India's intellectual property-based biomedical start-ups

*Gayatri Saberwal**

I have posed 50 questions each to the founders of 50 young Indian biomedical firms that are less than five years old. The questions were on the following themes: the backgrounds of the founders and their employees, the area of work of the company, its location and incubation experience, its funding and expenditure, its IP and licensing, its clients, and its risks and challenges. Several are doing pioneering work and the overall picture is impressive. The country should become a source of appropriate, high quality and affordable biomedical products and services in a few years.

Keywords: Biomedical firms, entrepreneurship, innovation, start-ups, venture capital.

IN the United States (US), start-up companies are a vital source of innovation in the development of novel drugs and other biomedical products. This large number of start-ups is possible in an environment that has many supportive institutions and practices, such as a large research base in the universities and research institutes, from which start-ups arise, many angel and venture capital funders, a good number of incubators, big pharma that looks for in-licensing opportunities, the tendency for big pharma to acquire small companies thereby giving early investors an exit, an intellectual property (IP) regime that favours academics taking their IP down the path of commercialization, a very large clinical trial sector (both public and private sectors), readily available consultants to advise a start-up on various issues, immediate access to a large market, and so on. In the past, India has not had large numbers of innovative biomedical start-ups, at least partly due to an inadequate ecosystem. The shortfalls have included (a) inadequate investment in research and development (R&D) by industry and almost no venture capital; (b) a small quantum of public sector R&D; (c) inadequate numbers of translational research centres and incubators or other facilities for start-ups (or pre-start-ups) to access high-end equipment in particular; (d) confusng regulations, and so on. I have described some of these issues in an earlier analysis of challenges that young biopharma companies in India face[1].

However, there is distinct change in the air. In an effort to understand the current biomedical start-up landscape, I interviewed founders at each of 50 firms that are up to five years old. One notes that the literature on entrepreneurship and innovation falls into three overlapping broad categories: (a) the national system of innovation (with a focus on the institutional framework in which technical innovation, in particular, takes place); (b) entrepreneurship (where the firm or the individual is the focus of attention and where many ventures are not innovative), and (c) entrepreneurial innovation (where innovative entrepreneurs are embedded in networks)[2]. Also, it is known that context plays an important role in what entrepreneurs can achieve[2]. There are various dimensions of context such as temporal, spatial, organizational, institutional, technological and social. In this article we have not done a detailed analysis of such a framework, focusing instead on a narrowly defined cohort of young firms and various parameters that describe them. Methodological details, including how the firms were recruited for the interviews, and the questionnaire, are provided in the Supplementary files 1 and 2 (see online). The questions were on the following themes: the backgrounds of the founders and their employees, the area of work of the company, its location and incubation experience, its funding and expenditure, its IP and licensing, its clients, and its risks and challenges.

Results and discussion

An analysis of the responses, with an emphasis on the most common ones, is presented here for most questions. For the remainder, details are provided in Supplementary files 3 and 4 (see online).

The age profile of the firms is as follows: 10, 10, 7, 10 and 13 companies are up to 1 year old, 1–2, 2–3, 3–4 and 4–5 years old respectively. Given the small sample size, this is a reasonably even distribution. In terms of the nature of work, the firms fall into the following categories (Table 1): diagnostic products (15 cases, of which 5 are developing omics-based proprietary tests and healthcare solutions), biologics-related products and services

Gayatri Saberwal is in the Institute of Bioinformatics and Applied Biotechnology, Biotech Park, Electronics City Phase 1, Bengaluru 560 100, India. *e-mail: gayatri@ibab.ac.in

(including cell- and stem-cell based work; 14), medical devices (10), small-molecule drug discovery (6), chemistry-based or other drug discovery services (6) and software-based services (6). There are seven overlaps (between diagnostics and biologics or software-based services, and between drug discovery product development and related services). In almost each of these categories, there have been earlier examples of local product development and commercial launch, and thus a sense that this work is doable in India. Overall I was struck by the self-confidence of the interviewees. Several of them used phrases such as 'unique in India' or 'internationally top notch' to describe their work.

The founders

In terms of the qualifications of the founders, 34 of the ventures have one or more Ph Ds (or people with postdoctoral experience) in the founding team. Eight of these teams include faculty members at prestigious institutions, six within the country and two in the US, with one overlap. A decade ago I had reported that about 10% of local biotech firms are founded by local academics, and in each case the founder had left academia[3]. The current interviews reveal a slightly higher proportion of academic co-founders, and none has left his/her primary job. In the remaining 16 cases, the founders have a Masters' degree as the highest qualification. Unsurprisingly, these are largely cases requiring engineering skills (software services, medical devices and omics-based products or services), although this set also includes five start-ups focused on biologics.

In terms of their location before starting the company, most of the teams were at least partially based in India (all the founders in 30 cases and some of them in 14 cases). Only one founding team was wholly foreign, with no prior links to the country. India has its idiosyncrasies, and a few years from now it will be interesting to examine whether prior familiarity with local conditions was important to the success of these companies. Some businesses have resulted from the Stanford–India Biodesign (SIB) program, and although SIB sends its fellows to California for some months, this was not considered being based abroad. For 10 firms, other companies were closely involved in their formation. Three of these cases are partially or wholly owned subsidiaries of the larger entity. Eight of the partners are local and the remaining are in Europe or North America. Although some of these cases involved finance or incubation-type support, in none was the support purely finance- or incubation-related.

Table 1. The nature of work in the 50 start-ups

Nature of work	Number of companies
Diagnostic products, including omics-based proprietary tests and healthcare solutions	15
Products and services using biologics or for the development of biologics (including cell- or stem cell-based work)	14
Medical devices	10
Small-molecule drug discovery (in one case, nutraceuticals)	6
Chemistry or other drug discovery services	6
Software services or platforms	6
Total	57

Regarding prior experiences that had been most useful for the venture, 29 interviewees mentioned their education, or research or technical expertise. Other responses included prior founder experience (10) or experience in business development (10), product development (often more than once per individual or in the founding team) (eight) or in a small-company or small unit (again, sometimes more than once amongst the founders) (seven). Twenty-six entrepreneurs also mentioned that there had been one or more individuals who were critical to forming the business, but who are not listed as founders. In almost all cases these were senior people in companies or other highly qualified people. Thus, other people with skills, networks, funds or corporate experience are actively engaged, thereby increasing the chance of success of these young companies.

Location and incubation

Overall, 92% of the respondents are based in six cities: Bengaluru, Chennai, the Delhi region, Hyderabad, Mumbai and Pune. A further 6% are based elsewhere in the same states as these cities. This parallels a recent report on start-ups in the Indian information technology (IT) sector that mentions that 90% are located in these six cities[4].

Companies were primarily drawn to specific cities due to the availability of suitable manpower (27 cases). Roots also mattered: in 14 cases either the founders were from that city, or they had studied or worked there. Other reasons related to the presence of many potential clients in the city (seven) and the medical expertise in the city (five), with some having close relationships with hospitals. In terms of the disadvantages of their location, seven respondents mentioned poor civic amenities or the lack of support from the State government. Some cities have also become expensive (five). Six interviewees commented on the poor start-up ecosystem overall (of enough institutions, investors, service providers, sharing of activities amongst entrepreneurs, and fora for young companies to talk with academia, large companies or the government), with some making unfavourable comparisons between Indian cities and the best global locations.

We can define four types of incubation that are supporting these ventures: (a) location in an academic

incubator or one set up by the central government, or informal access to academic facilities (22 cases); (b) close ties with a pre-existing company, either as its spin-off or due to social links (seven); (c) hosting by another organization (physically or virtually) or virtually by the SIB program (six), and (d) location in a hospital (three). Four have benefited by two such sources of support, sometimes simultaneously. Three of these are categorized in type (a), since such an incubator hosts most of their activities. For two cases in category (a), their own premises host most of the work with only a small portion of their activities in the incubator. Incubation has benefited most of the companies, since only 12 have not had such support. Seven of the 12 wished that they had access to (affordable) incubation. It is noteworthy that in several cities the incubators are coming up next to research campuses. It is known that such an arrangement can stimulate the growth of technology businesses[5], and one therefore expects that this will be one of the causes for the success of individual firms and of clusters of them in future.

Intellectual property

Given the highly technical nature of their work, I inquired about the IP holdings of the firms. Twenty-seven of them have a total of 110 filed or issued patents. The Patent Cooperation Treaty route has been the most popular (18 companies), closely followed by direct filing in India (16), with 7 overlaps. A further 10 plan to file patents which are under preparation in several of these cases. Nine respondents have not or 'not yet' filed patents; so at least some of these will do so in future. Finally, aside from some of those listed above, four others are using copyright, trademarks or trade secrets to protect their IP. Thus, about 44 of the 50 start-ups have protected their IP or intend to do so in future. Even accounting for some process patents related to biosimilars, this is a remarkable number given the Indian reputation for 'copycat' generics.

Funding and expenditure

And how is this work funded? The respondents listed 111 (overlapping) sources of funds (Table 2). In the absence of information on the exact amounts received, this is merely a qualitative description that is nevertheless instructive. Thirty-two mentioned the government as a source of funds, with seven receiving funding from two programmes and two companies from three programmes. All but one are programmes of the central government. The most widely cited programme (18 cases) was the Biotechnology Ignition Grant (BIG) of the Department of Biotechnology (DBT), Government of India (GoI). Started in early 2012, BIG primarily funds high-risk proof of concept work in a start-up that is less than three years old (or by individuals before the incorporation of a company). It provides up to Rs 50 lakhs for up to 18 months of work. As of March 2014, 643 proposals had been evaluated and 96 grants awarded, 55 to individuals and 41 to companies[6]. Aside from the government, there were other funders. Twenty respondents mentioned personal funds and 15 mentioned angels. Venture funding and funding by a closely linked firm (based in India or abroad) were each mentioned seven times. Other sources of funds included: Grand Challenges Canada (four cases), the Bill and Melinda Gates Foundation (three), the incubator or host institution (three), business competitions in India or abroad (three), funds from unrelated companies (two), and a bank loan (one). Three interviewees mentioned 'other' Indian or foreign sources. Two companies have been funded by the same programme twice each, but these have been counted only once each. Also, in three cases, the founders declined (significant) funding due to the constraints that would have come with it. In terms of the number of sources per venture (where each government programme is considered a separate source, and in the absence of further details 'venture funding' is considered a single source), the interviewees reported one (15 firms), two (20), three (7), four (6), five (1) and six (1) sources (Table 3). Several founders made countless attempts to obtain these funds.

Although many start-ups are deeply appreciative of the GoI programmes, especially BIG, what is particularly notable is the mention of venture capital. Typically this is much larger funding than from other sources (some

Table 2. The sources of funding for the 50 start-ups

Source of funds	Programme*	Number
Government	BIG	18
	BIPP	7
	SBIRI	7
	TDB	4
	Other	7
Personal funds		20
Angels		15
Venture capital		7
Closely linked company (based in India or abroad)		7
Grand Challenges Canada		4
Bill and Melinda Gates Foundation		3
Incubator or host institution		3
Money through business competitions (in India or abroad)		3
Other Indian or foreign sources		3
Funds from a company not closely linked		2
Bank loan		1
Total		111

*BIG, Biotechnology Ignition Grant; BIPP, Biotechnology Industry Partnership Programme; SBIRI, Small Business Innovation Research Initiative; TDB, Technology Development Board. The last is an initiative of the Department of Science and Technology, GoI, whereas the others are all from DBT, GoI.

companies having raised up to US$ 12 million to date), and stands in contrast to reports in recent years that there has been hardly any venture funding available for this sector in India[1,7]. Here too there are some parallels with IT-related start-ups, whose large number (the third largest group in the world after the US and the UK, and the fastest growing) is facilitated by a recent manifold increase in funding by venture capitalists and other investors[4].

When asked about their monthly expenditure, all but 13 respondents were willing to disclose a ball park figure (Table 4). This ranged from under Rs 50,000 to 50 lakhs or more. The most commonly reported figures were for Rs 1–2 lakhs, 2–5 lakhs and Rs 5–10 lakhs, with seven respondents each. Eleven firms reported Rs 10 lakhs or more. Although these sums may seem small to a Western audience, as one founder said 'Money goes far in a start-up', and even further in an Indian one it would appear. Most of the regular expenditure is on salaries (43 companies), consumables (20) and rent (12).

Risks and challenges

Unsurprisingly, the biggest challenges these companies face concern finance (25 respondents), with firms flagging the following issues: the small number of funding options, the low quantum of funding, delays in the receipt of funds, the high costs of importing equipment and the lack of technical knowledge amongst venture capitalists. Manpower is another challenge (19 cases), with founders fretting over the quality of available human resources and with the difficulty of attracting talent to a start-up or retaining it thereafter. The government came in for criticism on two broad fronts: (a) difficulties with government rules and regulations, and (b) challenges in dealing with government officials. Amongst the former, the most common complaint was the lack of clarity on what was expected to get government approval, including in cutting-edge areas that are evolving even internationally. Nine firms have faced incubation-related challenges, either in finding a suitable incubator or in operational headaches after becoming an incubatee. Although mentioned less often, the following are other important concerns: (a) conflict of interest of being both an academic scientist and an entrepreneur, (b) lack of networking fora for young ventures, and (c) lack of information on the size of the Indian market, especially for novel technologies. Overall, the companies have an extremely long wish list. Furthermore, the cities that are currently hot spots for biomedical entrepreneurship are, or may become, expensive to live or work in. This has been noted in other entrepreneurial centres, and in Silicon Valley, for instance, the median cost of a home is four times the national average[5]. This could have an inhibitory effect on the growth of these centres of innovation in the years to come.

Table 3. The number of funders per start-up

Number of funders per company	Number of companies
1	15
2	20
3	7
4	6
5	1
6	1
Total	50

Clients

Despite their financial constraints and despite being young and product-oriented, 24 companies have, or have had, clients. Of these, six said that these were small or pilot projects. Only three mentioned Indian academia or public sector laboratories as their clients, wholly or in part. For those that do not yet have clients, most are still developing the product, although a handful is currently in talks with potential clients. Seven firms reported break even in at least one year of their existence.

The future

In terms of the next few years, most of the firms (29) wish to develop their technologies. About one-third is hoping for out-licensing deals; these firms see themselves as R&D teams without the wherewithal (or in some cases the interest) to take up clinical trials or manufacturing (as relevant). Eleven have 'making impact' as their goal, with an ambition to be known as the country's leader in their type of work. When asked in what way all the entrepreneurial activity (whether successful or not) contributes to the development of the country, it became apparent that the entrepreneurs have a robust sense of these contributions, both tangible and intangible. Twenty-six felt that the societal impact of locally developed solutions was the most valuable. For instance, although the head of Cipla, the large generics firm, Yusuf Hamied, has talked of

Table 4. The monthly expenditure for 37 firms

Monthly expenditure (Rs)	Number of companies
Up to 50,000	3
51,000–1 lakh	2
1.1–2 lakhs	7
2.1–5 lakhs	7
5.1–10 lakhs	7
10.1–20 lakhs	1
21–30 lakhs	2
31–40 lakhs	2
41–50 lakhs	2
Over 50 lakhs	4
Total	37

bringing out biologics at US$ 1 a day[8], one of the interviewees mentioned that it should be possible to do so for even less. Other popular responses included building competence in the country (21), contributing to the Gross Domestic Product and foreign exchange (16), and creating jobs (14). Specific comments made by some of the entrepreneurs were most interesting: (a) providing solutions that actually solve problems, not just products in isolation; (b) building skill sets that large companies are not; (c) raising the level at which we have operated here; (d) evolving a paradigm different from the West, and (e) building a culture of innovation and fearlessness that builds national self-confidence. Further, firms in mature clusters such as the Silicon Valley co-create value. This value exceeds the sum of what firms acting alone could, and is a major reason that supporting clusters is an important part of competitiveness policy in the industrial world[9]. Are the companies of this study part of city-specific clusters, and if so how robust is each network? It will be interesting to examine this question in future.

Conclusions

In conclusion, we are seeing entrepreneurship in a range of fields, from software-based services to drug discovery. The teams are highly educated, well networked, globally aware and resourceful. Also, there are more academics from prestigious institutions involved with start-ups. Essentially all the firms are home-grown. Just six cities host most of the companies, with the availability of manpower a major draw. Four types of incubation support most of the start-ups. Most of the companies see themselves primarily as R&D teams and have filed patents or intend to do so soon. Government funding, although significantly more than a few years ago, has supported only 32 of the 50 firms. There have been several other sources of funds, including venture capitalists. Despite the better funding, most of the companies operate on lean budgets. They also face a range of other challenges. Nevertheless, unlike a few years ago, the Indian start-up scenario has incredible promise with large potential pay-offs. It would not surprise me if, in a relatively few years, the country becomes known as a source of appropriate, high quality and affordable biomedical products and services. The seeds are sprouting now.

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