors. The government was instrumental in absorbing risk for early-stage technology startups. The licenses to set up incubators were given out through competitive processes to among others, private equity, venture capital, angel investors, and other corporations. These incubator license holders financed 15% of the budget for a startup, and the government financed the rest 85%, where startup budget amounts to $0.6 million USD per firm. The government thus absorbed most of the risk by giving out grants that were paid back in the form of a small percentage of annual revenues generated, only valid in the case of startup success. The government's initial investment in risky, innovative startups contributed to mobilizing sizeable investments from the private sector. Between 1991 and 2012, government invested USD $650 million in 1700 startups, hosted in 24 incubators. Over 1500 startups graduated from incubation programs, and these startups had raised USD $3.5 billion private investments. The availability of private sector capital was boosted by the launch of Yozma in the early 1990s, a program that led to the establishment of several venture capital funds[13].

Finland: Among OECD countries, Finland is one of the most active in its policy support for startups. Tekes—Finland's main innovation-support agency—offers seed capital to young, innovative companies up to USD $1.3 million per company. Finnerva, a public agency, has helped in the creation of more than 3600 companies through loans and guarantees to develop and internationalize Finnish companies. The Vigo accelerator program aims to invite international talent to create startups in Finland (OECD, 2013a).

[13] See more at: http://www.incubators.org.il/

Appendix C: List of incubators with government support

ID	Name	City	State	DST NSTEDB	DeitY TIDE	Mo MSME	DBT	DST TDB	DSIR-PRISM	DSIR TePP	Year	Employment (last 5 Years) 2014	Incubaters and Graduates (Total) - 2014
1	Sri Jayachamarajendra College of Engineering-STEP	Mysore	Karnataka	✔		✔		✔			1985	2050	36
2	University of Pune-STEP	Pune	Maharashtra	✔			✔				1986	722	63
3	Trichirapalli Regional Engineering College-STEP	Trichy	Tamil Nadu	✔	✔	✔		✔		✔	1986	175	-
4	IIT Kharagpur-STEP	Kharagpur	West Bengal	✔	✔	✔			✔	✔	1986	550	76
5	National Institute of Technology Karnataka-STEP	Mangalore	Karnataka	✔	✔	✔		✔		✔	1994	1000	5
6	PSG College of Technology-STEP	Coimbatore	Tamil Nadu	✔		✔		✔		✔	1998	1000	128
7	Basaveshwar Engineering College-STEP	Bagalkot	Karnataka	✔							1999	2900	11
8	ISS Academy of Technical Education-STEP	Noida	Uttar Pradesh	✔		✔		✔		✔	2000	1120	66
9	Icrisat- Agri Business Incubator	Hyderabad	Andhra Pradesh	✔		✔		✔		✔	2003	280	40
10	Composites Technology Park- TBI	Bangalore	Karnataka	✔		✔					2003	1500	73
11	Kongu Engineering College- TBI	Perundurai	Tamil Nadu	✔		✔		✔			2003	230	45
12	Vellore Institute of Technology- TBI	Vellore	Tamil Nadu	✔		✔		✔		✔	2003	205	22
13	IKP Knowledge Park- TBI	Hyderabad	Andhra Pradesh	✔		✔	✔			✔	2006	1093	34
14	National Design Business Incubator- TBI	Ahmedabad	Gujarat	✔		✔				✔	2004	141	44
15	National Institute of Technology Calicut- TBI	Calicut	Kerala	✔	✔	✔					2004	417	40
16	Mitcon- TBI	Pune	Maharashtra	✔		✔					2004	100	-
17	Bits Pilani- TBI	Pilani	Rajasthan	✔	✔	✔					2004	70	-
18	IIT Bombay- Society for Innovation and Entrepreneurship	Mumbai	Maharashtra	✔	✔			✔		✔	2005	1063	46
19	Thapar University- STEP	Patiala	Punjab	✔							2005	64	23
20	Technopark- TBI	Trivandrum	Kerala	✔		✔			✔	✔	2006	4500	137
21	University of Madras- TBI	Chennai	Tamil Nadu	✔		✔			✔		2006	160	-
22	Periyar Maniammai University- TBI	Thanjavur	Tamil Nadu	✔		✔					2006	78	10
23	IIT Madras- Rural Technology and Business Incubator	Chennai	Tamil Nadu	✔		✔	✔	✔			2006	1020	35
24	National Chemical Laboratory- TBI	Pune	Maharashtra	✔		✔	✔	✔		✔	2007	52	23

25	Bannari Amman Institute of Technology- TBI	Erode	Tamil Nadu	✔		✔					2007	27	13
26	Krishna Institute of Engineering Technology - TBI	Ghaziabad	Uttar Pradesh	✔		✔					2007	188	22
27	Ekta Incubation Centre- TBI	Kolkata	West Bengal	✔		✔					2007	40	45
28	IIIT Hyderabad- TBI	Hyderabad	Andhra Pradesh	✔	✔	✔					2008	180	30
29	Amrita Vishwa Vidyapeetham- TBI	Kollam	Kerala	✔	✔	✔		✔			2008	-	-
30	Amity University- TBI	Noida	Uttar Pradesh	✔		✔		✔			2008	3500	16
31	IIM Ahmedabad- Centre for Innovation Incubation and Entrepreneurship	Ahmedabad	Gujarat	✔	✔	✔		✔			2008	1200	72
32	IIT Kanpur- TBI	Kanpur	Uttar Pradesh	✔	✔			✔	✔	✔	2008	900	44
33	University of Delhi- TBI	Delhi	Delhi	✔		✔					2009	22	9
34	Mudra Institute of Communications-Design Business Incubator	Ahmedabad	Gujarat	✔							2009	16	9
35	National Dairy Research Institute- Society for Innovation and Entrepreneurship	Karnal	Haryana	✔		✔					2009	11	5
36	Ehealth- TBI	Bengaluru	Karnataka	✔						a	2009	120	16
37	Dattajirao Kadam Education Society- TBI	Ichalkaranji	Maharashtra	✔		✔					2009	349	33
38	Kalinga Institute of Industrial Technology - TBI	Bhubaneshwar	Orissa	✔	✔	✔	✔	✔			2009	192	26
39	St. Peter's Engineering College- TBI	Chennai	Tamil Nadu	✔							2009	40	-
40	IIT Benares Hindu University- TBI	Varanasi	Uttar Pradesh	✔		✔			✔	✔	2009	5	11
41	University of Hyderabad- TBI	Hyderabad	Andhra Pradesh	✔	✔						2010	25	-
42	Global Incubation Services- TBI	Bengaluru	Karnataka	✔							2010	125	39
43	Shriram Institute- TBI	Delhi	Delhi	✔		✔					2010	160	-
44	Indian Angel Network- TBI	Delhi	Delhi	✔		✔					2010	134	43
45	Manipal University- TBI	Manipal	Karnataka	✔		✔		✔			2010	55	11
46	Veltech- TBI	Chennai	Tamil Nadu	✔				✔			2010	1	15
47	PCCE- Centre for Innovation & Business Accelerator	Verna	Goa	✔							2011	36	11
48	Tamil Nadu Agricultural University- TBI	Coimbatore	Tamil Nadu	✔		✔					2011	93	5
49	Adhiyamaan College of Engineering- TBI	Hosur	Tamil Nadu	✔							2011	30	-
50	College of Engineering Trivandrum- TBI	Trivandrum	Kerala	✔							2012	-	-

51	Technovate India Innovations- TBI	Bengaluru	Karnataka	✔							2012	18	-
52	Villgro- TBI	Chennai	Tamil Nadu	✔		✔					2001	3803	19
53	Indian Telecom Innovation Hub- TBI	Kochi	Kerala	✔							2013	1523	39
54	Bits Pilani Hyderabad- TBI	Hyderabad	Andhra Pradesh	✔							2013	-	-
55	IIT Delhi	New Delhi	Delhi		✔	✔	✔	✔		✔	-	-	-
56	IISc. Bangalore	Bangalore	Karnataka		✔						-	-	-
57	IIIT, Bangalore	Bangalore	Karnataka		✔						-	-	-
58	ABV-IIITM, Gwalior	Gwalior	Madhya Pradesh		✔						-	-	-
59	IIIT, Allahabad	Allahabad	Uttar Pradesh		✔						-	-	-
60	IIM, Bangalore	Bangalore	Karnataka		✔						-	-	-
61	Dhirubhai Ambani Institute of Information and Communication Technology	Gandhinagar	Gujarat		✔						-	-	-
62	IIT Guwahati	Guwahati	Orissa		✔	✔					-	-	-
63	Central University of Rajasthan	Ajmer	Rajasthan		✔						-	-	-
64	IIT Roorkee	Roorkee	Uttarakhand		✔	✔			✔	✔	-	-	-
65	IIT Gandhi Nagar	Gandhinagar	Gujarat		✔						-	-	-
66	MANIT Bhopal	Bhopal	Madhya Pradesh		✔						-	-	-
67	IIT Ropar	Ropar	Punjab		✔						-	-	-
68	IIT Madras	Chennai	Tamil Nadu		✔	✔					-	-	-
69	Banasthali Vidya Peeth	Jaipur	Rajasthan		✔						-	-	-
70	Sardar Vallabhbhai National Institute of Technology	Surat	Gujarat			✔					-	-	-
71	North Eastern Regional Institute of Science and Technology (NERIST)	Itanagar	Arunachal Pradesh			✔					-	-	-
72	Vivekanand Institute of Biotechnology	Pagrana	West Bengal			✔					-	-	-
73	Central Institute of Plastic Engineering & Technology (CIPET)	Lucknow	Uttar Pradesh			✔					-	-	-
74	Galgotias College of Engineering and Technology	Noida	Uttar Pradesh			✔					-	-	-
75	National Afforestation & Eco-Development Board	Kolkata	West Bengal			✔					-	-	-
76	MEPCO SCHLENK Engineering College	Sivakashi	Tamil Nadu			✔					-	-	-

77	Xavier Research Foundation	Ahmedabad	Gujarat			✔					-	-	-
78	Lady Doak College	Madurai	Tamil Nadu			✔					-	-	-
79	National Institute of Science & Technology	Behrampur	Orissa			✔					-	-	-
80	C.V.Raman College of Engineering Bidyanagar	Bhubaneshwar	Orissa			✔					-	-	-
81	Ramrao Adik Institute of Technology	Mumbai	Maharashtra			✔					-	-	-
82	Jadavpur University	Kolkata	West Bengal			✔					-	-	-
83	Padmasri Dr. B.V. Raju Institute of Technology	Medak	Andhra Pradesh			✔					-	-	-
84	Maharaj Vijayaram Gajapathi Raj College of Engineering	Vizianagaram	Andhra Pradesh			✔					-	-	-
85	Indian School of Mines	Dhanbad	Jharkhand			✔					-	-	-
86	Lakshmi Narayan College of Technology	Indore	Madhya Pradesh			✔					-	-	-
87	VNS Group of Education	Bhopal	Madhya Pradesh			✔					-	-	-
88	Research and Technology Development Centre	Noida	Uttar Pradesh			✔					-	-	-
89	Management Studies & Research Centre	Bokaro	Jharkhand			✔					-	-	-
90	Gujarat Energy Research and Management Institute	Gandhinagar	Gujarat			✔					-	-	-
91	Dalmia Institute of Scientific and Industrial Research	Sundargarh	Orissa			✔					-	-	-
92	Nizam College of Engineering & Technology	Nalgonda	Telangana			✔					-	-	-
93	GMR Institute of Technology	Srikakulam	Andhra Pradesh			✔					-	-	-
94	J.N.T.U.H. College of Engineering Hyderabad	Hyderabad	Andhra Pradesh			✔					-	-	-
95	Konark Institute of Science & Technology	Khurda	Orissa			✔					-	-	-
96	Inderprastha Engineering College	Ghaziabad	Uttar Pradesh			✔					-	-	-
97	Xavier Institute of Management	Bhubaneshwar	Orissa			✔					-	-	-
98	Institute of Engineering & Technology	Alwar	Rajasthan			✔					-	-	-
99	Business Planning and Development Unit	Anand	Gujarat			✔					-	-	-
100	Mahatma Gandhi Institute for Rural Industrialization	Wardha	Maharashtra			✔					-	-	-
101	Central Institute for Research on Cotton Technology (CIRCOT)	Mumbai	Maharashtra			✔					-	-	-
102	Nagaland Mini Tool Room & Training Centre	Dimapur	Nagaland			✔					-	-	-

103	NIFT-TEA College of Knitwear Fashion	Tirupur	Tamil Nadu			✔					-	-	-
104	D J College of Engineering & Technology	Ghaziabad	Uttar Pradesh			✔					-	-	-
105	Business Planning & Development Unit	Jabalpur	Madhya Pradesh			✔					-	-	-
106	Government College of Engineering	Aurangabad	Maharashtra			✔					-	-	-
107	Shri Sant Gajanan Maharaj College of Engineering	Buldhana	Maharashtra			✔					-	-	-
108	Gandhi Institution of Management Studies	Raigada	Orissa			✔					-	-	-
109	Radharaman Institute of Research & Technology (RIRT)	Bhopal	Madhya Pradesh			✔					-	-	-
110	Rajdhani College of Engineering and Management	Bhubaneshwar	Orissa			✔					-	-	-
111	Krishi Vigyan Kendra AT Durgapur (Badnera)	Amravati	Maharashtra			✔					-	-	-
112	Central Institute of Fisheries Technology	Cochin	Kerala			✔					-	-	-
113	Innovation Lab, Tedex Tech Park	Kathrikkadavu	Kerala			✔					-	-	-
114	Centre for Integrated Rural Development	Vishakapatnam	Andhra Pradesh			✔					-	-	-
115	Entrepreneurship Development Cell	Thiruvananthapuram	Kerala			✔					-	-	-
116	Indian Veterinary Research Institute	Izatnagar	Uttar Pradesh			✔					-	-	-
117	Institute of Technical Education & Research, S.O.A.University	Bhubaneshwar	Orissa			✔					-	-	-
118	Aditya Institute of Technology and Management	Tekkali	Andhra Pradesh			✔					-	-	-
119	Gokaraju Rangaraju Institute of Engineering & Technology	Hyderabad	Andhra Pradesh			✔					-	-	-
120	Coimbatore Institute of Engineering and Technology	Coimbatore	Tamil Nadu			✔					-	-	-
121	Modern Engineering & Management Studies	Balasore	Orissa			✔					-	-	-
122	Alwar Institute of Engineering & Technology	Alwar	Rajasthan			✔					-	-	-
123	CCS Haryana Agriculture University	Hisar	Haryana			✔					-	-	-
124	Indian Agriculture Research Institute	New Delhi	Delhi			✔	✔				-	-	-
125	Majhighaririani Institute of Technology and Science (MITS)	Rayagada	Orissa			✔					-	-	-
126	Sri Krishna College of Engineering and Technology	Coimbatore	Tamil Nadu			✔					-	-	-

127	Harcourt Butler Technological Institute (H.B.T.I.)	Kanpur	Uttar Pradesh			✔					-	-	-
128	Centre for Cellular and Molecular Platforms (C-CAMP)	Bangalore	Karnataka				✔				-	-	-
129	Society for Biotechnology Incubation Centre – SBTIC	Hyderabad	Andhra Pradesh				✔				-	-	-
130	B.V. Patel Pharmaceutical Education & Research Development (PERD) Centre	Ahmedabad	Gujarat				✔				-	-	-
131	CSIR-Central Scientific Instruments Organization (CSIO)	Chandigarh	Chandigarh						✔	✔	-	-	-
132	Central Mechanical Engineering Research Institute	Durgapur	West Bengal						✔	✔	-	-	-
133	Acharya Nagarjuna University	Guntur	Andhra Pradesh						✔	✔	-	-	-
134	TOCIC-NEIST	Jorhat	Assam						✔	✔	-	-	-
135	CSIR-Central Glass Ceramic Research Institute (CGCRI)	Kolkata	West Bengal						✔	✔	-	-	-
136	CSIR- Institute of Himalayan Bioresource Technology	Palampur	Himachal Pradesh						✔	✔	-	-	-
137	University Science Instrumentation Centre (USIC), University of Kashmir	Srinagar	Jammu & Kashmir						✔	✔	-	-	-
138	Sri Padmavati Mahila Visvavidyalayam (SPMV)	Tirupati	Tamil Nadu						✔	✔	-	-	-
139	College of Technology and Engineering(CTAE)	Udaipur	Rajasthan						✔	✔	-	-	-
140	ERDC Campus	Ambala	Haryana							✔	-	-	-
141	Chhatisgarh Swami Vivekanand Technical University	Bhilai	Chattisgarh							✔	-	-	-
142	Uttarakhand State Council for Science & Technology (UCOST)	Dehradun	Uttarakhand							✔	-	-	-
143	CSIR- National Environmental Engineering Research Institute	Nagpur	Maharashtra							✔	-	-	-
144	CSIR-Central Electronics Engineering Research Institute	Pilani	Rajasthan							✔	-	-	-
145	National Institute of Technology	Silchar	Assam							✔	-	-	-
146	Sri Siddhartha Institute of Technology-STEP	Tumkur	Karnataka							✔	-	-	-

Appendix D: Government initiatives to support incubators and startups

Government programs		For startups/incubatees				For incubators	
Department	Name of initiative	Max. support (INR lakhs)	PPP model (contribution from startup)	Loan conditions/ details	Target startups	Infrastructure, administration (INR lakhs)	Priority Sectors
DST – NSTEDB and TDB	NSTEDB-Technology Business Incubators (TBI)					Support for first 5 years	
	TDB fund	25 lakhs		Loan, equity [for incubatees affiliated to TBI/ STEP]	Developing new products or processes		
	NSTEDB – Seed Support Scheme	50 lakhs		Loan, equity, or sharing royalty [for incubatees affiliated to TBI/ STEP]	Product development, prototyping, scale-up, testing, marketing, IPR	-	
DBT – Dept. of Biotechnology	Bio-incubators Support Scheme (BISS)						
	Biotechnology Ignition Grant (BIG)	50 lakhs	-	Grant [BISS incubators manage incubatees]	Only up to proof-of-concept		Biomedical devices, biotech incl. agriculture, energy, healthcare, diagnostics, etc.

DSIR – Dept. for Scientific and Industrial Research	Prism Phase I Cat I [individual innovators]	2 lakhs	At least 10%	Grant [DSIR incubators – TOCICs –support and monitor startup progress]	Proof-of-concept [individual innovators]	- 12 lakhs/ year for expenses - 10% of grants for innovators to monitor projects	Green Technology, Clean Energy, smart materials, Waste to wealth, healthcare, water, management; (excl. software, basic research)
	Prism Phase I Cat II [individual innovators]	20 lakhs	At least 10%		Demonstration, IPR, tech transfer		
	Prism Phase II	50 lakhs	At least 50%		Scaling-up and enterprise creation		
DeitY – Dept. of Electronics and Information Technology	Technology Incubation and Development of Entrepreneurs (TIDE)	25 lakhs [6 grants/ incubator]	20%	Combination of loan and equity [for incubateesaffiliated to TIDE centre]		30 lakhs	ICT products and packages
MoMSME – Ministry of Micro Small and Medium Enterprises	MoMSME Grant	6.25 lakhs [10 grants/ incubator]	12-15%	Grant [affiliated to host incubator]	New products or services	4 lakhs	High tech (nanotechnology, biotech, IT, etc.), others (food processing, ceramics, etc.)

Appendix E: Case Studies

APPENDIX E-1
Center for Innovation Incubation and Entrepreneurship (CIIE) Indian Institute of Management, Ahmedabad

[14]This case study mainly presents CIIE's history and activities until end of 2015. Subsequent developments including updates around collaboration with other state governments, shift towards a national focus etc. are not discussed in detail here.

Center for Innovation Incubation and Entrepreneurship (CIIE) Indian Institute of Management, Ahmedabad

Background

Innovation is a risky business. The innovation system landscape often shifts very rapidly due to technical breakthroughs as well as macroeconomic policy and the changes in the wider social context. As such those responsible for nurturing fledgling enterprises within the innovation system have a responsibility to adapt and evolve continuously to the changing context within which these enterprises operate. CIIE, a leader and a pioneer in various aspects of incubation, has done exceedingly well in this respect. This stems, among other things, from one of the founding principles of CIIE- operating within gaps spawned by market failures. This has meant that CIIE has evolved much faster than many of its peers as it has strived continuously to fill these gaps.

The other core principle underpinning the activities at CIIE has been what it calls, the "Network Model". The CIIE is very intelligent and effective at leveraging the IIM Ahmedabad alumni, the IIMA brand name and a wide variety of connections and linkages, it has built over time. It has been able to build coalitions and partnerships with various government and non-government organizations as well as the corporates, bringing sustainability to its ventures and at the same time, providing a more effective platform and greater value to the incubatees.

The CIIE since its inception has consciously tried to avoid the trap of becoming an inward looking incubator. Being housed in an institute devoted to management and business studies means CIIE cannot provide access to labs and scientific equipment, as is the case with incubators housed in engineering colleges. Thus, CIIE has tended to distinguish itself by focusing its training and knowhow on the managerial and business aspects of entrepreneurship. CIIE believes (and with good reason) that the management can make or break a startup. So, the center engages

significantly more with outsiders (compared to other incubators) as they have more to learn about business and management than the students at IIMA. This also helps deepen the network effect.

Clearly, even though research into entrepreneurship formed the chief objective in the beginning, the center has tended to be driven more by considerations of common good and the desire to make maximum impact. The center is emphatic in their assertion that its success is determined by the time it takes in ceasing to exist i.e., it does so well that no more gaps exist for it to bridge.

Objectives/motivation

The initial motivation for setting up CIIE came from IIMA's desire to study entrepreneurship, an important facet of business and industry, which was never regarded with the same respect in India as elsewhere. The center grew in scope and evolved over time to grow into its present shape.

In the year 2002, IIMA setup a new academic centre for research in entrepreneurship and innovation. The initial group of six faculty members including Prof. Rakesh Basant, Prof. Pankaj Chandra, Prof. Anil Gupta, Prof. Devanath Tirupati realized that in order for their research to be useful it should not be limited to grand theorizing but should instead connect with reality. In order to bring a practical component to their research, they needed entrepreneurs on campus and this gave birth to the idea of an incubator at IIMA. The six faculty members were instrumental in getting Gujarat government & DST onboard. The Centre came up in 2007. With support from DST, IIMA and the Gujarat Government the center began to take its present shape. Gujarat Government provided support for constructing a building on land provided by IIMA. DST helped furnish the building and operating costs.

CIIE Building (Source- author picture)

Evolution

Over time the initial objective of entrepreneurship research has taken a back seat in many instances as the centre took off on its own. Activities largely driven by gap analysis for the 'greater good' have become the driving force.

In retrospect, CIIE is a key component in pulling together the IIMA motto of 'Vidya' (Education), 'Viniyog' (Application), 'Vikas' (Development) through application of knowledge for development.

The centre has reduced emphasis on information technology related startups over time and is diversifying into new areas. It's working on building regional ecosystems & building sectoral depth. CIIE has always been a national focused organization and not just for IIM-A students. Since, a lot of successful companies go to Bangalore or Silicon Valley; therefore, jobs from the entire country are getting concentrated in a few places. CIIE aims to help in building the regional ecosystem. As of now, it is focusing on Gujarat, Rajasthan and Maharashtra through Startup Oasis in Rajasthan and its own teams spread across Ahmedabad, Pune, and Bangalore.

Activities

The center started out in the IIMA old campus with a very small facility which had just one start up. The CIIE office at that time was a 10*15 sq. ft. room. A clear evolution is visible in its growth. CIIE started as a research center which moved into incubation. When its management realized that the landscape

was not quite supportive of entrepreneurship and entrepreneurs, the center moved into ecosystem building and outreach. As the first wave of IT start-ups started coming up in India, CIIE realized that they needed a different mechanism for support rather than the traditional business incubator and one of the first accelerators in India came up. The center is now trying to develop sectoral strength and has started a few sector-specific accelerators. INFUSE Ventures, a cleantech focused investment fund, is a recent endeavor of the center.

Early days

Anveshan was one of the first programs at the center and was the flagship program from its inception until the year 2007. It was a business plan competition in search of high tech-large impact innovations. The winning entries were offered incubation space and mentoring at CIIE, IIMA.

This phase of CIIE was that of finding its feet in search of a coherent strategy and direction while it scouted for innovations and innovators. This phase also laid the groundwork for the future in the sense that much of the infrastructure came on line during this time and some of the key talent hires were made during this time.

Kunal Upadhyay, CEO of CIIE, was one of the first people at the center apart from the faculty. He is an IIMA alumnus who was working at Citibank at that time. As a student, Kunal had worked with Prof. Basant. Prof. Basant reached out, met him and told him CIIE was struggling for talent. Kunal joined in 2007. Soon after he joined, the center underwent a major reflection exercise to recast the role of the center.

Gap assessment and change in course

The CIIE management did a reflection exercise in 2007 and their review yielded 3 key insights-

1. There were not enough product based startups
2. The center needed to build sectoral depth to make a lasting difference
3. The center had deliberately stayed away from IT until that time but it might be counter-productive in the long run

The initial focus on high tech or large impact gave way to ecosystem building. In 2007- 2008 the center made three interventions in response to specific challenges.

Lack of student entrepreneurship

In order to promote student entrepreneurship in the country, the center conceptualized a book which documented stories of successful role models. The idea for a book, documenting success stories of MBA entrepreneurs came from Professor Rakesh Basant[15]. The Center brought on Rashmi Bansal, an IIMA alumnus and co-founder of the popular youth magazine called Just Another Magazine (JAM) and was funded by the Wadhwani Foundation under the National Entrepreneurship Network (NEN) initiative. The book, called “Stay Hungry, Stay Foolish” follows the stories of 25 alumni from IIM Ahmedabad who eschewed lucrative jobs, to create successful businesses. The book became an instant hit, sold more than 500,000 copies in 8 languages and continues to be an inspiration for entrepreneurs looking for inspiration to make the plunge.

Lack of Product Startups

In 2007, the Indian startup ecosystem was consistently throwing up successful ventures in the IT sector but most of them had hitherto been focused on services and not product. CIIE launched iAccelerator as an accelerator program focused on IT in part-

[15]http://india.blogs.nytimes.com/2011/09/19/a-conversation-with-rashmi-bansal/

nership with Microsoft (a partnership forged due to the center's proactive efforts in cold-calling and pitching their new venture).

The focus of the accelerator was to help launch a greater number or product startups. Along with Morpheus, iAccelerator was one of the only two accelerator programs in India. The accelerator is inspired by the popular Silicon Valley accelerator Y-Combinator and follows what is called as the batch process.

The batch process is markedly different from the traditional model of an incubator where an entrepreneur was found and given space to do his own thing. Instead, the batch process followed a well-structured, rigorous model bringing together 10-12 startups together who would stay on campus for the duration of the program (typically a couple of months). The iAccelerator continued for about for 5-6 years and about 60 startups passed through it during this time.

Lack of freedom for IIMA students to pursue entrepreneurship

1. Student placement holiday was instituted in 2007 in IIMA. Because of the high fees IIMA students were unable to pursue innovation and entrepreneurship- now they had a backup.
2. IIMA alumni now contribute towards a two-year fellowship for aspiring entrepreneurs, called IIMAvericks to help them pursue entrepreneurship. The IIMAvericks also get a two-year placement holiday.
3. Starting from 2015, CIIE also started offering two month IIMAvericks internships for IIMA students to work on their startup idea. About, 15- 20 students out of the total batch of 400 students joined this internship program.

Later the center added two more activities to build entrepreneurship within IIM as explained below.

Courses for IIMA students

The center has had a very close working relationship with its host institution, IIM Ahmedabad. The participants for iAccelerator stayed in IIMA hostels and used other facilities. CIIE has also done its part by supporting entrepreneurs and entrepreneurship activities in the campus. CIIE runs courses for students related to entrepreneurship with some innovative courses like mock fund manager and a course, 'New Technology Applications, Design & Business Models' (NTADBM) in collaboration with the National Institute of Design since the last 6 years. The students can also work as interns or on consultancy projects with the incubated startups.

Young IIMAvericks Program

The Young IIMAverick Program is a joint program by IIM Ahmedabad, IIMA Alumni and CIIE that supports graduating IIMA students who wish to choose entrepreneurship as a career. The entrepreneurs are offered a fellowship of INR 30,000/month for a period of 2 years to help them financially sustain themselves. Apart from IIMAvericks fellowship, various funds are also available to students for prototype development.

Events

CIIE also supports the Entrepreneurship club at IIMA and the business festival conducted by IIM Ahmedabad called Confluence.

Ecosystem development

The center realized that the incubator could not perform very well in isolation if the rest of the ecosystem does not develop. The center began a host of initiatives to this end around the year 2009.

MentorEdge

MentorEdge was initiated by CIIE in October 2009. It aimed to create a platform wherein aspiring entrepreneurs could seek mentors across sectors, having a wide variety of experiences and expertise. Through MentorEdge opened up the closed and in-

accessible world of mentoring to anyone on his/her path to be an entrepreneur and not just those who had the "right" kind of connections to begin with. It also helped bring order and structure to the indecipherable chaos that networking for mentoring can be for first time entrepreneurs.

Power of Ideas

The Power of Ideas was first launched in 2009 by the popular newspaper Economic Times. CIIE joined in 2010, along with the Department of Science and Technology (DST), Government of India. CIIE was instrumental in bringing together a network of evaluators, mentors, and investors to audit every single business summary that comes to The Power of Ideas, to provide critical inputs to shortlisted startups, and to subsequently invest in a few selected on the basis of various parameters. As part of this program, CIIE offered an intensive ten-day incubation programme at the IIMA campus for all candidates who make it to the final cut-off list.

The event has grown phenomenally in the past 6 years of its existence. In the 2015 Power of Ideas event, over 16,000 business ideas were received, 504 entrepreneurs mentored and 75 startups given intensive mentoring at IIM Ahmedabad. About 35 startups received cash grants and 20 were provided with seed funding.

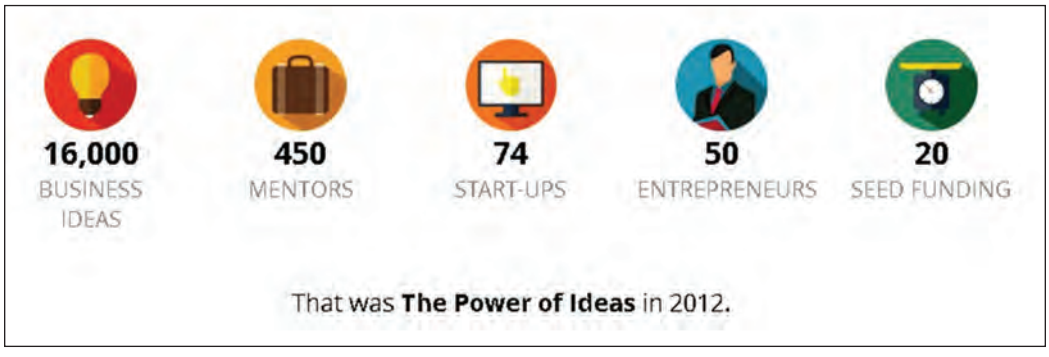


Image-2 Power of Ideas 2012 (Source- CIIE website)

Apart from strengthening the national entrepreneurship ecosystem the event serves as a great pipeline for talent for CIIE. Many promising participants end up getting incubated at (and receive funding from) the center. The latest Power of Ideas was organized in 2015. The event consisted of 4 phases as shown-

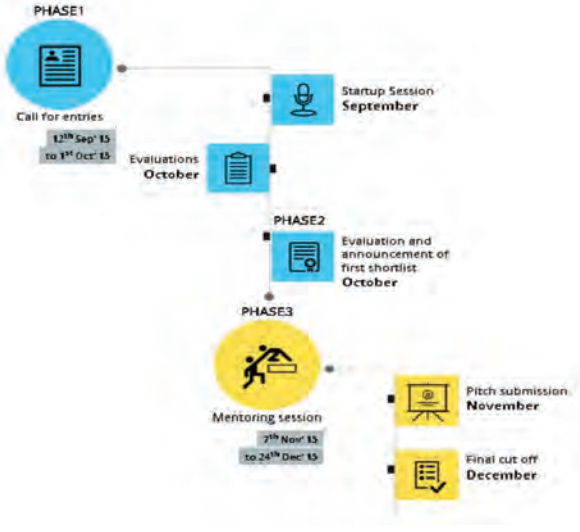


Image-3 Power of Ideas 2015 Workflow (Source- CIIE website)

Power of Ideas – 2015 performed quite well too-Non-core activities

The center divides its present activities into 2 major verticals: core and non-core. Apart from the core activities of incubation and acceleration, the non-core activities-

1) Research and training (analyze problem areas and do deep dives to study opportunity)
2) Events (raise awareness)
3) Incubator training (mentor and enable other incubators)

Research and training

The center continues to be firmly rooted in its initial identity as a research center. New programs are predicated on a gap analysis. The first step is to generate a hypothesis through market research. Initial validation is partly through the willingness of partners to be a part of the initiative. Ultimately, the success or failure of the initiative in terms of actual results obtained, serves as the final test. The success or failure of a venture, becomes a part of organizational learning through rigorous documentation. The center also conducts major reflection exercises (such as the one in year 2007 referred to in the beginning) which help set goals and direction for the center, every few years. In 2014, the center organized a three-month long exercise to strengthen internal processes and knowledge sharing.

The center has very good internal documentation. There are detailed documents on how to make your own incubator program, accelerator program prepared for managers, mentor training manuals etc.

Events

The center routinely organizes events for entrepreneurs as well as incubator staff. The events form one of the pillars of the network model. These events enable the center to impart training to the entrepreneurs as well as fostering linkages. There are events for staff to keep them updated with the changing innovation landscape (add social media training event).

Incubator training

CIIE has also helped mentor and train other incubators and supported them during their initial stages, such as the one at IRMA – Anand, Goa and the National Academy of Agricultural Research Management (NAARM). CIIE has also formalized its know-whow thorough documentation for how to setup accelerators& incubators.

Core activities

The center has evolved overtime from being an incubator and from an ecosystem development actor, to an accelerator and to being a fund manager over time. This has been driven mostly by the gaps.

Image 4- Co-working space at CIIE- IdeaPad (Source- author picture)

Accelerator

At the heart of CIIE's success and what sets it apart from most other incubators in India has been its sophisticated accelerator program which has evolved continuously as the ecosystem has matured. The center started with iAccelerator way back in 2007 in the IT sector. Over time as private sector investment picked up in the IT space, the center transitioned into building sectoral depth in a few strategic areas.

The center believes greatly in the batch process and the ability as well as the rigor of its accelerator programs. To borrow a Silicon Valley cliché, the accelerator programs help ventures fail faster and try out a larger variety of business models before they can achieve the holy grail of product-market fit.

Indeed, it's hard to predict successful innovations beforehand. Humans after all, are not perfectly rational decision makers or value optimizing functions. What seems like a breakthrough may fail miserably. Thus, accelerators by shortening the time to market or by providing crucial feedback from the market at an earlier stage can help save innovators a lot of pain.

The example of an Internet of Things (IoT) start-up called Lumos is particularly poignant. Consisting of three IIT Gandhinagar students, who were convinced they had the next big idea in IoT aimed to bring smart, internet connected switches to the mass market. Through great tenacity and hard work the founders were able to create their first prototype within 45 days and added another one for a different product within a month of that. However, all this time in their own admission, they really had not thought about the value proposition to the consumers or put their own assumptions to a rigorous test[16]. Neither did they know much about the realities of a hardware business, especially within India. It was not until they joined the Power Startprogramme in Bangalore (a CIIE's IoT accelerator) that they got their first feedback from industry veterans and seriously questioned their own assumptions.

[16]http://venturebeat.com/2015/06/16/5-reasons-why-my-iot-startup-failed/

Through their experiences at the accelerator and from the various challenges (some insurmountable) they faced with their startup, they were able to move forward and start their second venture. It is debatable, but perhaps, access to an accelerator early on in the development cycle may have saved them much heartburn due to the acrimony within the founding team.

All accelerators programs are built around customer validation and are thus, able to provide unique value to the incubatees which traditional incubators may be unable to provide.

Agri - accelerator / Water accelerator

A development in CIIE's accelerator programs is an attempt to bring acceleration to two key areas which would seem uniquely ill suited to it- agriculture and water. However, what seems like a strange choice is actually a product of the CIIE strategy of creating strategic depth. Both agriculture and water face urgent problems with national consequences if no solutions are found. These are also areas which face an innovation deficit in the country and can greatly benefit society. But there are also more practical reasons for this choice. IIMA has long run a post graduate program in agriculture management and has given birth to startups such as FarmNFresh etc. In water, CEO KunalUpadhyay has reasonable experience, having run a water startup called Sarvajal.

The center has had to adapt its strategy to these unique sectors. The product is, in general, not developed during the programme. The product or a prototype should already exist and the accelerator is geared towards stakeholder validation—i.e., validation from stakeholders, customers, or investors—in order to achieve product-market fit. This is because CIIE does not see itself as having much to offer by way of science and technology, rather, they can provide access to networks and help identify market and viability.

Seed Fund

Since, the year 2008, CIIE has run a very successful seed fund. By the end of 2015, the center claims a mortality rate of less than 5% for the incubated companies and over 80% of the portfolio have gone on to raise funding from venture capital firms, financial institutes and angel investors within 2 years of incubation totaling to above INR 125 crore. An interesting statistic that CIIE highlights is the ratio of CIIE's investment to the money raised by the incubatees from external sources which stands at 1:14 i.e. for every rupee invested by CIIE, the portfolio ventures have raised on an average INR 14 from other investors.

Infuse

The story of how INFUSE came about holds valuable lessons about the power of persistence and serendipity. It began with a call to the Ministry of New and Renewable Energy, Government of India, around 2010. This was when the CIIE had barely begun its move towards building sectoral depth, with energy as one of the focus areas. To CIIE's great surprise, the ministry expressed enthusiasm and invited CIIE management to a meeting. After a meeting with the top bureaucracy in the ministry, CIIE was able to get an in-principle approval within two weeks. Then, began the hard work of bringing together enough partners to build a viable venture. This involved reaching out to industry people. Finally, CIIE was able to bring BP on board. BP then leveraged its own networks and brought IFC.

Way Forward

The center has recently expanded to Pune and also setup Startup Oasis in Jaipur. The Pune center has an interesting experiment called Growth Camps, co-organized in association with an Anchor Corporate (market leaders in their specific sectors and looking to closely working with startups).

CIIE "Growth Camps" enable startups to collabo-

rate with corporates which can act as mentor for startup organizations and possible collaborators later on. The CIIE Growth Camp is a two-day program and includes product strategy review, sales channel enablement and a CXO dinner. CIIE currently runs Growth Camps for startups working in Fintech, Analytics, Cloud Computing, and Internet of Things.

CIIE management stresses on the importance of cultivating areas of strengths and on enabling greater ecosystem development in western India (hence, the expansion in Jaipur and Pune). The center is also moving into fund management with great enthusiasm as a means of ensuring long term financial sustainability.

APPENDIX E-2
Centre for Cellular and Molecular Platforms (C-CAMP), Bengaluru

Centre for Cellular and Molecular Platforms (C-CAMP), Bengaluru

Background

The Centre for Cellular and Molecular Platforms (C-CAMP) was established in 2009, as part of the Bangalore Life Sciences Cluster set up by the Department of Biotechnology (DBT). The Bangalore Life Sciences cluster was born out of the DBT belief that Indian biotech research needed greater linkages and as the primary government organization responsible for biotech research in India, the DBT was well placed to play the role of a coordinator and facilitator. The Bangalore Life Sciences cluster comprises of three major institutes: National Centre for Biological Sciences (NCBS), Institute for Stem Cell Biology and Regenerative Medicine (inStem) and Centre for Cellular and Molecular Platforms (C-CAMP).

The cluster was in part an attempt to build critical mass of scientists and engage with private sector R&D for translation of fundamental research into products and making government funded research more accessible. Housed in the Gandhi Krishi Vignana Kendra (GKVK), the three organizations are located right next to each other. The NCBS, established in 1992, had been a historic center of excellence with proven credentials in fundamental research in biotech. However, there had been a gap between research and the market. With the formation of the bio-cluster as originally envisioned, NCBS continues to conduct original basic research, while inStem is focused on stem cell biology and translational or applied research. C-CAMP was envisaged to play the role of an enabler in the ecosystem by developing new technological platforms to help both academia and industry with high-end technology. C-CAMP, more focused on innovation and technology, also aimed to promote entrepreneurship with an emphasis on encouraging academic entrepreneurs.

The genesis of C-CAMP lies in NCBS, a part of TIFR and then DAE. Prof. Siddiqi, who started NCBS had envisioned such an institute. Around 2009, the NCBS

Director, Prof. Raghavan (who went on to become and is currently, the Secretary, Department of Biotechnology (DBT)) and then DBT secretary (Dr. MK Bhan), with other leaders on campus, conceptualized this enabler organization i.e. C-CAMP. Prof. Raghavan hired, Prof. Ramaswamy and Dr. Taslimarif, who returned from the US and C-CAMP was setup as a Section-25 Company to enable quick execution.

Objectives of C-CAMP and evolution of the incubator

At C-CAMP, there is no formal demarcation between the incubator and the larger organization. Given the large presence of scientific research in the bio-cluster, C-CAMP started in 2009 with a mission for technology development and support (as a technology enabler). C-CAMP sees incubation as a part of its larger mission of enabling the transition of innovative science and technology to the market, and it incorporated incubation and funding into its mandate in the year 2012, nearly 3.5 years into its operation.

With its dedication to early stage startups, the incubator at C-CAMP came about quite organically. In 2012, a genomics company working on liver toxicity (or hepatotoxicity) needed access to the wet labs at C-CAMP and approached them to work together. C-CAMP decided to institutionalize the process and focus on early stage innovative startups working in the biotech domain. The center charges one base fee that includes rent for office space, and provides access to all facilities at C-CAMP. The latest experiment for C-CAMP is moving into translation (planning started in the year 2013 and implemented in 2014) or as they refer to it as acceleration.

The C-CAMP sees its niche as late stage science and early stage incubation. C-CAMP sees itself as an enabler of high-end research and its mission is to (i) develop new technology, (ii) develop new technological services (enabling accessibility), and (iii) provide technology education and training (to researchers from academia as well as industry- 200 organizations). The center is developing new technologies and technological platforms in the life sciences sector, which are first in world in some cases.

Image 1 – Incubator is integral to C-CAMP with no formal demarcation (Author picture)

Activities

C-CAMP sees itself as filling the gap between late stage research and early stage commercialization, resonating with the aims for DBT in setting up C-CAMP. DBT and C-CAMP work in close coordination and C-CAMP is an implementing partner for

Image 2 – C-CAMP building (Author picture)

many of the programs started by DBT and its other agencies.

Selecting start-ups

The incubator at C-CAMP was setup almost simultaneously as DBT's Biotechnology Industry Research Assistance Council (BIRAC) launched the Biotech Ignition Grant Scheme (BIG) for spurring commercialization of research through very early stage grants to scientist entrepreneurs from research institutes, academia, and s. The BIG was launched in partnership with three incubators—including C-CAMP—eligible to host successful candidates.

The BIG constitutes a majority of the pipeline for C-CAMP. Entrepreneurs and startups, who get BIG funding are automatically eligible for incubation at C-CAMP while others are evaluated based on compatibility. The evaluation of other potential incubatees is based on the value added by C-CAMP to the entrepreneur, and the value added from the entrepreneur to C-CAMP.

C-CAMP has incubated three batches of BIG companies, with the first batch of 6 (BIG) companies having already graduated. Of those 6, 2 stayed on and continue to be incubated at C-CAMP.

Incubation services (physical and virtual)

C-CAMP provides physical and virtual incubation services. C-CAMP currently hosts nearly 70 startups with 15 resident startups (physical incubation) and 55 non-resident startups (non-resident incubation). Of these, all of the 12 BIG grantees are housed on campus, per the requirements of the grant.

As part of its physical incubation services,C-CAMP offers an open-lab system with shared laboratory facilities. The open-lab system provides the same facilities to nearly 100 scientists and incubatees, encouraging the two groups to work together and creating synergies for both groups. The incubatees get exposure to top quality research and cutting edge science. The scientists get a better sense of how their research work may help create value in real world applications.

Image 3 – Open lab shared by incubatees and in-house researchers (Author picture)

Managing the incubator

C-CAMP works in close coordination with DBT and meetings are held routinely for information exchange and program coordination. Since C-CAMP was setup relatively recently, many of the systems and robust learning processes are still under development. But, maintaining good documentation is a requirement for demonstrating accountability to the funding agency (DBT). C-CAMP is also working on evolving metrics for impact analysis and innovation performance assessment. C-CAMP works with a staff of about 10 people with entrepreneurship and business development as the major focus areas.

Managing funding for start-ups

Most of the 70 incubatees are funded by BIRAC through C-CAMP. Apart from BIG, the incubatees are funded through the Small Business Innovation

Research Initiative (SBIRI) for supporting early stage research in small businesses for realizing a proof of concept and/or validation, and the Biotechnology Industry Partnership Programme (BIPP) available to firms trying to get research to market. As startups mature from the early stages that are supported by BIG, they opt for SBIRI, and then BIPP. C-CAMP has also been selected by NITI Aayog to be supported under its Atal Innovation Mission's Incubation Scale-up Support. C-CAMP also has seed fund scheme with MoMSME.

Managing funding for the incubator

While DBT continues to be the major source of funding, C-CAMP has been trying to diversify its revenue sources and build towards sustainability. C-CAMP is trying to create access to funds by inviting other stakeholders to support early stage translation from academia to industry. Additionally, C-CAMP receives licensing fees for some of its technological platforms as well as revenue from technological services its provides to more than 200 private and public sector organizations. The incubator also generates a small sum from the flat base fees that C-CAMP levies on all its incubatees.

Mentorship

C-CAMP makes considerable efforts to establish its niche among academic scientists in particular, taking late stage science to market and promoting entrepreneurship. Mentorship and hand holding is particularly important for scientists who tend to lack understanding of the business aspect of running a startup. To this end, C-CAMP has a robust mentorship network and hosts several mentorship programs.

a) **Mentorship camps for BIG:** Specifically for BIGincubatees, who tend to be less versed with non-technological aspects of running a business, an event is organized right after they are funded. The incubatees interact with mentors from industry (with domain knowledge), academia, and government, in order to refine their business models and clarify technology strategy. Such interactions continue for the entire period they are incubated. Every six months, meetings are organized with mentors to provide ongoing feedback. Experts such as Dr. Balamanian from Reametrix and Dr. Rashmi Bharbhaiya from Artemis have been involved in helping new entrepreneurs.

b) **Quarterly Friday Forum:** C-CAMP organizes a quarterly forum wherein successful entrepreneurs and senior executives from industry are invited to speak on entrepreneurship and the biotech and life sciences industry in general. After the first forum, which was open only to C-CAMPincubatees, the subsequent forums have been open to all, irrespective of affiliations.

c) **Dining with Czars:** C-CAMP organizes a special dinner for the graduating batch of incubatees with an industry titan. This is to help motivate the young entrepreneurs but also to help them get valuable exposure. Kiran Mazumdar Shaw, the founder-chairman of Biocon—India's largest publicly traded biopharmaceutical company—was the guest for the first graduating batch.

Way Forward

C-CAMP continues to expand both, its incubation services as well as research on technological platforms. The number of technological platforms has grown from three to eight. There has been greater emphasis on encouraging entrepreneurship, especially among academics.

Fundamentally, C-CAMP believes that its distinguishing feature is its strength in science (life sciences in particular) and it aims to spawn world class startups and organizations by bringing new research to market. One of the more innovative experiments at C-CAMP is their work in translation and the concept

of a new kind of accelerator (not in the traditional sense of an accelerator for startups).

C-CAMP's Discovery to Innovation Accelerator programme aims to fill the gap between academic research and industrial application by translating high risk, yet promising research towards industry-ready technology to create niche areas of strength and novelty. C-CAMP is already undertaking 3 such ambitious projects (e.g., treatment for restoring immune activity in HIV patients) and aims to expand further with government support. The hope is that world-class research with emphasis on application and entrepreneurship will help spawn a biotech revolution in the country.

APPENDIX E-3
Incubator at IKP Knowledge Park (IKP), Hyderabad

Incubator at IKP Knowledge Park (IKP), Hyderabad

Background

When N. Chandrababu Naidu first came to power in 1995, he launched an ambitious program of turning the erstwhile Andhra Pradesh into a fast growing economy similar to the Asian tiger success stories. Along with its more famous peer, the HITECH City, Genome Valley was founded as a pharmaceutical (pharma) and biotechnology (biotech) innovation hub to propel biotechnology research in the country. After Bharat Biotech International, IKP was the second organization at the Genome valley[17]. IKP, which was known as ICICI Knowledge Park at the time of its founding, had been set-up by ICICI Bank. ICICI Bank was thus, also one of the private partners in the setting up of the Genome Valley, which established itself as one of the foremost biotech research hub in the country, in the next few years.

IKP was conceived as a response to the formalization of The General Agreement on Tariffs and Trade (GATT) in 1995. Industry titans worried about the effects of the impending dismantling of barriers. This was true everywhere but more so in the pharma sector where India had been able to create a massive industry on the back of generic drugs. But the prognosis for the sector did not look as good. R&D in biotech is expensive- it has a long pipeline, requires expensive facilities and there is a long and painful

[16]http://www.rediff.com/business/slide-show/slide-show-1-meet-the-man-behind-indias-genome-valley/20110107.htm#9

testing and regulatory process. It was around this time that Mr. Narayanan Vaghul, then chairman of the ICICI group, decided to set-up a science park to help Indian pharma companies make the transition to R&D. IKP was incorporated in July 1998, as a Section-25 (not-for-profit) company by the ICICI Limited. The Government of Andhra Pradesh gave 200 acres of land in Turkapally village of Shameerpet Mandal, 40 kms outside Hyderabad and thus IKP was commissioned in 1999. IKP was conceptualized as a science park to promote all areas of high end research and innovation in the country and was thus named 'Knowledge Park'. Being located in Hyderabad, famous for both pharmaceuticals as well as seeds, life sciences research, emphasizing pharma and biotech was the first choice. The incubator came much later in the year 2006. IKP was the first privately backed incubator to be funded by NSTEDB.

The IKP operating philosophy has been to find a niche or a unique premise for promoting innovation where it could have maximum impact and evolve with changing government policies, technology and the socio-economic context.

Objectives/motivation

Hyderabad had already gotten a critical mass of pharma giants such as Dr. Reddy's, Aurobindo, Natco etc. by the 1990s. But they were mostly devoted to manufacturing and not research to the same extent. Observing that the industry lacked R&D capabilities for producing innovator drugs a knowledge oriented biotech research park was investigated. At that time Dr. Ashok Ganguly (Hindustan Lever), who saw R&D as a tool that could deliver sustainable growth, realized that the academic research in India was quite far from the product driven R&D. So, he pushed for a science park devoted solely to commercial research. At the same time Mr. Vaghul who believed that in the long term, the banking sector will flourish only if the industry did well, also got interested. Ultimately, Mr. Vaghul, Dr. Ganguly and Dr. R. A. Mashelkar (then Director General, CSIR, Government of India) formed a small group to drive the creation of a Science Park where companies get access to labs and other research facilities.

The idea was to provide small and large corporates taking their first steps into business driven R&D in a hassle free space. This was especially crucial in Pharma as the barriers to entry are very large compared to IT (where STPIs had done quite well and had already outgrown their utility).

The second big idea was to promote contract research in the same space. This would allow MNCs which did not want to setup full-fledged R&D units, to commission research on an as needed base, with the hope that in the long term they will realize the value of R&D. Matrix Laboratories, GVK Life Sciences, Sai Life Sciences were some of the companies which started out by promoting contract research for big pharmaceutical companies.

The third big driver was to entice large MNCs into starting research labs to lift up the entire ecosystem as they bring global knowledge & experience on how to do research. Indeed, Astra – Zeneca (UK) – has trained many excellent scientists during their operations in Bangalore, out of which, at least 7 went on to start their own companies while many worked at others. These included Dr. Janakiraman Ramachandran among others, who went on to found GangaGen (a firm developing treatments for anti-biotics resistant infections). IKP decided to bring in R&D arms of MNCs as its anchor companies.

Evolution

Since the very beginning, IKP aimed to kickstart a biotech cluster in Hyderabad, by bringing together large MNCs, contract research organizations, MSMEs and forging linkages with the many educational institutions that already existed in Hyderabad.

The model of the science park was to co-house small

and medium companies for a short time in a shared space along larger anchor companies which stayed for a longer term. The small and medium companies were to leave within a short time having a received a push for R&D while 7-8, large Indian companies or MNCs, stayed permanently to support the eco-system.

Around 2006, as the science park gained scale and stability, IKP felt a need to encourage startups and make them a part of the nascent cluster taking shape in the Genome Valley. In order to give a push to entrepreneurship in the life sciences area, an incubator which promoted startups as well as individuals with ideas or MVPS was conceived. The incubator at IKP Knowledge Park was, thus, born. More than 60 companies have been incubated till now.

Image 1- IKP Knowledge Park main building (Source- author picture)

Activities

IKP works with what it calls the gap model. The aim is to find gaps in the innovation ecosystem and make efforts to fill those. When IKP was first established the region was missing even a rudimentary innovation ecosystem in the life sciences.

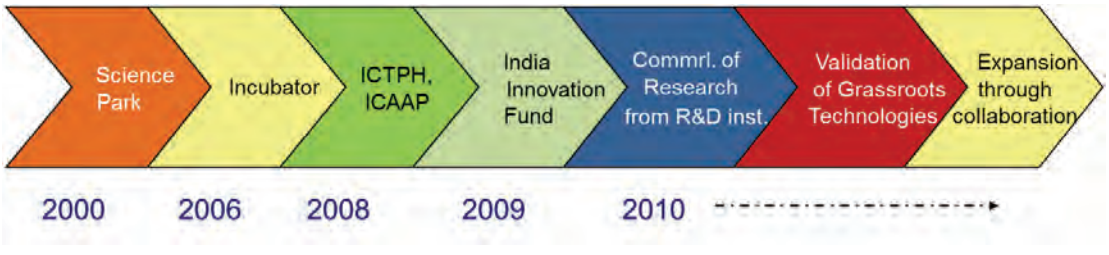


Image 2- IKP Activity evolution (Source- IKP website)

So, IKP began as a science park inviting SMEs and MNCs to work together and help kickstart a life-sciences cluster. In due time, realizing the increasing importance of entrepreneurship, IKP started an incubator and then moved into grant management. The next section describes these activities in greater detail.

Incubation

The life sciences incubator aims to encourage and nurture startup companies and spin offs in pharmaceutical and biotechnology related areas. The incubator has an incubation space of around 10,000 sq. ft. for around 16 incubatees.

All incubatees get access to common equipment such as dedicated lab space, shared equipment facility and an analytical facility with an array of analytical instruments. The Analytical facility (setup with support from Biotechnology Industry Research Assistance Council (BIRAC)[18]) provides services in Nuclear Magnetic Resonance (NMR), Mass Spectrometry, Differential Scanning Calorimetry (DSC), Thermal Gravimetric Analysis (TGA) etc.

The incubator provides support in four major verticals:

Infrastructure related

Dedicated fitted out lab (about 225 sq. ft.) with fume hood/ laminar flow cabinet, work bench, ventilated cabinet and office furniture; Shared equipment, facilities management, access to vendors

Business related

Assistance in company incorporation, vetting/writing business plans, mentoring

Funding related

Flexible lease rentals with minimal initial cost, fund raising, networking with venture capital firms and other funding agencies

Technology related

Information services, regulatory compliances, technology licensing and management, IP management

Image-3 Analytical facility (Source- Author picture)

Image 4- Greenhouse set up by incubatees at IKP incubator (Source- Author picture)

[18] Biotechnology Industry Research Assistance Council (BIRAC) is a not-for-profit Section 8, Schedule B, Public Sector Enterprise, set up by Department of Biotechnology (DBT), Government of India with the aim of encouraging research and innovation within the private sector

Grant management

In the last 5 years, the incubator realized they needed to expand to have scale & impact. So, they diversified into Grant Management to cater to larger ecosystem development activities. Activities such as grant management are also helpful for the financial sustainability of the incubator as they get a small fee for grant management, an activity which fits in nicely with the larger mandate of the incubator. The incubator first partnered with the Bill & Melinda Gates Foundation (BMGF) in 2011 for the Grand Challenges Exploration. In 2012, IKP partnered with USAID on a Grand Challenge on TB Control that needed matching funding that was contributed by BMGF and later by BIRAC and Department for International Development (DFID). Subsequently, in 2012, when BIRAC launched BIG, IKP was one of the 3 incubators selected for grant management. In 2016, IKP partnered with the Government of Karnataka to launch the Grand Challenges Karnataka program. IKP has so far raised around INR 114 Crore as grants from its partners and funded around 100 startups and innovators.

Governance

The current promoter of IKP is IKP Trust. The Park has a CEO and the incubator is administratively a part of the Park. The incubator has 7 employees.

Funding

The initial funding support for the Life Sciences Incubator (LSI) at IKP came as a INR 1.58 crores grant from the National Science & Technology Entrepreneurship Board (NSTEDB) of the Department of Science and Technology (DST), Government of India. It was later on supported by BIRAC with an additional grant of INR 7 crores.

LSI also received INR 3 crores from the Technology Development Board (TDB) and NSTEDB to support incubatees. Later on LSI also added the TEPP and the MoMSME programs to support its incubatees.

Supplementary activities

In order to achieve sustainability, the incubator also provides technology services to the many pharma related enterprises in Genome Valley as well as other parts of Hyderabad and other nearby cities. Income from running tests on high end machines such as the NMR machine contributes towards making the incubator sustainable. It also helps the optimum utilization and monetization of expensive equipment and helps strengthen the overall life sciences ecosystem.

India Innovation Fund

A few years back, two highly promising incubatees at IKP moved abroad due to their inability to carry out trials in India. This was primarily due to the lack of venture funding The VC community in India, while quite developed in areas relating to IT, has not been very supportive of the life sciences sector. So, companies find it difficult to find funding as they grow.

Life sciences companies are more science focused. The long technology development phase in life sciences also contributes to difficulty in finding funding. The initial technology risk is mostly being borne through government support and other grant funds. However, follow on funding from angel investors and venture capital firms are not as forthcoming.

So, realizing that there was a need for an early/seed stage venture capital fund in life sciences in India, IKP teamed up with NASSCOM to start the India Innovation Fund (IIF). The fund size was INR 50 Crore and it was dedicated to funding early stage innovative companies in the life sciences and IT product domains. IIF has invested in seven startups and is currently in the process of exiting from its investments.

Pre-incubation

IKP, was funded by BIRAC in the year 2013, to setup

a new center to support the regional innovation system (RIS). BIRAC Regional Innovation Centre (BRIC) has 2 major activities-

Mapping of the Life Sciences RIS

The BRIC is trying to map the major innovation actors and the linkages between them, which constitute a regional innovation system. To this end, IKP has conducted an academia-industry study to understand the biotech-pharma innovation ecosystem, in four southern Indian clusters- Hyderabad, Bangalore, Chennai-Vellore and Trivandrum-Kochi. Currently it is mapping 6 clusters across Western and Central India.

Intellectual Property (IP) and technology transfer support

IKP has an IP and technology transfer support cell as part of BRIC. This is funded by BRIC and assists all BIG grantees by default. The Center also aims to support academic institutes and startups (non-BIG) who seek help in order to further its aim of promoting entrepreneurship among academia.

Diversification and the Road Ahead

IKP is undergoing significant changes. While continuing to build upon the learnings from the life sciences incubator, they are also distinctive in significant ways-

IKP- EDEN

In 2015, IKP expanded its operations and set up a 25,000 sq. ft Hardware Product Incubator and Makerspace, called IKP Engineering Design and Entrepreneurship Network - IKP EDEN (www.ikpeden.com) in Bangalore. It is aimed at providing prototyping facilities and design support to all types of product startups including medical technology startups. IKP EDEN also serves as a facility to test out ideas before innovators can decide to take a plunge into full-time entrepreneurship and is open for membership to hobbyists, enthusiasts and inventors. It has so far hosted 41 startups. IKP EDEN conducts regular weekend events including hackathons, workshops, investor meets and networking meetings and plans to launch its acceleratorprogramme shortly. Based on the response, Government of Karnataka has awarded INR 22.68 crore to IKP to set up 5 satellite incubators in 5 tier II cities in Karnataka.

India Innovation Fund-2

IKP aims to significantly scale up the activities of the India Innovation Fund and increase both is scope as well as its geographical reach. IKP is also working towards launching a second fund, IIF-2, in the healthcare sector with specific focus on medical devices, IT for healthcare and primary health-care related services.

APPENDIX E-4
Technology Business Incubator at Kongu Engineering College (TBI@KEC), Erode

Technology Business Incubator at Kongu Engineering College (TBI@KEC), Erode

Background

Until 1984, there were all of 7 engineering colleges in Tamil Nadu. It was MG Ramachandran, the legendary Tamil actor and chief minister of Tamil Nadu, who liberalized the monopoly regime in higher education allowing for the opening of a host of colleges. This wave gave birth to several famous colleges such as Vellore Institute of Technology (VIT), Kumaraguru College of Technology etc. among others. Among these was the Kongu Engineering College (KEC), situated 15 kms from a small town in Tamil Nadu called Erode. Kongu is the name of a region in Western Tamil Nadu consisting of Erode, Coimbatore etc. The dominant community in Kongu region, the Vellalars were traditionally into agriculture but had also branched into business and other fields, although the overall education level continued to be low. 41 eminent people from the community and noted philanthropists contributed INR 1 lac each in 1983 and formed a trust (The KVITT), seeking to advance technical education in the region, at a time when there were only 7 engineering colleges in all of Tamil Nadu.

Objectives/motivation

The trust has a curious structure and that has been, in part responsible for the founding and subsequent success of the technology business incubator (TBI) at Kongu Engineering College. Of the 37 alive, out of the 41 original founders of the trust, office bearers are elected on a rotating basis for a 3-year term. The desire to make their own mark on the administration results in a desire to do something different and has helped Kongu engineering college stand out amongst its peers and was the driving force behind the setting up of an incubator at KEC.

Mr. Venkateshwaran, a technopreneur, was elected secretary of the trust (The KVITT) in 2001 and realized that technology led entrepreneurship was going to become quite important in the future. He was also quite well connected and had heard about the newly launched DST scheme for TBIs. When he found out about PSG STEP in nearby Coimbatore, he asked Prof. Balamurugan (head of the TBI)[19] to talk to the Executive Director, PSG STEP, Raghavendra Prasad and prepare a proposal. Prof. Balamurugan then attended a 2-day workshop at Trichy for TBIs organized by DST for Vice Chancellors and heads of institutes. Participating in the workshop was a turning point. PKB Memon (who was heading the National Science & Technology Entrepreneurship Development Board (NSTEDB at that time) and a GM from Bharat Heavy Electricals Limited (BHEL) Trichy explained the vision & utility of TBIs.

The management realized that the region had been traditionally entrepreneurial with substantial concentration of industry at Coimbatore. But, the region was lagging behind as the local industry lacked ICT capabilities. The host institution, Kongu Engineering College could help by creating a new breed of entrepreneurs. After considerable research and effort on creating a proposal and several rounds of appraisal, Kongu Engineering College was chosen as a candidate for setting up of a new TBI.

Although the TBI@KEC started as a one-man effort born out of a passion to make a difference through technology, the management soon saw value, both long-term (in terms of developing the region) and short-term (good publicity and as a USP to attract talent), in the project.

Setting up the TBI

Government support brought trust & social capital inside the Host Institution (HI) i.e. KEC. The initial cost of setting up the TBI was INR 3.95 crores. Of the INR 2.50 crores for initial capital, one half had to come from HI. The HI gave a part of new building (totaling 20000 sq. feet) to the TBI valued at INR 1 crore & 25 lakhs further as cash which was deposited in

Image 1- TBI entrance (Source- TBI administration)

[19]He retired from service on superannuation, a few months after he was interviewed for the case study

the TBI account. INR 1.25 crore was provided by DST as a Lump sum in the very beginning. Of the running cost of INR 1.45 crore (spread over 5 years), 95 lakhs were to be generated by the TBI and 50 lakhs was provided by DST on a deficit funding model. Thereafter, the TBI@KEC has been self-sufficient.

The TBI got the sanction in 2002 and started operations in 2003 after necessary approvals. Prof. Balamurgan was asked to be the head of TBI and a Deputy was selected to aid him in day to day working of the TBI.

Image 2- TBI Building (Source- author picture)

Activities

The TBI @ KEC has had a long journey and struggled in its quest to gain visibility and viability while being located relatively far from any major industrial city or cluster. It has been helped in its cause by coverage in traditional media sources, through ecosystem development, fiscal discipline and cultivating sources of supplementary income. We describe these activities in detail in the following sections.

Pre-Incubator

KEC has traditionally attached lots of important to industrial linkages and to that end, started an Industry Institute Partner Cell (IIPC) in 2001 under a DST scheme. The IIPC continues to function and complements the role of the TBI, serving as an interface with industry for consulting while also generating leads for the TBI.

Early days- getting the word out

The center spent the first 3-4 years mostly building the facility and gaining visibility. Initially, since the idea of an incubator was new, the management sought guidance from different sources. The head of the NSTEDB at that time, Dr. Jain, helped provide guidance and advised the management of TBI to visit other excellent institutions to build networks and imbibe best practice. The management

of the TBI visited industries and academic centers of excellence. The TBI had a modest beginning but the top management of the HI was quite supportive because quite a few of them were entrepreneurs. KEC was visited by many famous people & TBI was treated as a flagship initiative which helped provide visibility both within the HI and without. The TBI also conducted workshops for nearby industries and participated in trade fairs to gain visibility.

Growing the pipeline

One by one entrepreneurs started coming from outside having heard about the TBI@KEC from-

1) Trade fairs
2) Word of mouth
3) CODISIA (The TBI has a Partnership with CODISIA and the CODISIA chairperson is a board member of the TBI)

The links with CODISIA have been quite invaluable to a TBI located in a pretty remote place and led to their first big breakthrough. The TBI@KEC's first product launch came with help from CODISIA for a German manufacturer of industrial vacuum cleaners called Hako. An incubatee at the TBI got a subcontract through ROOTS industry (contractors) and one of the resident entrepreneurs T. Kumar made the controls. This helped TBI get a lot of press visibility and helped the center "take-off".

Image 3 – Breakthrough product for TBI, controller for Hako (Author picture)

Governance at TBI @ KEC

The TBI @ KEC runs an incredibly lean operation with 5 staff members only. This has been one of the major reasons for its survival and sustainability. Both the administrative structure and funding are reflective of the TBI's need to operate efficiently.

Administrative Structure

For a long period after its inception, the TBI's administrative Structure consisted of a Board of Governors (BoG) and Project Appraisal Committee (with external members) for monitoring.

First, the Project Appraisal committee (PAC) approved an entrepreneur or a startup for funding. Then it went to the BoG. But, practically only the chairman of the BoG was able to review it and most external members of the PAC could not devote a lot of time. Raghavendra Prasad (STEP, PSG) suggested that in order to make the incubator more entrepreneur friendly they should cut the number of processes. As a result, the Project Approval Committee was disbanded as an independent body.

Instead, an internal project appraisal & monitoring committee was constituted which reviews every project every 2 months and sends recommendations to the Chairman, BoG. The committee consists of 4 People – head of TBI, head of IIPC and 2 other senior professors.

Funding

The TBI@KEC was initially run from the original corpus that came from the original project cost of INR 3.95 crore wherein the running cost was covered partially by the DST grant. Over time, the TBI has managed to gain financial sustainability primarily through charging rent from incubatees and by generating revenue from the various supplementary activities discussed in the next section.

Supplementary activities

Due to its unique geographical location, far away from any of the metros or any major technology hub, the incubator has had to take on many roles which a typical incubator will not be expected to undertake. This has been necessary to develop the ecosystem and to create a pipeline of entrepreneurs and human resources with the skills and also startups.

Workshops

Apart from the work of being an incubator, the TBI@ KEC does host of other activities for ensuring is own financial sustainably as well developing the wider ecosystem. The TBI organizes workshops, wherein the deputy head of the TBI, Mr. Kannan organizes & follows-up.

Hands-on training

One of the major activities at the TBI is hands-on training for the students of the HI. The TBI conducts a wide variety of courses in electronics on topics such as VLSI design, embedded, wireless DSP, electronic card repair, digital signal processing for UG as well as PG students. The TBI has 2 employees with diplomas in Electronics and Communication Engineering (ECE) who conduct these programs (as enablers) and help with the lab for the in-house entrepreneurs. The incubator has also developed a course on entrepreneurship and management development and conducts it for the HI students.

Ecosystem development

To support the larger ecosystem, the TBI conducts an Entrepreneurship Awareness Camp for about 75-80 undergraduate students which are selected from the HI (funded by NSTEDB).

The TBI also runs a Faculty Development Program for training academics in entrepreneurship from other colleges in the region, consisting of 20-25 faculty. The program is of 2 weeks duration and is funded by NSTEDB through EDI Ahmedabad.

Electronics repairing

The TBI @ KEC has a very good repair facility which is employed by the HI and SMEs from neighboring areas. Electronics boards from HI and surrounding industry are repaired by the 2 diploma holders. The incubator has also developed competence in PCB Design, testing and fabrication.

Image 4- Repair Facility (Source- author picture)

Funding

The TBI started seed funding after about 3-4 years of its existence. The funding is currently given as loans and not equity. The management of TBI experienced great difficulty in preparing entrepreneurs for receiving funding initially. According to the management there are some entrepreneurs who found it hard to manage large quantum of money, received in one go. Out of the original NSTEDB fund of INR 2 crores, only 1.5 lakhsare left from the first batch.

Funding is still in the form of soft loans. But when funding quantum is high, it is released in installments. At the time of the interview, 6 entrepreneurs had received between INR 20-25 lakhs (max. INR25 lakhs) and 5 entrepreneurs had received INR 40-50 lakhs (max. INR 50 lakhs). Similarly, for paying back, most do so in monthly installments. But if things do not happen as planned there is a provision for deferment (6 months to 12 months).

That said, there is no write off mechanism and the borrowers are expected to return the loan in full. The TBI is afraid that if there were a write-off provision, it may lead to entrepreneurs misusing such a provision and not repaying the loan.

The TBI is currently recycling funds from some of the entrepreneurs who have already paid back. When they avail the second batch of 2 crores from NSTEDB, the TBI may also utilize the equity mode.

The Path Forward

Despite its relatively disadvantageous location, the TBI has done admirably well in terms of coming up with new product launches (KEC exhibit-A) and ecosystem development in a relatively secluded geography. That said, attracting entrepreneurs continues to be a challenge. The TBI is also trying to improve project management and fund utilization for the entrepreneurs.

The TBI aims to create greater synergy with the HI and involve students& faculty of HI more in the activities of TBI. The TBI is also considering diversification into energy and ecology sectors.

Products Developed at TBI@KEC

S.No	Product Developed		Incubatee Company
1	GSM Motor Starter		Realtech Systems
2	Energy Saver (introduced in Madurai and Coimbatore Municipal Corporations)		Realtech Systems
3	Fuel Saver for MPFI petrol cars		Kulothung Automotive Systems
4	Vacuum Assisted Pump (for Medical electronics)		Fort Pharma
5	Electronic Control Panel for Scrubber Drier Machine (for overseas market)		Realtech Systems

6	Biometrics Reader		Sybiean Infosystems
7	Multivoltage Electronic Horn		Realtech Systems
8	Tower Maintenance System (TMS)		Krish Equipements
9 & 10	Handheld computer with printer for Micro financing sector Handheld computer with printer for Vehicle tracking systems		Vyakul Technology Solutions and Srishti Research Labs
11	DSP based products for "Power Sector"		Numeric Power Systems

12	Forward Reverse Timer, Preventor's Timer, Autostarter control panels, Temperature controller		Elgon Systems
13	Time and Attendance software		Sybiean Infosystems
14	GSM ON-OFF Timer		V-Tech Systems
15	3D Elevation design		Ideagate
16	Embedded Development Board		Elite Systems and Controls

17	Web based College Management System		Skymax Systems
18	Needle Positioner for Medical applications		Perfint Engineering Services
19	RFID product for retail business		Subramanian
20	Hagen Smart-iPhone Web Application		Vasithwam
21 & 22	Biometric based centralized employee management system and Biometric ID-Finder		Sybiean Infosystems

23	Vibration Sensor		V-Tech Systems
24	Energy Indicator		Realtech Systems
25	Universal Power Regulator for DC Motor(for overseas market)		Realtech Systems
26	Flow Monitoring for Effluent treatment plant		Realtech Systems
27	Timer controllers for range of UV therapy products and controllers for range of baby warmer products		Perfint Engineering Services

28	Campus Management Software		Sybiean Infosystems
29	Virtual tour		Ideagate
30	Website Design		Ideagate
31	Embedded Controller Products		Unity Electro Systems
32	PIC programmer		Kulothung Automotive Systems

33	CBT's for 6th , 7th , 8th & 9th standard Physics and Chemistry-Matriculation syllabus		Media
34	Controller for Automated Bell Ringing System		Realtech Systems
35	Ttriolinux for ARM processor boards		Trioztech
36	RFID LF Reader		Sybiean Infosystems
37	QUAD Processor VME board		Cornet Technology P.Ltd

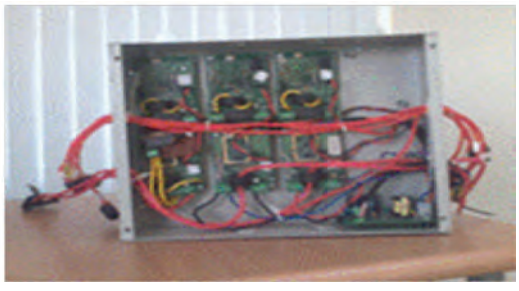
38	GSM Modem		Sybiean Infosystems
39	CPLD Development Kit based on Xilinx for use in VLSI design		Winnii Solutions
40	Embedded controller card for conveyors		Vsource Technologies
41	WinCE Based Embedded System		V-Tech Systems
42	RFID Trainer Kit		Elite Systems and Controls

43	Bio Bubbles- Timer Controller board		V-Tech Systems
44	Agni Designs-Billing Application		Vasithwam
45	Audiomatic Controller		V-Tech Systems
46	SMS Communication Software		Sybiean Infosystems
47	Astronomical Street Light ON-OFF Timer		V-Tech Systems

48	Electronic tagging of book like objects		Balaji Sowmyanarayanan
49	Horn Data Logger		Realtech Systems
50	Solar Charger Controller		Signal Systems
51	Web based Customer Relationship Management (CRM) Software development for SMEs		DACAM Systems P.Ltd
52	Smart Building		Evolutech Networks Pvt Ltd

53	Loom Automation		Sri Electro Controls
54	Fly Ash Brick Machinery Automation		K-Square Automation Pvt Ltd
55	Secure Track		V-Tech Systems
56	Renewable Energy SCADA System		Evolutech Networks Pvt Ltd
57	EasyTab		Samvit Technologies Pvt Ltd

58	Solar Management System with MPPT Controller		Intron Devices
59	QR Code based Mobile Commerce Platform		Wifin Technologies Pvt Ltd
60	PatentAt		945 Signals
61	MyGovin		945 Signals
62	Legalme		945 Signals

63	Open Source Content Management System (Social E-Commerce application)		Weblogicx India
64	Single phase Energy Monitoring device in a wireless network		Evolutech Networks Pvt Ltd
65	Road Survey Master System (RSMS)		Krish Equipments
66	Soalr Hybrid Charge Controller		K Square Automations
67	Quick Dezider		Hoorecon IT Sys Pvt Ltd

68	Vanigan		Samvit Technologies Pvt Ltd
69	SecureTrack Android Application	android Secure Track	V-Tech Systems
70	Multiversal Casper 8.0 Low Frequency Power supply		Multiversal Technologies
71	eSUCCESS		Set Infotech P.Ltd
72	Bore Well Rig Automation		

73	Legalme		
74	Software for Agriculture product auction		
75	HHO Fuel Saver cum Pollution Reducer		
76	PlasShineE1TM		

APPENDIX E-5
Society for Innovation & Entrepreneurship
IIT Bombay (SINE), Mumbai

Society for Innovation & Entrepreneurship- IIT Bombay (SINE), Mumbai

Background

The various institutions that collectively make up the Indian Institute of Technology (IIT) system are regarded as some of the finest engineering schools for undergraduate education in the world. Yet, there has been, until very recently, a feeling that they have not been able to contribute to the economic progress of the country as much as they should have or could have. In part, this has been attributed to the lack of opportunities and an underdeveloped industrial ecosystem in the country. A significant number of highly talented graduates from the IITs ended up migrating abroad for better job opportunities (a process famously known as "brain drain"). Especially at the turn of the new millennium, brain drain was considered one of the most significant issues concerning institutes of higher studies in particular and national economic development, in general. With the benefit of hindsight, there exists now, a more nuanced understanding of the problem (as well as related phenomena such as reverse brain drain), however, it was (and in some ways, remains) a deeply emotional issue for the country at large.

IIT Bombay (IITB) decided to tackle this problem, way back during the dot-com bubble, by encouraging greater entrepreneurship among students. The management wanted to enable their students to become job creators instead of job seekers. Initially, the aim was to provide a platform for student entrepreneurs and commercialize technology being created at IITB. The faculty, BOGs director & alumni came together and SINE was founded.

Origin story

Although SINE was founded formally only in 2004, the origin story goes way back. An alumnus Kanwal-Rekhi (an Indian-American businessman, venture

capitalist, angel investor and entrepreneur), funded an IT school in IITB. An incubator was conceived as part of the same project and became an integral part of the new school. The incubator came up with in the same building as it was being built. Nandan-Nilekani provided operational support. The IT incubator was run as a pilot project for 4-5 years.

When The DST launched TBI program in the year 2002, IITB had already built up substantial knowhow and there was interest in entrepreneurship on campus. So, SINE was founded in 2004 as a broad spectrum technology incubator and not just IT. The focus was on product based companies and those that generated IP (intellectual property) and which had done some proprietary work.

SINE has so far incubated 110 companies, (including 13 from the pilot), with 22 companies presently in the incubator, and other 20 companies under acceleration programs. Close to one fourth of the incubated companies include IITB faculty and similar number of incubatees are spinoffs from technology developed at the host institute. According to the management, SINE incubatees (including graduated ones) have collective revenues of about INR 500 crores, and have generated thousands of jobs.

Activities

SINE has, so far, preferred to not tinker much with the traditional method of incubation. High-potential ventures are invited and given the freedom to operate as they see fit while the incubator helps by providing support services and access to auxiliary services such as marketing, accounting, legal help etc. Having been housed in one of the premium technology institutions, SINE has put a lot of stress on product innovation and IP generation. Since, it is located in the commercial capital of the country and as such, ventures have access to VC money and mentoring, the private sector mostly took care of acceleration for IT startups. Recently, noticing a market gap, SINE has launched accelerators for hardware startups and social ventures in corporate partnerships. The next section describes the major activities and how they have changed over time.

Life as IT incubator

The genesis of SINE is in the IT incubator founded in the IT school. The IT incubator was run as a pilot project for 4-5 years. This was a learning opportunity for the IITB administration and they were able to build knowhow through this experience. For the

Image 1- SINE building (Source- SINE website)

duration of the pilot, the incubator was focused solely on IT, an area where fledgling startups were showing promise and a modicum of private funding was already available. During this time most of the companies were services companie swhich had their markets abroad in developed countries.

Evolution of accommodation options for incubatees

In its first life as an IT incubator, the entrepreneurship ecosystem in India was still quite immature. Since the companies were at an early stage and capital was hard to come by, the first 2 years of incubation were completely free and for the 3rd year SINE charged 3% equity.

However, around the time the first batch of companies were graduating, the dotcom bubble burst and it was hard to achieve any kind of financial sustainability through equity idealization or revenue from these ventures. Thus, when SINE was setup formally in 2004, the management introduced a rent company (highly subsided around one-fourth of the market value) for the first 18 months. For the next 18 months, the rent progressively became higher. The SINE management could do so as the ecosystem had somewhat matured and the startups were able to get funded. Thus, the economic model evolved.

After 2004, SINE started a mixed model with both rental and equity components. But SINE soon realized companies were hesitant about parting with equity. So, an option for revenue sharing was introduced. SINE now allows a varied mix of rent, equity and revenue share.

Governance

SINE is registered under the Societies Registration Act, 1860 and is run as a not-for-profit independent organization hosted by IITB. The 16 member SINE board, chaired by the Director, IIT-Bombay, has an equal representation of internal members (IITB faculty and director) and external members, including industry titans, alumni, venture capital firms, and entrepreneurs. A 'professor-in-charge', who also sits on the board of SINE, acts as the coordinator and ensures synergy between IITB and SINE.

Mentoring

SINE has a mentor pool and all incubated companies are required to have one mentor on board. Since most SINE companies and founders tend to be technology oriented, the mentor has to be one with a substantial understanding of the business side and the incubatees are expected to interact with them quite frequently for business advice. This is primarily the reason why, entrepreneurs are often invited to give talks about their experiences and learnings but there are no formal events to encourage one to one interactions.

Selection mechanism

Incubatees tend to be selected on the basis of whether they have a strong technology component. The applications undergo both an internal due diligence and an external review by domain experts, seasoned entrepreneurs and industry experts. SINE used to automatically exclude IT services companies until recently, requiring applicants to be product oriented companies. This stipulation was relaxed as the past few years have witnessed the rise of a few alumni-lead services companies which have become really massive. However, SINE is increasingly focusing on physical products based startups, and would eventually want to build sector specific strength in the areas of electronics hardware products, medtech (medical technology) startups and cleantech (clean technology) sector.

There is two step review process. In the first step companies are reviewed internally at SINE to check their suitability as a tenant consistent with the values of SINE. At this stage, SINE works with the applicants to finesse their business plan and much iteration is

done. For the external review, SINE reaches out to domain experts (industry professionals, entrepreneurs or investors) to evaluate technology as well as the business model.

Funding

In the beginning SINE primarily used DST grants to fund incubatees. This included an initial incubator grant of INR 2 crores (of which INR 1 crore was used). Currently, SINE funds incubatees through a DeitY, DST and TDB programs to dispense seed money. SINE also funds startups up to a maximum of INR 20-25 lakhs per grant. However, funding has been relatively less of a focus area. This has been due to SINE's location within the financial hub of the country and its proximity to the emerging startup cluster in Powai. As such venture capital money is well developed and accessible to startups at SINE. The SINE management claims that more than 40% companies are funded by angels, venture capital firms, and financial institutions, and are also revenue-generating.

Since, the Indian company's act has restrictions on taking loanfrom existing stake-holders; SINE tends to follow a single model of funding i.e., loan or equity. When SINE takes equity it liquidates its own stake in the very first funding round to minimize risks (sometimes losing out on much larger potential payouts downstream).

SINE also has a well-developed write-off mechanism which helps free failed startups (and entrepreneurs) to start over if they fail and not be weighed down by their debts forever.

The Way Forward

The SINE management wants to increase capacity and the number of activities at SINE without making any drastic changes to the model. There are plans to increase incubation capacity to 50-60 companies. A bigger infrastructure of 60000 sq. ft. is coming up in next 2-3 years with enhanced support such as lab facilities and end to end programs starting from proof of concept grant, fellowship for entrepreneurship, traditional incubation, accelerators and seed support.

SINE aims to widen the pipeline through pre-incubation by targeting the student body and helping test and validate their ideas.

APPENDIX E-6
Startup Village (SV), Kochi

Startup Village (SV), Kochi

Background

It was the year 2005, when Sanjay Vijaykumar first got access to Broadband internet in his third year of college. It was a revelation for the 20-year-old, who was decisively bitten by the startup bug. To him broadband internet was akin to an information highway enabling access to world class information and technology. But the offline reality was somewhat more sobering. He was living in Kerala- a state notorious for its adverse business climate (despite having, somewhat paradoxically, the highest literacy rate in India). At that time Technopark Trivandrum was the one bright star in common imagination and a shining example of how businesses could come to Kerala and succeed. Sanjay Vijaykumar, Sony Joy and Vivek Steve Francis, approached Technopark with their startup, MobME, while they were still in college. MobME (known as Torque at that time), was the first startup to be incubated in the Department of Science and Technology (DST) Technology Business Incubator (TBI) at Technopark and helped the new incubator evolve their systems and processes as the two nascent organizations grew up alongside each other.

By 2009 Technopark had reached 100 incubatees and was struggling to scale further. It was at this point that the idea of a PPP model was floated and MobME submitted an application for the establishment of Startup Village Kochi.

Objectives/ motivation

To understand Startup Village, we must understand the early days of MobME. Having decided he wanted to startup, Sanjay Vijaykumar and his co-founders approached Technopark Trivandrum to enquire about the procedure for a startup to be housed at Technopark. Originally set up as an IT park, Techno-

parkdid not have incubation facilities initially. Incidentally, the Department of Science and Technology (DST, Government of India) was promoting the TBI program at that time and Technopark applied to be an incubator. The procedure took a year in all. By that time, MobME had already managed funding for INR 80 lakhs from High Net-worth Individuals (HNI). MobME (known as Torque at that time) was incubated at Technopark and became the first incubatee. Due to their unique position as the first startup at Technopark, MobME was made a part of the board and their experience helped Technopark formulate policies for subsequent incubatees.

By 2009, MobME had raised half a million US dollars and was employing more than 100 people. Having demonstrated a reasonable amount of staying power and sustainability, MobME attracted a lot of press and was widely hailed as a success within Kerala. The fact that MobME owed a lot to others was not lost on the young MobME team. MobME had received support from DST schemes such as TePP 1, TePP 2, TDB, DST incubation, DST seed money scheme. Sanjay Vijaykumar had also been in touch with Kris Gopalakrishnan (one of the founders of Infosys) since MobME's early days as a startup. The MobME team wanted to give back to the community and when Dr. Harkesh Mittal (NSTEDB, DST, GoI) floated the idea of a PPP, they jumped at the opportunity. The proposal took two years to get approval and became the first incubator to be initiated as a PPP with a private company (MobME, in this case). Kris Gopalakrishnan took on the role of Chief Mentor, providing credibility to the venture. Housed on the land provided by Kerala government, Startup Village was able to raise money from HNIs MobME which helped them match the DST requirement for equal money to be raised from other sources.

Activities

Instead of just looking at the incubator as an isolated entity, Startup Village looks at their mission as being a systemic one. This was also necessitated by the reality of starting an incubator in Kochi (with a relatively nascent startup environment). So, SV aims to develop the entire ecosystem and carries out their activities along 5 major directions-

1) Incubator
2) Infrastructure
3) Policies
4) Seed funding
5) Create innovation pipeline

Incubator

The incubation activities have been mostly focused on the IT sector during the initial phases of the incubator. This has helped keep infrastructure costs low. The incubator does not charge rent or equity from the incubatees, making it an attractive proposition for most founders looking to start up.

This, among other things, helped the incubator achieve stunning success in attracting incubatees. In the very first year Startup Village got 1000 applications even though they had only planned to house 48 startups in all. In the three years of its existence Startup Village received over 6,000 applications and incubated more than 70 physical and 500 virtual startups in just over three years.

Startup Village has a slightly unconventional take on incubation- rather than trying to select a few winners and concentrating resources to help them succeed and become big companies, it seems to be focused more on spreading startup culture and making entrepreneurship as a viable career choice after college (even if it does not necessarily lead to the creation of massive enterprises in the short term). This is reflected in their startup manual (available to would-be entrepreneurs on their website) which lists 6 ways for graduating from the incubator (See Box A- Graduating Startup Village). Most of these ways require access to networks and linkages with ecosystems such Bengaluru, Silicon Valley, so on and so forth. SV has worked quite hard to build these

linkages and a representative example is that of SV Square. In SV Square promising startup founders are sent to Silicon Valley for a week to gain exposure and inspiration.

run out. The recent legislation by central government to make incubators eligible to receive CSR-funding is being seen as a potential source of funding by SV as also consultancy fees by guiding other

BOX A- Graduating Startup Village

Get funded- your startup gets funded through a venture capital firm or an angel investor. Get into a Startup Accelerator- Your team is selected into a recognized Startup Accelerator. Get Acqui-Hired- Your founding team is hired on by another company that values your skills. Become Self Sustainable- Your revenue and cash-flows stabilize and then grow, allowing you to scale up. Get a job- You get hired at a great company because of the skills that you acquired while building your startup. Go for Higher Education- You decide to build upon the skills you acquired by getting a formal degree

Source- Startup Village website (www.sv.co)

Event management

Startup Village conducts more than 100 events in a year. This is especially useful as this helps bring together the virtual incubatees who can use these events to gain vital knowhow and create valuable links and networks. The events also help SV generate publicity and spread the word about its activities.

Financing

The incubator currently pays its bills through the long term grants. Startup Village is focused on growing quickly and is not trying to optimize for financial sustainability. As of interview, the operational expenditure was double of capital expenditure. SV pays its top executives well and the pay is supplemented by industry (around 33% comes from industry in the case of CEO).

The initial funding for SV came mostly from grants with a long horizon. The DST provided INR 1.2 crores (95.35 lakhs for Capital expenditure and 24.65 lakhs for operational expenditure). Kerala Industrial Infrastructure Development Corporation (KINFRA) provided infrastructure subsidy (valued at INR 75.25 lakhs) and the private sector contributed the rest of 2.5 crores required to be raised to match DST grant.

But SV is trying to transition its model to make sure the incubator is sustainable by the time the grants

incubators being set up by enthusiastic state governments everywhere.

Infrastructure

The incubator is primarily aimed at IT startups. As such the physical infrastructure needs are quite basic. The incubator is situated at the KINFRA Hi-Tech Park, Kalamasserry, a little far from the city center. The incubator was one of the earliest places in India to get gigabit speed internet (downloads over 1 Gbps) and generated considerable media buzz.

Image1 - Startup village incubator building in Kalamassery (Source- http://kinfra.org/departments/kinfra-hitec-park-kalamassery-2)

In the coming future, SV is setting up a new electronics accelerator with funding from Ministry of Electronics and Information Technology (erstwhile Department of Electronics and Information Technology, DeitY) at a cost of INR 50 crores. SV has also set up a makerspace in collaboration with MIT Fab Lab as technology and knowledge partner, in Kochi and another one is said to be coming up in Thiruvananthapuram.

Public policy

SV has been built with the Kerala government support. As such the Kerala government has been a key stakeholder in SV's success. In return, Startup Village has worked closely with the Kerala government on a variety of issues relating to innovation and entrepreneurship in the state. SV worked closely with the government in helping them draft the Kerala Innovation Policy which was one of the first instances of a state coming out with their innovation policy. The Kerala innovation policy stipulates, among other things, that the government must spend 1% of its budget on innovation and related initiatives. Spurred in part by SV, the Kerala Technology University (KTU) has initiated a grace marks system for those students who take up entrepreneurship during college.

SV has also been working with Telangana govt. and Gujarat Technical University for enhancing the innovation ecosystem in Gujarat and Telangana. SV is also involved in helping shape the RBI guidelines for crowdfunding of startups with equity. SV is also working with the Seemandhra government and managing the Sunrise Startup Village in Visakhapatnam.

Seed funding

So far, Startup Village has mostly dispensed grants from other sources but according to the chairman Mr. Sanjay Vijaykumar, SV is now trying to start a INR 100 crore fund.

Pipeline

Since its trying to kick-start an innovation ecosystem where none existed before, SV has had to reach quite deep and upstream to build a pipeline. This has involved efforts at school level, the undergraduate level and beyond. As part of this, SV in partnership with the Kerala government, circulated 7500 Raspberry pi kits (a simple but powerful platform to build electronic and IT applications) to 8th standard students and aims to circulate 10000 every 6 months. SV square is another effort to engage with promising youngsters by sending them to Silicon Valley (California, United States) and give them exposure to entrepreneurship.

According to Mr. Sanjay Vijaykumar, the entrepreneurs who come to SV are often quite inexperienced and after being incubated they spend the initial time getting basic entrepreneurial education and skills. Then they undergo, on average, around 4 different interactions of the idea-execution cycle. That is, they get an idea, build a prototype, get their first customers and then refine their initial idea based on feedback. After undergoing this cycle 4 times, they often hit a product market fit and then, they must find efficient way of getting customers (beyond early adopters) and scale. SV wants to enable entrepreneurs to startup during college, so that they can pursue entrepreneurship without being forced by their parents to chase stability (by working in big companies).

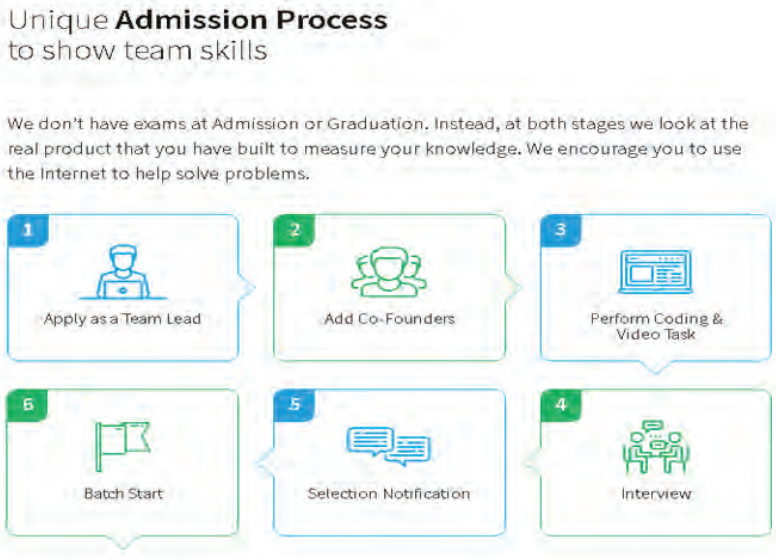
Future

In its mid-term report (the SV 1000 Days Impact Report), complied 2 years 10 months into its existence, Startup Village claims to have 533 active startups (shooting past the initial target of 48). Of the 6492 applications, 960 ideas were incubated. 58 were housed physically at Startup Village Kochi. 902 of these were virtually incubated and 477 are still active[21]). 205 have been legally incorporated and 231 have received funding (26% raising funding

[21]Source- SV 1000 Days Impact Report, https://goo.gl/d3fAO4

from sources other than friends and family, totaling upto INR 27 crores).

Startup village is now embarking on a new phase of expansion and has "pivoted" (changed course in startup jargon) to providing online entrepreneurship education. In association with universities, industry and governments, SV is trying to make entrepreneurship a viable career option by providing knowhow and linkages to would-be entrepreneurs. The #StartInCollege Initiative consists of an online digital platform called SV.CO that provides online learning courses on creating new startups. The 180 day program costs 37,500 per founder (fully refundable if the founder opts out in the first 60 days). There are also 20 graduation partners consisting of late stage startups (such as Ola, Freechare etc.) and firms looking for investment opportunities such as Microsoft ventures, Kalari Capital, Indian Angel networks etc[22]. The first batch is likely to start on 2nd January and its success or failure will have a major impact on SV's future[23].



[22]https://www.sv.co/

[23]SV's digital entrepreneurship initiative, SV.CO, was announced after the interviews for the case study had been completed. As such, this section is based mostly on secondary sources.