

How Distinct are Technology-Based Start-Ups in India? Features, Policies and Evolving Ecosystems

M H Bala Subrahmanya*

Abstract Tech start-ups and their ecosystems are gaining increasing prominence globally and so are in India, due to their potential to contribute to employment generation, innovations, productivity, national income and exports. Against this backdrop, this article analyzes the key characteristics of tech start-ups relative to traditional start-ups and modern start-ups in India. Further, the salient features of tech start-up promotion policies initiated by the government of India and government of Karnataka as well as the current regional and sectoral distribution of start-ups is elucidated. Subsequently, the structure and components of entrepreneurial ecosystems currently under evolution in the metro cities of India are examined. Finally, the key factors contributing to the growth of different ecosystem components and its implications for the future growth of tech start-ups are outlined.

Keywords Start-ups, technology, ecosystems, entrepreneurship, policy, structure, India

I. Introduction

A technology based start-up (tech start-up) revolution is underway in the global economy. The world's most dynamic areas are increasingly focusing on promoting a pro start-up environment to create "ecosystems" that facilitate the nurturing of "new ventures" (Manzella, 2015). Tech start-ups tend to improve their chances of survival and success when inserted into an entrepreneurial ecosystem that encourages business development and innovation (Arruda, et al, 2015). Accordingly, fast emerging tech start-ups and their ecosystems are assuming increasing attention from policy makers and empirical researchers alike, the world over. Tech start-ups have a high potential for employment contribution, innovation generation and export promotion, and a well-developed ecosystem is considered a pre-requisite for an accelerated growth of tech start-ups (Bala Subrahmanya, 2017b).

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* Department of Management Studies, Indian Institute of Science, Bangalore-560012; bala@mgmt.iisc.ernet.in

In the global start-up landscape, India as an emerging economy is considered unique for the following reasons:

- It is recognized as one of the potential sources of tech start-ups in the global economy (Gai and Joffe, 2013),
- It is currently ranked third among the global start-up ecosystems in the world, both in terms of start-up emergence and start-up exits, with nearly five billion dollars of funding in the year 2015, and it has three to four startups being born every day (TOI, 2015; NASSCOM, 2015).
- It has about 10,000 start-ups currently, of which about 4300 are considered to be tech start-ups. The number of tech start-ups is expected to increase to about 11,500 by 2020 (Grant Thornton, 2016).

Tech start-ups and unique ecosystems for their promotion have been spontaneously emerging, despite the absence of explicit policy support till recently, across Indian economy. Against this backdrop, this article attempts to ascertain the distinctive features of tech start-ups relative to non-tech start-ups of various kinds, key features of emerging policy support, sectoral and regional distribution of start-ups, the characteristics of prevailing entrepreneurial ecosystems, and its role in tech start-up promotion for employment generation and economic growth. Finally, it ascertains the key factors that are contributing to the strengthening of ecosystem components and thereby brighten the prospects for the emergence and growth of tech start-ups in India in the future.

II. Start-ups, Tech Start-ups and Ecosystems: Definition

Start-ups are new ventures which have no precedence or previous history of operations. They are started on a small scale with limited resources, relative to medium and large scale enterprises. With no reliable base of support to begin with, access to finance, market, and human resources poses a formidable challenge to such new ventures (Bala Subrahmanya, 2015). Start-ups are new ventures which are not more than one-year old (Kane, 2010). Business researchers have defined the age of start-ups to be in the range of one to eight years, in different contexts. It is important to note that start-ups do not include enterprises that are taken over by new management or inherited by younger generations from the older ones, and they do not include “spin-offs” where a large enterprise has a control, directly or remotely (Bala Subrahmanya, 2015).

Tech start-ups represent a recent phenomenon within the sphere of start-ups, emerging rapidly all across the globe, including emerging economies like India. They are, obviously technology-based or a means as well as an outcome of

technological innovation, prompted by technology entrepreneurship, spearheaded by science/engineering degree qualified/knowledge based founders. A tech start-up is typically a newly-emerged, fast-growing business that aims to meet a market need by developing or offering an innovative product, process or service.

The Government of Karnataka (Department of IT, BT and S&T, 2015) defined a technology based start-up as one that creates a technology-based service or product or uses technology for enhancing functionality or reach of an existing product or service. It must have been registered/incorporated for not more than four years (for IT start-ups) and not more than seven years (for BT start-ups) from the date of an application for any incentive applied under the policy. At least, 50% of its workforce (excluding contract employees) must be located within the state of Karnataka. A start-up will cease to receive any benefit under the policy once its revenue reaches Rs.500 million (about US\$7.5 million). These start-ups must not be a subsidiary or a franchisee or directly or indirectly promoted by a large firm, or derive more than 50% of its income from investments and loans.

According to the Government of India (Department of Industrial Policy and Promotion, 2016), a start-up means an entity, incorporated or registered in India not prior to five years, with an annual turnover not exceeding Rs.250 million (about US\$3.75 million) in any preceding financial year, working towards innovation, development, deployment or commercialization of new products, processes or services driven by technology or intellectual property, provided such an entity:

- Is not formed by splitting up, or reconstruction, of a business already in existence.
- Shall cease to be a startup if its turnover for the previous financial years has exceeded Rs.250 million or it has completed 5 years from the date of incorporation/ registration.

We would confine our definition of technology start-ups to Government of India definition.

Based on a synthesis of definitions found in the literature, Mason and Brown (2013) define an entrepreneurial ecosystem as ‘a set of interconnected entrepreneurial actors (both potential and existing), entrepreneurial organizations (e.g. firms, venture capitalists, business angels, banks), institutions (universities, public sector agencies, financial bodies) and entrepreneurial processes (e.g. business birth rate, numbers of high growth firms, levels of ‘blockbuster entrepreneurship’, number of serial entrepreneurs, degree of sell out mentality within firms and levels of entrepreneurial ambition)

which formally and informally coalesce to connect, mediate and govern the performance within the local entrepreneurial environment?

Overall, different empirical studies have indicated more or less the same ingredients or components for the ecosystem for high-tech start-ups: (i) entrepreneurs and sources of entrepreneurship, (ii) investors or financiers, comprising angel investors (AIs)/private equities (PEs)/venture capital funds (VCFs), (iii) government driven polices and institutions, (iv) private support agencies in the form of business incubators and/or accelerators, apart from mentors, (v) educational & research institutions, (vi) large domestic/foreign companies, which can provide direct or indirect support to new ventures, (vii) service providers of various kinds, and (viii) cultural aspects. Accordingly, we define ecosystem for start-ups to broadly comprise these eight components.

III. Start-Ups: Why Do They Emerge? How?

The concept of “start-up” has been coined recently, but “start-ups” are not new to the Indian economy, as much as to the global economy (Bala Subrahmanya 2015). Historically, start-ups have emerged for a variety of reasons/objectives. Broadly, they can be classified under five heads:

- (i) As a means of livelihood or as a source of employment: Unemployed youths who repeatedly fail to get a satisfactory job or who are forced out of their jobs mid-way (particularly in periods of economic recession) may be compelled to start their own new ventures.
- (ii) Policy support/inducements: A ready availability of concessional finance and assured market, apart from infrastructural support from national/regional governments might prompt some to initiate their own start-ups.
- (iii) Needs and requirements of large firms: Industrial enterprises, particularly in manufacturing industries which involve assembling of parts and components, would always look for cost reduction and quality improvement. This provides ample scope for innovation-induced start-ups to introduce newer/substitutable parts/components or other intermediate products on a continuous basis.
- (iv) Understanding the wider market opportunities: In a rapidly changing global economy characterized by the ever growing application of information and communication technologies, the scope for the creation and adoption of new technologies through new ventures is becoming virtually infinite.
- (v) Innovative ideas based on knowledge acquired and experience gained, over a period of time: Technically or techno-managerially qualified MNC

executives who acquire “adequate” knowledge and experience as well as financial capability and social networking, over a period of time, join the “entrepreneurial stream” to initiate tech start-ups. Even “would-be graduates” from technology universities or management schools who have “zeal and motivation” to give shape to their innovative ideas, become tech start-up entrepreneurs.

However, these objectives might overlap in most cases, and therefore, they cannot be treated as watertight compartments. Given this backdrop, a start-up may emerge as an individual proprietorship or partnership or as a private limited company or even as a cooperative enterprise (Stokes, 1995). Therefore, start-ups can emerge in all forms and sizes. Strictly speaking in a developing or an emerging economy like India, start-ups can emerge in three different sectors, namely, (i) traditional industries and services, (ii) modern industries and services, and (iii) technology/knowledge intensive industries and services.

In traditional industries and services, start-ups may emerge as an individual proprietorship or as a partnership firm (in the form of a household enterprise or an unregistered workshop) or as a cooperative enterprise. Traditional start-ups generally emerge in age-old ancestral and time-tested professions, making use of obsolete technologies. Hardly educated or less-educated ones from poor-income households, who barely succeed to obtain “employment in the organized sector”, initiate traditional start-ups, as a means of subsistence. Their source of finance is mostly self-finance, and occasionally from friends and relatives.

There are five government bodies created exclusively to promote traditional industries & services including start-ups, namely, (i) Coir Board, (ii) Handloom Board, (iii) Handicrafts Board, (iv) Khadi and Village Industries Board (KVIB), and (v) Sericulture Board (Bala Subrahmanya, 1995). But, entrepreneurs of traditional start-ups are often guided by their elders in the family and hardly access or able to access government support as they are largely based in rural interior hinterlands. They primarily make use of local skills and local resources to meet local market needs (Bala Subrahmanya, 1993). As a result, they would hardly experience any growth either in employment or in revenue and cash flow. This is primarily “livelihood-induced entrepreneurship”.

In modern manufacturing industries and services, a start-up might emerge as an individual proprietorship or as a partnership firm (in the form of a micro- or a small-scale enterprise) or as a private limited company (in the form of a small-scale or a medium-scale enterprise). It is observed that entrepreneurship might emerge from a cross-section of societies from diverse income groups with qualifications varying from as low as hardly educated to as high as

doctorate holders in management or technology (Bala Subrahmanya, et al, 2002).

A modern start-up might emerge as a means of livelihood, or due to policy incentives and concessions, or in response to large enterprise needs, or by recognizing unique market needs or even due to innovative ideas. However, a modern start-up would invariably avail government policy support varying from mere information, to institutional (bank) finance, subsidy, public sector procurement, technology information and inputs, price preference, subcontracting assistance, raw material imports, procurement of machinery on lease, subsidized infrastructural inputs, industrial sheds, technology upgrades, participation in international exhibitions or even manufacturing of products reserved exclusively for SSI manufacturing (Bala Subrahmanya, 2015). Therefore, this may be broadly called “policy-sponsored entrepreneurship”. Such start-ups intend to expand steadily in terms of employment, investment and turnover, over a period of time.

In technology/knowledge intensive industries and services, tech start-ups generally emerge as private limited companies (registered with the Registrar of Companies, Government of India). The application of ICTs in some form or the other, based on technological knowledge or innovation outcome of the founder/s is the key characteristic of such start-ups. There exists neither a pre-defined human talent nor a reliable financial source nor a well-defined market. Therefore, some of the critical tasks are to build a co-founder team to secure key skills, know-how, financial resources, and other elements to conduct research on the target market. Accordingly, they suffer from the liability of newness in the initial stages for procuring inputs as well as market identification, resulting in losses, but if successful will have exponential growth subsequently (Aulet, 2013).

Typically, a tech start-up will begin by building a first minimum viable product (MVP), a prototype, to validate, assess and develop the new ideas or business concepts. In addition, tech start-up founders do research to deepen their understanding of the ideas, technologies or business concepts and their commercial potential. Invariably, the founders are technical or techno-managerial graduates/post-graduates or doctorates, emerging directly from Technology Universities or Management Schools (within India or from abroad) or with work experience from large firms, mostly MNCs, located globally. It is observed that non-graduates are largely non-existent and non-technical graduates are exceptions (Krishna and Bala Subrahmanya 2014; iSPIRT 2014). Therefore, this is predominantly “technology / knowledge - based entrepreneurship”.

The nature and forms of emergence of start-ups in three different sectors of Indian economy is depicted in Figure 1. The distinctive features of (i) traditional start-ups led by livelihood induced entrepreneurship, (ii) modern

start-ups led by policy sponsored entrepreneurship and (iii) tech start-ups led by technology/knowledge based entrepreneurship are briefly presented in Table 1. The probable revenue, cash flow, and jobs over time for the three kinds of start-ups are given in Figure 2. Given the distinctive features of tech start-ups, it is appropriate to ascertain the nature of policy support extended to them.

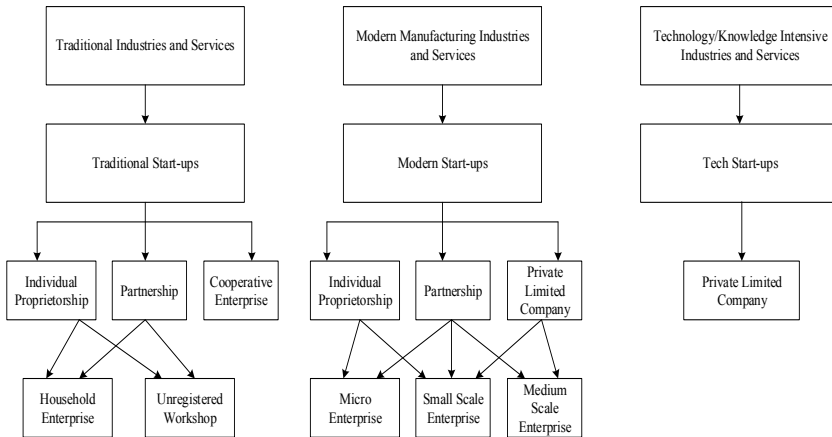
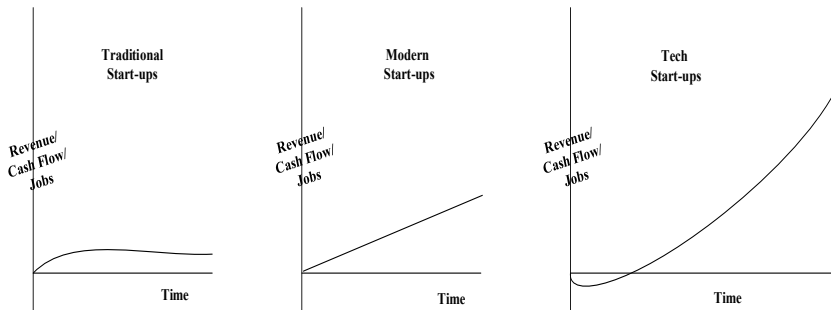


Figure 1 Possible routes for start-up emergence in India



Sources: Anderson (1982); Bala Subrahmanya (1993); Aulet (2013)

Figure 2 Revenue, cash flow and jobs overtime of start-ups

Table 1 Distinctive features of tech start-ups

Dimensions	Traditional Industries Entrepreneurship	Modern Industries Entrepreneurship	Tech / Knowledge Industries Entrepreneurship
Entrepreneurship - origin	Poor income households	Households of diverse - low, middle and high - income groups	Diverse sources, mostly from middle and higher income groups
Entrepreneurial Education	Hardly educated	Less educated to professionally qualified	Professionally qualified with techno-managerial degrees
Sources of Finance	Family / Friends	Bank Finance	Seed funds/ Angels/ Venture Capital
Market	Local	Local/National/ Global	Local / National / Global
Human Resources	Family or Household based – often single labour based	Local/Regional	Local or Immigrated
Support System	Coir board, Handloom board, Handicrafts board, Khadi & Village Industries board, and Sericulture board	SME promotion Agencies and Infrastructure (Industrial Estates, MSMEDIs, etc.)	TBIs of Institutions, Accelerators of MNCs, Co-working spaces of private individuals or companies
Mentorship	Family/Elders	Consultants or Friends/Relatives	Professional (Business/Technology) Mentors
Geographical spread	Mostly rural based	Rural areas, Towns & Cities	Mostly Metro city concentrated

Sources: Bala Subrahmanya (1993); Bala Subrahmanya, et al (2002); Bala Subrahmanya (2017a)

IV. Government Policy for Tech Start-Ups: Key Features

Start-ups as a whole have attracted the attention of policy makers in India only recently. The first ever policy document that made explicit reference to start-ups and proposed policy support was the recommendations of the Inter-Ministerial Committee for Accelerating Manufacturing in Micro, Small and Medium Enterprises Sector in 2013. The initiative emerged in response to the World Bank’s 2013 report on ‘Ease of Doing Business’ that emphasized on the need to ease regulations for start-ups in India (Ministry of MSMEs, 2013).

First and foremost, the Inter-Ministerial Committee (Ministry of MSMEs, 2013) proposed several measures to strengthen financial support for start-ups in the form of:

- Angel investors (who also provide mentoring and network access to entrepreneurs),
- Removal of policy and fiscal impediments for enhancing the flow of angel and early venture capital funding for start-ups,
- Creation of India Opportunities Venture Fund by Small Industries Development Bank of India (SIDBI) with a corpus of Rs.50 billion,
- Proposal for creating an India Inclusive Innovation Fund (with a corpus of Rs.55 billion),
- Framework for public funding of Early Stage Venture Capital, among others.

In addition to the above, the Inter-Ministerial Committee proposed the following:

- (i) Promotion of Open Hub Systems to bring all the ecosystem stakeholders under one single umbrella, by defining their responsibilities, privacy issues and future benefits for them,
- (ii) Increasing the number of incubators considerably through local, state and central governments in partnership with relevant public institutions as well as the private sector,
- (iii) Funding of incubators by the private sector through Corporate Social Responsibility (CSR) budget,
- (iv) Promotion of Technology Business Incubators (TBIs) through IITs, NITs and private engineering institutions,
- (v) Tax exemption for start-ups in the initial three years, and
- (vi) Encouraging credit flow to start-ups through employment generation schemes.

Subsequently, the Government of India launched an exclusive Start-up India Action Plan in January 2016 (Department of Industrial Policy and Promotion, 2016). The new start-up policy primarily focused on (i) regulatory issues, (ii) funding support and incentives, (iii) promotion of industry-academia partnerships and (iv) incubation centres.

Under regulatory issues, the policy insisted on valuing self-certification by start-ups for ensuring their compliance with various laws, promotion of start-up India hub to ensure the various key components for start-ups under a single umbrella, simplification of registration of start-ups, legal and intellectual property examination support at a low cost, relaxation of “prior experience” and “prior turnover” rule for start-ups to enable them to avail public procurement schemes (meant for SMEs) of central government, state governments and public sector undertakings, and swift and simple exit process

for winding up unsuccessful start-ups. Thus the policy underlined the significance of supporting not only birth of start-ups but also exit of unviable ones, as quickly as possible.

To provide financial support, a fund of funds with a corpus of Rs.100 billion has been proposed. In addition, a credit guarantee fund for start-ups is proposed to facilitate the flow of venture debt from the banking system. Tax exemption for capital gains is proposed, if investments are made in the Fund of funds recognized by the government, apart from tax exemption for start-ups in the initial three years. Further, to encourage seed investments in start-ups, tax exemption is proposed for investments in the form of shares whose value is above the Fair Market Value (which would in normal circumstances attract tax as per the Indian Income Tax Act).

To promote industry-academia partnerships for encouraging start-ups, the policy proposed Innovation Centres at Institutes of national importance; seven Research Parks (on the line of IIT Madras) at IIT Guwahati, IIT Hyderabad, IIT Kanpur, IIT Kharagpur, IISc Bangalore, IIT Gandhinagar and IIT Delhi; and launching of innovation focused programs for science and technology students. To promote incubation of start-ups, the policy proposed setting up of incubation centres in public-private partnership mode, bio-clusters and bio-incubators, and an annual “incubator grand challenge” to promote world-class incubators in India.

Overall, India’s recognition of the growing importance of start-ups is of recent origin and its policy for start-up promotion is at its infancy. However, many State governments have either preceded or followed the footsteps of Government of India in extending policy support either exclusively or as part of their information technology and biotechnology industrial policies. Among the states, Government of Karnataka was one of the earliest to launch an exclusive policy for start-ups in 2015 (Department of IT, BT and S&T, 2015).

The vision of Karnataka Start-up Policy (2015-2020) is to create a world-class start-up ecosystem in the state through strategic investments and policy interventions leveraging the robust innovation climate prevailing in Bangalore. This is proposed through multiple means. The important ones are: (i) encouraging entrepreneurship in education through implementing new age incubation scheme not only in engineering institutions but also in all professional and post-graduate institutions in tier II cities in the state, (ii) fostering strong partnerships between R&D institutions and industry by setting up TBIs in institutions of higher learning, (iii) providing early stage, i.e., idea to proof of concept funding, (iv) creating incubation infrastructure through public-private partnership mode, and networking and aggregation of common instrumentation facilities, (v) start-up funding through fund of funds, (vi) incentives and concessions, (vii) facilitating start-up emergence through setting-up of a start-up cell, start-up portal and hotline, a start-up council, apart

from publicizing operational guidelines, which will be reviewed annually (Department of IT, BT and S&T, 2015).

Given that policy support has started emerging only recently, it is unlikely to have made any impact on the entrepreneurial ecosystem or the growth of start-ups in India yet. Further, the ecosystem concept for start-ups has not yet gained adequate recognition of the policy makers, either at the national level or at the regional level. The four major areas which have been getting increased attention are: (i) funding, (ii) industry-institute interactions, (iii) regime of regulations and incentives, and (iv) promotion of incubation centres through academia and/or public-private partnership mode.

However, almost all the ecosystem components have emerged in different cities in India (which are also clusters of modern manufacturing industries, hubs of educational and research institutions, and regional governments), prior to the introduction of start-up policies in the country (Bala Subrahmanya, 2015). Further, it is the rapid spring-up of tech start-ups in different cities of the country for more than a decade now, which has prompted the national and regional level policy makers to introduce and lend policy support to start-ups in different forms, gradually and steadily. Therefore, it is appropriate to understand the profile and distribution of start-ups in India between different sectors as well as between different start-up hubs.

V. Profile of Start-Ups in India

There is no systematic database of start-ups available in India yet. However, national level industry promoted associations such as Associated Chambers of Commerce and Industry (Assocham), and National Association of Software and Service Companies (NASSCOM) have recently come out with exclusive reports on Start-ups and Start-up ecosystems, which present an approximate picture of start-ups operating in different sectors and regions of the country. Broadly, start-ups in India are heterogeneous ranging from highly visible high-tech ICT start-ups in Bangalore and Mumbai, to non-tech start-ups and social start-ups across both urban and rural areas (CII, 2015).

One of the earliest reports on Start-ups emerged from NASSCOM in 2014. According to NASSCOM (2014) estimates, India was the fourth largest start-up location globally with more than 3,100 technology start-ups operating in the country, with an addition of more than 800 start-ups in 2014 alone. The focus areas of these start-ups comprised primarily B2C (59%), followed by B2B (37%) and B2C/B2B (4%). The start-up founders' profile indicated that 73% of the founders were less than 36 years of age, 48% had MNC work experience, and 36% were solely engineers. It is interesting to note that 43% of

the product/digital start-ups had a focus on the global market. However, the key drivers were (i) large domestic market, (ii) evolving ecosystem comprising investors and mentors, (iii) increasing exit opportunities for investors in the form of Mergers & Acquisitions (M&A), among others. Geographically, 28% of the start-ups were concentrated in Delhi-NCR and Bangalore.

A year later, according to NASSCOM (2015), India emerged as the third largest start-up location globally with more than 4,200 technology start-ups operating in the country. The start-up verticals comprised Internet of Things (IOT), Analytics, Health-tech and Hyperlocal E-Commerce. Bangalore, National Capital Region (NCR), Delhi and Mumbai together accounted for nearly 65% of the total Indian start-ups. Hyderabad, Chennai, Pune, Jaipur and Ahmedabad are identified as the major up-coming start-up locations. B2C start-ups followed by B2B start-ups accounted for the majority. Successful start-ups, growing ecosystem of investors and mentors, technology driven large domestic market, encouraging entrepreneurial environment were the prime driving factors. About 72% of the founders were less than 35 years of age, and about 39% of the founders were engineering graduates/post-graduates.

A more recent report on Start-ups in India, by ASSOCHAM (Grant Thornton, 2016) reveals that there are currently about 10,000 start-ups operating in the country, of which 4,300 are technology based start-ups whereas the remaining 5700 are non-tech start-ups. The sector-wise compositions of tech start-ups and non-tech start-ups are given in Table 2. While tech start-ups comprise E-Commerce, B2B, Internet, Mobile apps, SaaS and others, non-tech start-ups consist of engineering, construction, agricultural products, textile, printing & packaging, transport & logistics, outsourcing & support, and others.

Table 2 Sector-wise composition of tech and non-tech start-ups in India - 2016

Technology based Start-ups (No. = 4300)		Non-Technology based Start-ups (No. = 5700)	
Sector	Share (%)	Sector	Share (%)
E-Commerce	33.00	Engineering	17.00
B2B	24.00	Construction	13.00
Internet	12.00	Agriculture products	11.00
Mobile Apps	10.00	Textile	8.00
SaaS	8.00	Printing & packaging	8.00
Others	13.00	Transport & logistics	6.00
Total	100.00	Outsourcing & support	5.00
		Others	32.00
		Total	100.00

Source: Grant thornton (2016)

Assocham report (Grant Thornton, 2016) also noted the gradual improvements that have taken place in the ecosystem parameters such as

increase in the number of incubators as well as funders, i.e., venture capitalists (VCs) and private equities (PEs). Further, there has been a steady increase in the number of annual tech start-up emergence, majority being from entrepreneurs who are less than 30 years of age.

Against this backdrop, it is important to explore what kind of an entrepreneurial ecosystem has emerged for nurturing start-ups in general, and tech start-ups in particular, in India? What is the structure and what are its key components? What factors contribute to the growth of these ecosystem components and what are its implications for the future growth of tech start-ups in India? It is appropriate to examine these issues.

VI. Entrepreneurial Ecosystem for Tech Start-Ups: Structure and Components

The new generation tech start-ups began emerging in India rather spontaneously since the onset of economic liberalization in the early 1990s (Bala Subrahmanya, 2015). This is in response to (i) the Information and Communication Technology (ICT) Revolution, and (ii) globalization characterized by the freer movement of labour and capital between countries, which transformed the organization of production throughout the world, where firms increasingly work in networks (OECD, 2013). The tech start-up emergence and growth are predominantly confined to metropolitan cities such as NCR-Delhi, Bangalore, Mumbai, Pune, Hyderabad, and Chennai, among others. Each of these cities has its own entrepreneurial ecosystem, emerged due to historical public policies, on the one hand, and market forces, on the other (Bala Subrahmanya, 2015; 2017a).

Tech start-ups, due to their limited internal resources and strength, are highly dependent on the local environment for critical resources that are essential to sustain their operations (Romanelli and Schoonhoven, 2001). Tech start-ups that are nurtured in a structured and vibrant regional entrepreneurial ecosystem have a higher probability of success relative to those that are not so nurtured (Arruda et al., 2013). This is because supportive entrepreneurial ecosystem is found to have a positive impact on start-up fertility, stability and growth (Cukier et al., 2016). A vibrant entrepreneurial ecosystem will have the ability to innovate, build exceptional enterprises, and create jobs (Aleisa, 2013). Precisely for this reason, tech start-ups have started emerging and growing in and around India's "industrially vibrant" metros. Given this, it is important to understand the structure and key components of entrepreneurial ecosystems prevalent for start-ups in Indian metros, and the factors that determine or contribute to its vibrancy.

The major factor primarily responsible for a gradual and steady emergence of an entrepreneurial ecosystem in cities like Bangalore and Hyderabad is the dominant presence of Triple Helix consisting of academia, industry and government (A-I-G), contributed directly as well as indirectly by public policies of the national government after India's independence in 1947 (Bala Subrahmanya, 2017a). To begin with, the establishment of premier academic and research institutions, national research laboratories, Central Public Sector Enterprises (CPSEs), and national government directed economic policies (implemented through regional governments) led to the creation and a steady growth of Triple Helix comprising A-I-G in the metros. By the mid-1980s, modern industrial clusters (in terms of machinery and electronics industries as well as pharmaceutical industries) had emerged. The origin and growth of machinery and electronics industries created a fertile environment for the growth of ICT industries whereas that of pharmaceutical industries facilitated the growth of biotech industries. This got further fillip with the launching of India's economic liberalization in 1991.

The steady entry of ICT MNCs and growth of domestic IT large firms, gradually and steadily led to the setting up of engineering and development centers in many of these metros. This, coupled with the engineering institutions and public R&D laboratories, created the much needed technology talent availability in these cities, which led to the entry and growth of R&D affiliates of MNCs. In fact, birth of most of the domestic IT firms represented the earliest form of tech start-ups in India, the entrepreneurship for which emerged from either domestic large firms/MNCs and public R&D laboratories/institutions or "brain circulation" due to the return of technically/ techno-managerially qualified former MNC executives from abroad.

Thus, it is the sequential emergence of three distinct but inter-related clusters, namely, (i) modern industrial cluster, (ii) IT/BT cluster, and (iii) R&D affiliates cluster which slowly and steadily laid the foundation for the emergence of an appropriate entrepreneurial ecosystem for tech start-ups in different metros of India. This was primarily characterized by the formation of a Triple Helix consisting of government, academia and industry. The national government led initiatives for industrialization led economic development (soon after India's independence in 1947) in the form of setting up of Central Public Sector Undertakings (CPSUs), national R&D institutions, engineering & technology educational institutions played a key role in the formation of this Triple Helix in the metros, resulting in modern manufacturing industrial clusters by the 1980s.

The economic liberalization led IT/BT industry growth followed by the emergence of R&D affiliates' cluster in many of these metros ensured a steady spring up of diverse sources of entrepreneurship, finance, human resources, and markets, apart from business and technology mentors. Along with this, a

unique support system in the form of technology business incubators (promoted by government support) and Accelerators (set up by MNCs) followed by co-working spaces (promoted by private entrepreneurs-cum-investors-cum-mentors) started coming up. It is the cross-migration of talent between the metros and migration from tier II and tier III Indian cities to the metros, apart from “brain circulation” from the developed countries, particularly from the US with vast international exposure and experience, which gradually led to a steady flow of sources of entrepreneurship, finance, human resources, mentors, and links to external based MNCs for markets. As a result, these metros started experiencing supportive and vibrant entrepreneurial culture. All this led to increasing media attention, so much so that many of the national dailies and magazines started devoting exclusive spaces for news and developments in India on the start-up front.

But it is important to note that the entire ecosystem is driven towards and led by tech start-ups, for which the Triple Helix provides the base, and its interactions generate entrepreneurship on the one hand, and sources of finance, human resources, market, mentors and support system, on the other. The cross-cultural migration and media support emerged in the process. Given this, the structure of entrepreneurial ecosystems that have emerged and currently prevailing in Indian metros, can be broadly described as given in Figure 3. The structure has a base in the form of a Triple Helix comprising academia, industry and Government, and a nucleus consisting of tech start-ups and prospective tech start-ups, with two outer layers. The first outer layer has five indispensable factors, namely, finance, human resources, market, mentors and the support system, whereas the second outer layer consists of two supplementary factors, namely, supportive culture and media.

A unique characteristic of this ecosystem is the Triple Helix base that represents public-private partnership, at the outset. The stronger the interaction between the triple helices, the stronger is the public-private partnership prevailing in an ecosystem, adding vibrancy for the benefit of tech start-up generation. In the Indian context, the initial passive and unintended participation of the national and regional governments in the triple helix interactions has all of a sudden led to their deliberate and active participation in the form of exclusive policies for start-up promotion (as it emerged from the national government as well as from various regional governments in the recent years), to benefit prospective entrepreneurs through:

- (i) favourable legislations,
- (ii) facilitating commercialization of innovations and technology transfer from R&D laboratories and engineering education institutions through industry-institute interactions,

- (iii) setting up of “Fund of funds” to encourage financing of early stage start-ups, through seed funds, among others,
- (iv) early market adopters, and
- (v) building up a strong support system in the form of TBIs.

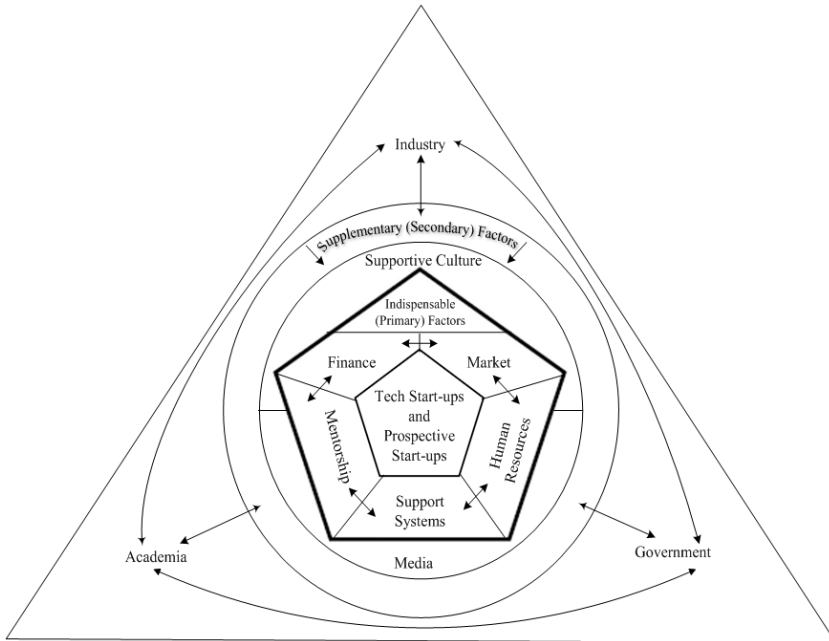


Figure 3 A typical entrepreneurial ecosystem for tech startups in India: structure and components

Perhaps what is not explicitly emphasised in policies is on the role of mentorship, both business and technology. However, the ever growing pool of financiers, successful serial entrepreneurs, failed start-up founders, and retired MNC executive personnel in these metros is contributing to a gradual increase in “multiple-role players” in the ecosystem as “co-founders/financiers/mentors/talent providers”. Some of them join or set up their own TBIs/co-working spaces to nurture tech start-ups.

Given the structure of a typical entrepreneurial ecosystem for tech start-ups in India, it is appropriate to examine what promise Indian ecosystem offers to tech start-ups in the future? There are certain factors that strongly favour or contribute to the strengthening of ecosystem components in the country in general, and in most of the metros in particular. It is necessary to examine them with reference to each of the ecosystem components, as given in Table 3.

First of all, it is the nucleus of the ecosystem, i.e., tech startups and prospective tech start-ups. India has a vast and growing pool of engineering graduates (about 0.8 million graduates annually) emerging from about 3700 engineering education institutions located across the country. Of these, just about 40% engineering graduates get employment whereas the remaining 60% of them have to be self-employed or drift towards non-technical jobs (IndiaToday.in, 2017). In addition, there are 757 universities/university level institutes, and 426 business schools, apart from 154 professional institutes under different ministries of the Government of India (Ministry of Finance, 2016). The annual net employment generation in Indian economy is hardly able to absorb any considerable number of graduates, technical, techno-managerial or non-technical. At least, a portion of these graduates is likely to pursue entrepreneurship for tech start-ups.

In addition, cities like Bangalore are attracting a growing number of Indian born-entrepreneurs, MNC executives, and even VCs, particularly from the Silicon Valley, as the new tech entrepreneurs (Bala Subrahmanya, 2017b). This would hold good for other metros such as National Capital Region, Delhi; Mumbai, Hyderabad, Chennai, Pune, Kolkata and Ahmedabad as well. Among others, the above global-average economic growth, and rising per capita income are two of the important factors attracting globally located Indian-origin entrepreneurial talent back home.

A large and growing pool of experienced technical and techno-managerial personnel in the large firms including MNCs within India is another potential source of entrepreneurship for tech start-ups. The concentration of R&D affiliates and their interactions with publicly-funded higher education institutions in the metros, where a growing technical talent pool is available, is a major boost for tech start-up emergence in India today. Further, the penetration of MNCs through FDI not only to tier I cities but also to tier II and tier III cities (NCAER, 2009), thereby exposing them to newer and newer socio-economic challenges, is a welcome development as it would offer more opportunities for entrepreneurial emergence in the form of solutions to diverse socio-economic challenges at regional and sub-regional levels.

The growing sources of finance for tech start-ups are another encouraging development. Initially though it was primarily confined to venture capital funds, soon it has been followed by the support emerging from angel investors and private equities, the former as a source of early stage start-up finance whereas the latter as a source for scaling up and growth. With the recent introduction of national and regional policy initiatives exclusively for start-ups, more and more seed funds and grants are emerging for tech start-up generation. Thus, financial support for the entire lifecycle of tech start-ups have emerged in India and are becoming stronger day-by-day. Even here “brain circulation”, and the explicit entry of foreign VCs into Indian economy add to the growing

financial support for tech start-ups. The availability of finance was found out as a vital factor influencing the growth of high-tech start-ups in India (Kshitija and Krishna, 2014).

Table 3 Factors strengthening the ecosystem components for tech start-ups in India

No.	Ecosystem Components	Factors strengthening the Ecosystem Components
1	Nucleus: Tech start-ups	A vast pool of technical graduates; a large base of techno-managerial institutions; brain circulation; growing pool of experienced technical/techno-managerial personnel based in large firms, particularly MNCs; diverse socio-economic problems across India, etc.
2	Primary components: (i) Sources of finance	Increasing number of domestic seed funds from the government, Angels, corporate sector VCs, and increasing entry of foreign VCs.
3	Primary components: (ii) Market support	Growing number of tech-intensive large firms including MNCs and their R&D centres; a steadily growing tech savvy middle class population.
4	Primary components: (iii) Human resources	A vast pool of technical graduates; a large base of techno-managerial institutions; brain circulation; a growing pool of experienced technical/techno-managerial personnel based in large firms, particularly MNCs.
5	Primary components: (iv) Support system	Government policy; steady increase in the number of corporate sector accelerators/education institution based incubators & private co-working spaces.
6	Primary components: (v) Business & Technology Mentors	Brain circulation; growing pool of experienced technical/techno-managerial personnel based in large firms, particularly MNCs; techno/techno-managerial institution based research intensive Professors; growing number of start-up founders.
7	Secondary components: (i) Supportive culture	Cross-cultural migration due to education and job opportunities in the metros; growing number of start-up promotion events; success stories of tech start-ups emerging from across the globe.
8	Secondary components: (ii) Media	Increasing flow of investments towards tech start-ups from diverse sources, particularly from leading industry personalities; fast emerging corporate sector accelerators & education institution based TBIs; emerging technologies offering solutions to diverse socio-economic problems, etc.

The steadily growing market space for tech start-ups is another positive factor. Tech start-ups are broadly of two kinds: B2B or B2C. For B2B tech start-ups, the market support emerges primarily from tech-intensive MNCs and

their R&D affiliates, both of whom are growing in number in the metros, apart from the MNC based Indian diaspora located in the US, particularly in California. MNCs look for tech start-ups with technologies which are complementary or which can support their own products and services or which can enable their further penetration or diversification in the Indian market. Even existing and more established tech start-ups lend market support to emerging tech start-ups. For B2C tech start-ups, the market is largely confined to the city itself in which it has emerged, as the tech savvy population is growing in number due to the widespread usage of Internet, smart phones and other communication devices. Internet penetration was considered to be another important ecosystem factor influencing the growth of high-tech start-ups in India (Kshitija and Krishna, 2014).

The number of Internet users in India was 373 million (accounting for 28% of the population) in 2016 and it is expected to reach 829 million (about 59% of the population) by 2021, according to Cisco. During the same time, networked devices will go up from 1.4 billion to 2 billion (YourStory, 2017a). Urban India with an estimated population of 444 million already had 269 million (60%) using the Internet in 2016 and India's smartphone user base grew to over 300 million in December 2016 as the smartphone market grew by 18% for year ended December 2016 as compared to the global smartphone market which grew at 3% (LiveMint, 2017). All this would explain the potential for tech start-up growth in India in the future.

The growing availability of a talent pool of human resources is another critical support for the future growth of tech start-ups. Both technological and techno-managerial institutions and the graduates emerging from them and experienced techno-managerial executives of large firms including MNCs offer human resource support for potential/emerged as well as stabilized tech start-ups for their growth. Of late, higher education (technology and management) institutions in the form of Indian Institutes of Technology (IITs) and Indian Institutes of Management (IIMs) have been set up in almost every state of the country, thereby promising high quality sources of workforce as well as potential entrepreneurs. A pre-existing critical mass of relevant high technology businesses and skill-sets was identified to be an important critical factor influencing high-tech start-up growth in India (Kshitija and Krishna, 2014).

Of late, the governments through technological and techno-managerial institutions explicitly encourage the unique tech-entrepreneurship support system in the form of TBIs across the country. In addition, many MNCs such as Accenture, Cisco, Google, Intel, Microsoft, SAP, Target, etc. have set up exclusive "start-up accelerators" for the promotion of tech start-ups in many of the metro cities such as Bangalore (Bala Subrahmanya, 2015; Bala Subrahmanya, 2017b). This is in addition to the initiatives taken for start-up

promotion by NASSCOM, among others (Bala Subrahmanya, 2015). Further, many experienced angel investors or VCs have set up a variety of co-working spaces in the metro cities. All these will only contribute to the strengthening of the start-up ecosystems gradually and steadily. Of course, efforts towards the development of what LeBlanc (2012) calls “Mass incubators”, drawing on the tents of Y Combinator and 500 start-ups in the US, have not yet emerged, with the exception of may be, Centre for Innovation and Entrepreneurship (CIE) of Indian Institute of Information Technology, Hyderabad (IIITH) and T-Hub in Hyderabad (Bala Subrahmanya, 2017a).

Though there is no precise information on the quality and availability of technology and business mentors, the factors which are contributing to tech-entrepreneurship, finance, and human resources such as “brain circulation”, large pool of experienced techno and techno-managerial personnel, and growing number of tech start-up founders are expected to contribute to both quality and availability of much needed mentorship for promoting tech start-ups. Even an increasing number of education (technological & techno-managerial) institution based professors seem to join the growing “start-up stream” as mentors either through their institution based TBIs or directly.

To begin with, none of the metro cities had an inherent culture favouring the generation of tech start-ups. But the steady immigration of young population from diverse corners of the country for education and in search of employment opportunities over a period of time, and exposure to cross-cultural issues is directly and indirectly contributing to the evolvement of supportive culture for tech start-ups. What is equally noteworthy is that there are numerous private websites (such as india.startuplogic.com; desistartups.in; Start-upNews.in, etc.) what facilitate the diffusion of much needed preliminary information, and programmes (such as Start-up Garage) that enable prospective entrepreneurs to understand the “pre-requisites” of entrepreneurship. Such events even link prospective start-up founders with mentors, financiers and lead them to accelerators/TBIs/co-working spaces. Many of them bring both successful and failed start-up founders to narrate their experiences to the prospective ones, to enable them to know the nuances of entrepreneurship. In addition, The Indus Entrepreneurs, commonly known as TiE, promotes tech entrepreneurship through 18 chapters in India through various networking events (tie.org website, 2017). All this nurtures supportive culture for tech start-ups.

Finally, the media. Media attraction towards tech start-ups is steadily growing and it is duly reflected in dedicated spaces allotted for start-up news by all the leading business and general newspaper dailies across the country. The business dailies such as The Economic Times, Financial Express, Business Standard, and general dailies such as The Times of India, The Hindustan Times, The New Indian Express, The Hindu, Deccan Herald, Deccan Chronicle report news items relating to tech start-ups almost on a daily

basis. In addition, business magazines such as Business Today, Business India, etc., periodically publish news on tech start-ups. The formation of YourStory as an online newspaper exclusively devoted to entrepreneurship including start-ups is another important development. The major objective of its formation is ‘to evaluate, expound and showcase the awesome spark of creation in every entrepreneur and change maker’. YourStory has published close to 60,000 stories of entrepreneurs and change-makers and helped more than 50,000 entrepreneurs access networking and funding opportunities (YourStory, 2017b).

The increasing flow of investments both from abroad and within India, particularly from leading industry personalities; the setting up of accelerators by an increasing number of MNCs; opening up of education institution based TBIs; introduction of start-up policies from more and more state governments, in addition to the national government; unique solutions developed by some of the tech start-ups for the common socio-economic problems, etc. have led to more and more media attention. This would have a favourable influence on further nurturing of start-up culture in the country.

Thus all the primary/indispensable and secondary/supportive components are gradually and steadily growing from strength to strength, in India in general, and in the metro cities, in particular. It is important to note that the triple helix of government, industry and academia is playing a crucial role, directly as well as indirectly, in this development. If the growing ecosystems across the country can accelerate the emergence, stability and sustenance, success and growth of more and more tech start-ups, their cumulative contributions to employment, innovations, productivity, national income, and exports can transform the economic structure of India in the coming decades.

VII. Summary and Conclusions

The tech start-up revolution pervading all across the global economy has been embracing Indian economy as well. Along with tech start-ups, a suitable entrepreneurial ecosystem for its nurture is emerging all over, including India. Of late, the realization that ‘entrepreneurial ecosystem’ can play a decisive role in the promotion of ‘tech start-ups’, which contribute to employment generation, innovations and economic growth, has led both of them to assume increasing attention of both policy makers and empirical researchers alike. In the global start-up landscape, India as an emerging economy occupies a unique position as one of the locations of fast emerging tech start-ups, number of tech start-ups as well as potential sources of tech start-ups.

Tech start-ups are distinctly different from other kinds of (modern and traditional) start-ups (which continue to emerge in Indian economy even today), in terms of sources of entrepreneurship, nature of firm emergence, sources of finance, nature of market, kind of human resources, support system, mentorship, probable revenue, cash flow and jobs, among others. Given this, it is only when a sizable number of tech start-up emergence and operations became visible in the local economy (in terms of entrepreneurship, job generation, financing, market size, formal and informal support system and mentors) that a formal policy for start-ups emerged at the national level followed by that of regional levels. However, the policy support extended to tech start-ups is primarily confined to finance, support system, regulations and incentives, and industry-institute interactions, and the policy as a whole is at its infancy.

Much before the introduction of exclusive policy support for tech start-ups, a unique entrepreneurial ecosystem started taking shape in many of the metro cities of India. The origin of these ecosystems, however, could be traced back to public policies (introduced after India's independence in 1947) which gradually and steadily led to the development of Triple Helix of academia-industry-government resulting in a modern industrial cluster followed by an IT/BT cluster and then by a R&D centres' cluster. This sequential emergence of three clusters supported by the triple helix base, led to the spring up of entrepreneurship, finance, human resources, market, support system and mentors, along with a supportive culture and media.

Thus, an entrepreneurial ecosystem currently prevalent in India is defined as a structure containing a nucleus in terms of tech start-ups and prospective tech start-ups, surrounded by two outer layers with an overall triple helix base. The first outer layer comprises five indispensable components such as finance, market, human resources, support system and mentors whereas the second outer layer consists of culture and media. These ecosystem components, as of now, support not only the emergence of tech start-ups but also their survival and sustenance. But, an accelerated growth of tech start-ups through either attracting large scale investments of private equity and investment funds or "going public" has not yet emerged in a big way. This is substantiated by the fact that, as of now, India accounts for only 10 unicorns out of more than 4000 tech start-ups operating in the country, as against a global total of 177 unicorns (LiveMint, 2016). To that extent, ecosystems in India are still in the process of evolving towards attaining maturity.

However, the evolving ecosystems that are growing from strength to strength in terms of all the components, ably supported by the triple helix of Government, Industry and Academia, have the potential to promote large scale generation of tech start-ups in the future. This would eventually transform

Indian economy through their contributions to employment, innovations, productivity, national income and exports.

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