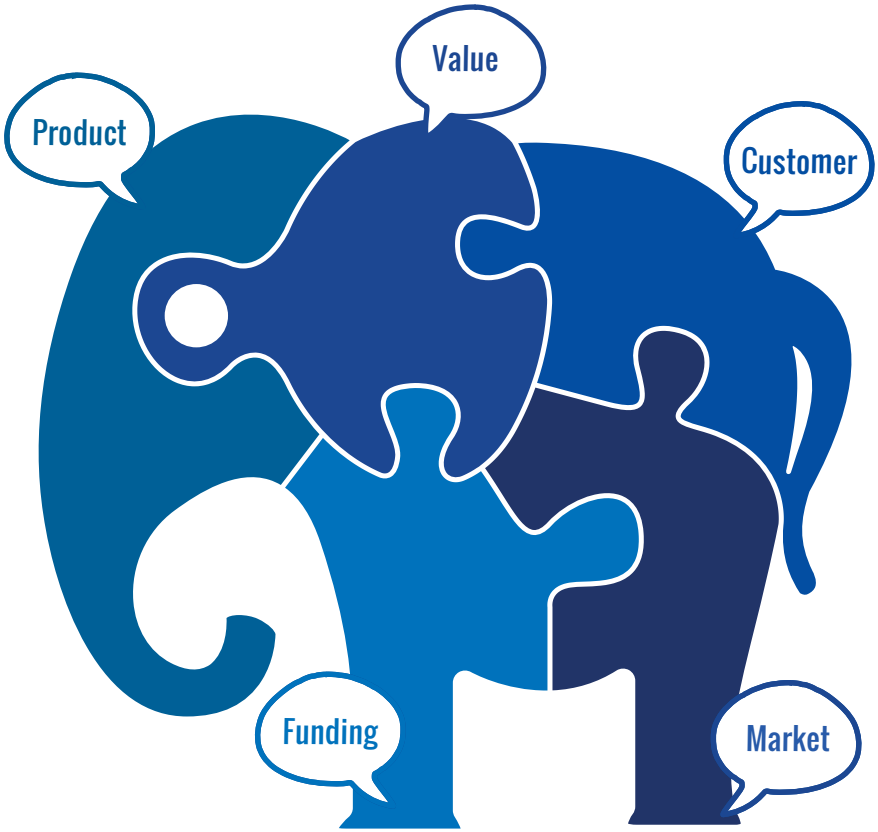
AIM PRIME PLAYBOOK

A practical guide to science based entrepreneurship



EDITED BY HIRAN VEDAM

Initiative of
NITI Aayog
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authors
UPFRONT

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Foreword

Dr Chintan Vaishnav, Mission Director,
Atal Innovation Mission (AIM)

Atal Innovation Mission (AIM), NITI Aayog, set up in 2016, is Government of India's flagship initiative launched with an aim to promote a culture of innovation and entrepreneurship in the country. Towards this end, AIM has taken a holistic approach to foster innovation and encourage technology development by engaging universities, research institutions, start-ups, and even individual innovators.

Science and technology are changing the way we live and the way we experience everything. They are changing at an exponential pace and at the same time are becoming affordable, accessible and available. India is a country of 1.3 billion people with a strong culture of scientific temperament inculcated in our educational institutions. While we have the advantages of

a large demographic dividend and a fast-growing economy, we also face major challenges like being a large agrarian economy, pressures of urban migration and a large segment of the population below the poverty line.

We are in a unique position to leverage all the advantages of technology to spur innovation and entrepreneurship to a new level. We should develop mechanisms to translate our research into practical innovations that can solve the major challenges of our society. Traditionally, there is a big gap between lab and market and it is a long journey. Hence, we need a structured approach to enable this translation and make the results market ready.

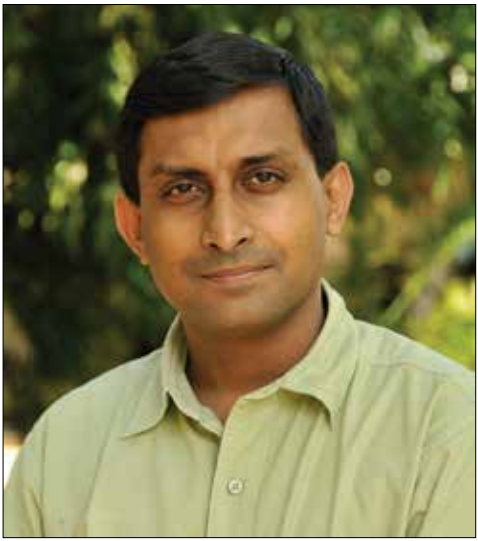
The AIM-PRIME programme is our strategic initiative aimed at promoting science-based, deep technology ideas to the market through training and guidance over a period of 12 months. It brings together valuable knowledge from experts in India and abroad and the best practices to translate research to world class products and create impact.

This playbook has been created as part of the AIM-PRIME programme to capture this knowledge and to create a comprehensive resource for academic researchers, entrepreneurs and incubators involved in translating research from lab to market.

“We should develop mechanisms to translate our research to practical innovations that can solve the major challenges of our society.”

Dr Chintan Vaishnav

Preface



Dr Premnath Venugopalan,
Director, Venture Center

Venture Center is India's leading inventive enterprises and science-based business incubator. Hosted by CSIR-National Chemical Laboratory, we nucleate and nurture entrepreneurs who develop technology innovations for the welfare and development of the people and the nation. We specifically focus on knowledge-based businesses and inventive enterprises which are sustainable and scalable over a period of time. We work closely with various government organisations to contribute to several national missions.

Science-based start-ups leverage scientific insights and deep understanding of the problems or knowledge, and carry inherent risk and uncertainty. By virtue of this, the way they are developed is very different. They are differentiated by the time it takes them

to mature and generate revenue. There is also the element of scaling the technology and business that is unique to such start-ups. They often leverage specialised know-how that is protected by various forms of intellectual property. The need for a supportive ecosystem with the right facilities, diverse talent and diverse funding mechanisms is crucial. Also, founder conviction and clear IP strategies are essential to their success.

Keeping the needs of science based start-ups in mind, the AIM-PRIME programme is aimed at providing new energy and focus on science-based startups in the country. It is a programme where people who are working on deep scientific developments can learn about different tools and methodologies to take their ideas to market and build start-ups that are sustainable and scalable over a period of time.

This playbook captures global insights and best practices, combined with India-specific information and insights to train and mentor start-up leadership teams and academic entrepreneurs on setting up and advancing science-based startups. It will also prepare and equip incubation managers in mentoring science-based start-ups.

"Science-based start-ups leverage scientific insights, deep understanding of the problems or knowledge and carry inherent risk and uncertainty."

Dr Premnath Venugopalan

List of Abbreviations

Acronym	Full form
ARPU	Average revenue per user
B2B	Business to Business
BIRAC	Biotechnology Industry Research Assistance Council
BMC	Business Model Canvas
BOD	Board of Directors
CCAMP	Centre for Cellular And Molecular Platforms
CCDs	Compulsorily convertible debentures
CCPS	Compulsorily convertible preference shares
CE Certification*	Conformité Européenne
CEO	Chief Executive Officer
CFO	Chief Financial Officer
COO	Chief Operating Officer
CTO	Chief Technology Officer
CIPET	Central Institute of Petrochemicals Engineering & Technology
C-MET	Centre for Materials for Electronics Technology
COCA	Cost of customer acquisition
CROs	Contract Research Organizations
DSIR	Department of Scientific and Industrial Research

Acronym	Full form
ECBs	External Commercial Borrowings
ESIC	Employee State Insurance
ESOP	Employee Stock Option
FDA	Food and Drug Administration
FEMA	Foreign Exchange Management Act
FIPCO	Fully Integrated Pharmaceutical Company
FMV	Fair Market Value
FSSAI	Food Safety and Standards Authority of India
GST	Goods and Services Tax
IEC	Importer-Exporter Code
IP	Intellectual Property
IRDPP	Industrial R&D Promotion Programme
IRLs	Investment Readiness Levels
IRR	Internal rate of return
KOLs	Key opinion leaders
LLP	Limited liability partnership
MCMs	Most Critical Module
MIT	Massachusetts Institute of Technology
MSME	Micro, Small, Medium Enterprises

* The CE mark means that the manufacturer takes responsibility for the compliance of a product with all applicable European health, safety, performance and environmental requirements.

Acronym	Full form
NAFARI	National Agriculture and Food Analysis and Research Institute
NASA	National Aeronautics and Space Administration
NDA	Non-Disclosure Agreement
NPO	Non-profit organisation
NSTEDB	National Science & Technology Entrepreneurship Development Board
OCDs	Optionally convertible debentures
OCPS	Optionally convertible preference shares
P&L	Profit & Loss
PAN	Permanent Account Number
PE	Private Equity
POC	Proof of Concept
POP	Proof of Principle
POSH	Prevention of Sexual Harassment
POV	Proof of Value
PT	Professional Tax
ROC	Registrar of Companies

Acronym	Full form
SAFE	Simple Agreement For Future Equity
SAM	Serviceable Addressable Market
SARs	Stock Appreciation Rights
SDG	Sustainable Development Goals
SITRA	SOUTH INDIA TEXTILE RESEARCH ASSOCIATION
SME	Small and Medium Enterprises
SOM	Serviceable Obtainable Market
TAM	Total Available Market
TAN	Tax Deduction and Collection Account Number
TDS	Tax deducted at source
TRLs	Technology Readiness Levels
TTOs	Technology Transfer Offices
UN	United Nations
US PAIR	Patent Application Information Retrieval
WIPO	World Intellectual Property Organization

1. Science-Based Entrepreneurship – An Introduction

"There is no Plan B, because there is no Planet B"

– UN Secretary-General Ban Ki-Moon

The big challenges of our times such as UN SDG goals, climate change and pandemics impact billions of people living on this planet today and transform the way of life for the billions yet unborn. Solving these challenges requires the power of science and the vision of an entrepreneur.

These challenges have inspired generations of scientists and researchers to develop new inventions that push the frontiers of science. But many of these inventions get stuck in the world of research and do not make a tangible impact in the real world. This playbook aims to bridge the gap between scientific minds and business acumen to transform these inventions into products and services that transform lives and create real-world impact.

It aims to equip scientists with the necessary know-how to go beyond their technical ideas to understand when, where and on whom their science can have the most tangible impact. It will equip them with the tools to do this while creating value for the various stakeholders involved.

1.1 What is Science-Based Entrepreneurship?

"The future belongs to science and those who make friends with science"

– Jawaharlal Nehru

From the neighbourhood grocer to the sugarcane juice vendor, every business is solving a problem or meeting an unmet need. In addition, these firms have figured out a way to make money. This ability to make money and sustain growth are the hallmarks of successful businesses. One can view a business as having an internal engine of productive assets. The business uses these assets to convert various inputs to create and deliver value to its multiple stakeholders. The more productive the internal engine, the more value is created. One of the many ways to increase productivity of this internal engine is grounded in science and technology. The deeper the science and technology base of this engine, the greater its productivity. This deep grounding distinguishes science-based enterprises from other types of businesses.

One of the distinguishing features of science-based enterprises is the large upfront investments in science and technology that need to be made several years ahead of the value delivery and extraction. The assets created from these early investments are often intangible and hard to monetise. The risks associated with these assets are also difficult to characterise fully, as lead times are long. These features make it very difficult for early stage investors to fully comprehend the true value created in the venture and the risks involved.

Another distinguishing feature of science-based enterprises—especially in the early years—is the need for highly talented and

highly specialised personnel. The mix of these specialisations also changes with the evolution of the business. Science-based ventures may need expensive equipment and unique infrastructure. Hence, science-based start-ups often have to work with different technical consultants, form partnerships and share resources to afford access to the required talent and infrastructure. These make for complex relationships with external organisations and very porous boundaries of asset ownership.

Science-based start-ups also have non-linear and discontinuous growth profiles. As these businesses are ahead of market needs, they often use very different planning and marketing tools as compared to those of traditional businesses dealing with immediate customer problems.

1.2 Ecosystem for Nurturing Science-Based Entrepreneurship

> *"Technological change is never an isolated phenomenon. This revolution takes place inside a complex ecosystem which comprises business, governmental and societal dimensions"*
>
> *– Klaus Schwab*

Just as it takes a village to raise a child, nurturing science-based enterprises to create real-world impact takes several actors and factors beyond the group of scientists that conceived the inventions. They can be broadly grouped into the following:

- **Research Cluster:** To have a strong pipeline of science-based ventures, we need a strong research cluster that includes high calibre academic and research institutions. These research organisations have a strong mandate and institutional mechanisms to encourage

the commercialisation of research. These include incorporation of commercialisation as a criterion in internal grant reviews and evaluations for recruitment, promotion and salary increments. They also include soft-touch approaches, like celebrating the successes of researchers doing such work. The institutions also have the flexibility to recruit high calibre scientists, and support them with research infrastructure and funding to train teams and perform top-notch research.

- **Innovation Cluster:** The output from research organisations is generally not immediately ready for the market. The intellectual property underlying the science needs to be protected and evaluated for commercialisation potential. These functions are typically carried out by the technology transfer offices (TTOs) that enable IP protection, identification of commercialisation partners and signing of contracts with them. In addition to the TTOs, the innovation cluster includes physical and virtual platforms to bring together people with science, engineering, legal and business skills to interact and form teams to commercialise the science. The innovation cluster also consists of innovative industry players and consumers willing to accept a less-than-perfect but potentially better solution to their problems. Apart from this, the innovation cluster includes physical facilities and equipment, standardised test-bedding facilities and demonstration platforms that all innovators with suitable technologies can access to take the science closer to the market. To keep this entire innovation cluster functioning seamlessly, it also includes strong

mentorship, substantial long-term government funding and patient private capital.

- **Entrepreneurship Cluster:** Taking any solution to the market and creating an impact requires a strong entrepreneurial cluster that supports young start-ups and existing companies developing and commercialising advanced technologies. The components of this cluster are:
  - a pool of experienced entrepreneurs and industrial players
  - a network of incubators and accelerators that support young start-ups with mentoring, product development and business creation activities
  - a diverse pool of investors who can fund different stages of venture growth

  In addition, it comprises players who can manufacture the product in different volumes and the infrastructure to support their specialised development and production needs. Finally, easy access to the domestic and international markets is another success factor for commercialising any new solution.

- **Enabling Macro Environment:** Pieces of each of the clusters discussed above exist in some shape or form in emerging economies. A nurturing ecosystem for science-based start-ups is one where these clusters are connected to create a thriving ecosystem. It includes strong policies that promote patient capital investment and reduce early-stage risk. In such an environment, legal and financial frameworks are consistent and clear; regulations on adaptation of new technologies are proactively defined to fit the

unique social and cultural norms of the society. The ecosystem also celebrates successful entrepreneurs.

1.2.1 Indian Ecosystem

India has the third largest number of active programmes for nurturing start-ups in the world and has over 70,000 start-ups. The Indian government maintains a start-up portal (https://www.startupindia.gov.in/) as a one-stop resource for tools and resources for entrepreneurs in India. The government has also made several provisions to support the start-up ecosystem. For example, start-ups can register

Table 1.1: Startup India

Registration	Details
Startup India Registration (basic)	• Eligibility for certain funding schemes – grants, seed funding • Enabling provisions for angel/ VC/ FVC investments • Relaxations in public procurement • Self certification for compliance under: Labour laws, environment laws • Facilitation: Intellectual property • Ease of business: Company law
Startup India Registration with tax exemption u/s 56	• Post getting recognition a start-up may apply for Angel Tax Exemption
Startup India Registration with tax exemption u/s 80 IAC	• Post getting recognition a start-up may apply for tax exemption under section 80 IAC of the Income Tax Act • Post getting clearance for tax exemption, the start-up can avail tax holiday for three consecutive financial years out of its first ten years since incorporation

for three different kinds of recognition under Start-up India (see Table 1.1) that makes the start-up eligible for certain funding schemes and tax exemptions. Companies generating revenue can avail of the Udyam registration scheme under the Ministry of MSME, which offers protection against delayed payments. The ministry also provides schemes that offer public procurement benefits and provide credit and financial support (see Table 1.2). Research intensive start-ups can apply for recognition of their in-house R&D units under DSIR-IRDPP offered by the Ministry of Science and Technology, which also provides GST exemptions to start-ups incubated at NSTEDB/BIRAC approved incubators (see Table 1.3). Apart from financial benefits, DSIR issued a notification in 2009 permitting the scientific establishment and full-time researchers to own equity in scientific enterprises and spin-offs, to enable the commercialisation of academic research. The notification also encourages institutions to set up incubators and facilitate the mobility of researchers between industry and academia. The GoI has also set up several support programmes and facilitation centres to protect and commercialise intellectual property (see Table 1.4).

Specialised Scientific Facilities

All government-funded academic institutions and research organisations in India give outsiders access to their facilities and specialised equipment. In addition, specific organisations like CIPET, SITRA, C-MET, led by line ministries like the Ministry of Textiles, are available to the public (see Figure 1.1). Start-ups can engage with these facilities and organisations in different modes, such as technical or consulting services, in-licensing technology, mentoring and access to staff and students. The different modes of

Table 1.2: MoMSME Schemes

Registration	Details
Udyam (MSME) registration	• Link: https://msmeregistrar.org/ • Loans: Interest rate subsidy on bank loans, collateral free loans from banks • Prompt payments: Protection against delayed payments, against material/services supplied • Reservation: Special beneficial reservation policies in the manufacturing/ production sector • Business support: Ease of obtaining registrations, licenses, and approvals, International trade fair special consideration • Subsidies: MSME registered entity gets eligible for CLCSS (credit linked capital subsidy scheme), NSIC performance and credit rating fees subsidy, patent registration subsidy, barcode registration subsidy, industrial promotion subsidy (IPS), subsidy eligibility • Concessions: Government security deposit (EMD) waiver (useful while participating tenders), electricity bills concession, stamp duty and registration fees waiver, ISO certification fees reimbursement • Exemption: Direct tax laws rules exemption
Public procurement benefits	• Link: http://www.nsicspronline.com/ • The units registered under Single Point Registration Scheme of NSIC are eligible to get the benefits under Public Procurement Policy for Micro & Small Enterprises (MSEs) including free of cost tender information, exemption from EMD, advantage in tender participation, procurement quota from MSEs
Credit and financial support	• PMMY MUDRA: https://www.mudra.org.in/ • MoMSME-UDAAN CGTMSE -https://www.cgtmse.in/ • Stand-up India-https://www.standupmitra.in/

engagement with such organisations and some guidelines for engaging with them are discussed in Table 1.5.

In addition, different incubators like Venture Center and CCAMP have specialised facilities that are available to start-ups. Service providers like CROs and testing labs are valuable for certifying performance, as they are authorised to provide such certifications. Industry-led facilities like AutoCluster Institute and NAFARI for the food industry are useful for start-ups in those sectors. Table 1.6 provides a sample of such specialised facilities in India. Venture Center has a full suite of facilities for MedTech start-ups, from proof-of-concept to cleanrooms for sterilisation and packaging, as shown in Figure 1.2. More broadly, the Pune ecosystem has a suite of facilities shown in Table 1.7 for biotech start-ups.

Funding Sources

Funding for science-based start-ups in India is at a very nascent stage and varies significantly based on the

Table 1.3: MoS&T

Registration	Details
Recognised R&D center	• DSIR: DSIR-IRDPP: Granting recognition to in-house R&D units of industries- https://dsir.gov.in/ • Eligibility for certain grants/ funding schemes; income tax benefits; lower GST on products purchased; lower import duty benefits; credibility as a research intensive entity
Incubatee of a NSTEDB/ BIRAC approved incubator	• Link: https://www.indiafilings.com/ • No GST charged by incubator • Eligible start-ups can also not charge GST upto a limit

domain and stage of the commercialisation journey, as shown in Figure 1.3. Venture Center Funding Website (http://funding.venturecenter.co.in) provides timely information about available grants and their details for innovators and start-ups in India. While the availability of many of these funding sources is limited to specific technologies and domains, the later stages of the pre-revenue commercialisation journey are especially difficult across all sectors in India.

Table 1.4: Intellectual property

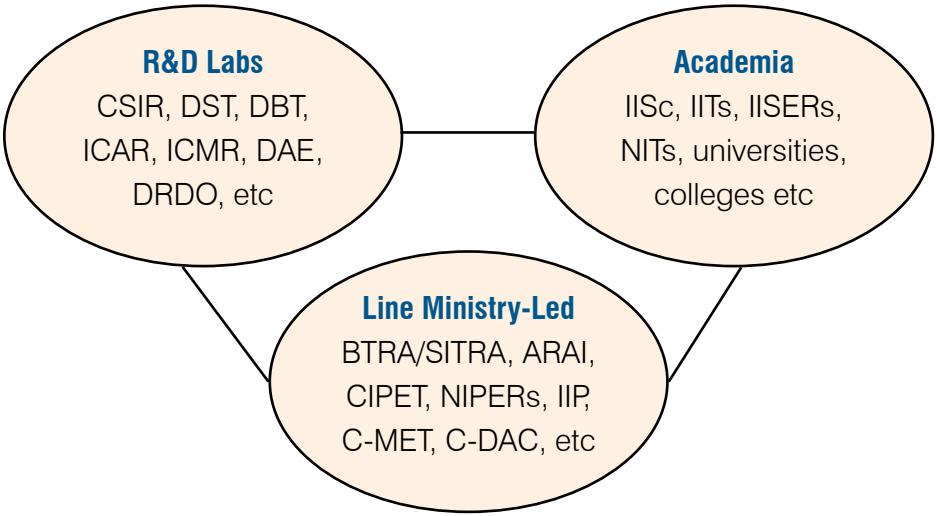
Programme	Details
IP/patent facilitation	• RTTOs of NBM: https://birac.nic.in/ • IPFC of MSME: http://dcmsme.gov.in/IPFC.pdf • PFC of TIFAC: https://tifac.org.in/
Support programmes	• BIRAC PATH: https://birac.nic.in/ • Start-up India - SIPP: http://ipindia.gov.in/ • Support for international patent protection in electronics and & information technology (SIP-EIT):https://www.meity.gov.in/ • MSME scheme: http://www.dcmsme.gov.in/ • State government schemes—for example—MSInS (Patent filing assistance): https://www.msins.in/; Gujarat, Karnataka and others have similar schemes
Programme to facilitate advancing IP from R&D orgs	• Technology acquisition: DSIR PACE: https://dsir.gov.in/ • BIRAC ETA: https://www.birac.nic.in/ • BIRAC PACE: https://www.birac.nic.in/

Grant Funding

Grants are typically provided by governments and non-governmental organisations to achieve specific positive outcomes for society. An example of one such outcome

is encouraging innovation, entrepreneurship and private investments in areas of strategic importance to the country. Grants may also be provided to attract companies to a region, create an attractive ecosystem for start-ups and grow local employment opportunities. A start-up that can attract grant funding can reduce the risk for investors and thereby improve return on investment. In general, grants do not need to be paid back to the funder. However, they include contractual obligations like prototype demonstration, submitting a report, setting up the company in a certain location and hiring local people. Grants might also place encumbrances on the IP generated from the funding. However, most grants available in India offer significant flexibility in the use and commercialisation of the IP resulting from them.

Figure 1.1: Sample of Organisations with Facilities and Equipment Accessible to Entrepreneurs



Commercialisation teams can optimise the chances of securing and utilising grants with a clear non-overlapping scope for each grant application. If the underlying invention has multiple broad applications, the team should ensure that the base invention is fully owned by the start-up and

Table 1.5: Mode of Engagement and Guidelines for Engaging with R&D Labs/Academia

Modes of Engagement	Guidelines
• Technical services: Use of equipment, analytical services, testing services, sourcing from a collection • Consulting services: Advice, reports • Sponsored R&D • Collaborative R&D (usually supported by 3rd party) • Consortia mode programmes • Knowhow/ IP licensing • Spinouts • Pro bono name association; high level advice; mentoring; referrals • Leveraging an institute as students/staff/ faculty	• Keep transactions simple, predictable and within rules; best are listed/ published services • Careful about terms in agreements Remember such organisations do not have too much scope for post-agreement flexibility or changes. Audit is a concern • Avoid unpredictable/ open-ended financial liabilities like patent costs. Fix your costs • PL should be aware of and sensitive to confidentiality, IP boundaries, etc. PL should understand importance of time • Factor in some leakiness of information, especially if students are involved • File background IP before any collaborations • Your mission critical decisions should be with you • See if there are any concessional terms for start-ups/MSMEs/ social/ rural impact. Register under Start-up India

Table 1.6: Sample of Specialised Facilities for Prototyping, Testing and Certification in India

Facilities	Links
Incubators and associated facilities	• BIRAC BioNEST: https://www.birac.nic.in/ • NSTEDB related TBIs: https://www.nstedb.com/ • AIC: https://aim.gov.in/
R&D labs	• CSIR labs: https://www.csir.res.in/ • DST labs: https://dst.gov.in/ • DBT labs: https://dbtindia.gov.in/ • ICMR labs: https://main.icmr.nic.in/ • ICAR labs: https://icar.org.in/ • MEITY: https://meitystartuphub.in/ • URDIP's Anusandhan.net list: https://www.anusandhan.net/
Scientific facilities/ analytical facilities/ testing labs	• NABL: https://nabl-india.org/ • ISTEM: https://www.istem.gov.in/ • SATHI: https://dst.gov.in/ • NTSC (MSME): https://www.nsic.co.in/ • Testing centers (MSME): http://dcmsme.gov.in/ • NTH: https://nth.gov.in/ • NBM: https://www.birac.nic.in/ • DSIR-CRTDH: https://dsir.gov.in/
Prototyping	• Prayshala: https://www.nidhi-prayas.org/ • NBM: https://www.birac.nic.in/

is unencumbered. Application-specific developments can be developed using grants that support the prototyping and validation stages. They can also be narrowly defined collaborations with corporate partners at later stages. Grants available to encourage science-based start-ups from different grant agencies in India are included in Table 1.8.

Figure 1.2: Specialised Facilities for MedTech Product Development at Venture Center

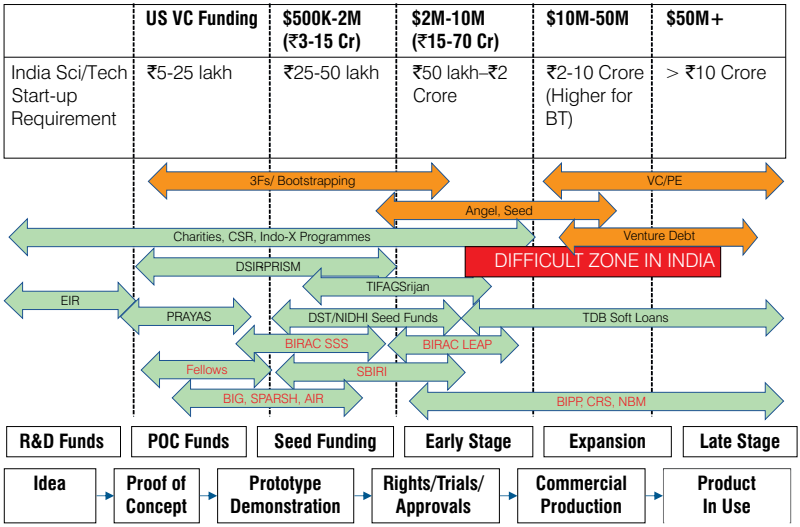
Table 1.7: Facilities Available in the Pune Bio-Innovation Ecosystem

Facilities	Links
Scientific facilities	• CSIR-NCL, IISER-Pune, NCCS, Pune BioCluster, ARI, C-MET, NIV, NARI, NRCG
Facilities at incubators	• Venture Center (VC Analytix, CAMS, Cell Studio), COEP
Industry focused facilities	• ARAI, Auto Cluster Institute, NAFARI
Collections	• NCIM (NCL), NCMR (NCCS), Cell Repository (NCCS), iPSC core banking (NCCS)
Testing and analysis	• CBA (Venture Center), NCIA (IRSHA)
Animal studies	• Intox, Prado, NTC-APT
Clinical studies	• JCDC, various CR arms of hospitals

Seed Stage Funding

Apart from grants, the Government of India provides seed-stage funding ranging from less than ₹30 lakhs to more than ₹1 crore to start-ups through different government agencies and approved incubators, as shown in Table 1.9. In India, private investment is available in select sectors,

Figure 1.3: Funding Sources for Science-based Start-ups in India



Source: funding.venturecenter.co.in

Table 1.8a: BIRAC ("Biotech" defined widely)

	Pre-incorporation	Post-incorporation	₹
Concept → Pre-POC	• SIIP • E-YUVA • SITARE-GYTI		50K/mo 30-50K/mo + 2-5L < 15L
Concept → Pre-POC → POC → Further validation/ scale-up	• BIG (for individual) • SPARSH (for NPO) • AIR (for NPO) • CRS (for NPO) • ETA; ATGC (for NPO)	• BIG • SPARSH • SBIRI • NBM	< 50L < 50L; < 75L + 25L < 50L; <75L + 25L No cap
Trials, regulatory approvals		• BIPP • NBM	No cap (50:50)
Late stage commercialisation and market entry		• PCP fund	Approx < 700L
Fellowships → Grants → Grant with Capped Royalty → Matched Grants → Benefit Sharing with Cap			

https://www.birac.nic.in/

with most funding available in e-commerce, consumer tech, mobile apps, services and ITES. In healthcare, the top categories attracting investment are Health-IT interface and MedTech, followed at a distant third by therapeutics. In recent years, there has been increased activity in FinTech and EduTech. While AgriTech investment is showing signs of growth currently, access to private investment in MedTech is likely to take longer, and investment in ClimateTech is significantly lagging.

Angel investment is the first external private investment into start-ups. Business angels are successful entrepreneurs

Table 1.8b: NSTEDB, DST

	Pre-incorporation	Post-incorporation	₹
Concept → Pre-POC	• NIDHI-EIR • NewGen IEDC Proto Dev Grant		< 30K/mo < 2.5L
Concept → Pre-POC → POC → further validation/ scale-up	• NIDHI-PRAYAS • IIGP Univ Challenge • MA – Stage 1 • MA – Stage 2	• NIDHI-PRAYAS • IIGP OI Challenge • MA – Stage 1 • MA – Stage 2	< 10L < 10-25L < 30L < 100L
Special calls		• DST CAWACH	Grant: Loan (50:50)
Bi-national Programmes	• GITA	• GITA	
Project finance		• TDB	Occasional grant for nationally important projects

https://nstedb.com/new-programmes.htm
http://www.millenniumalliance.in
http://www.indiainnovates.in
https://gita.org.in
http://tdb.gov.in/

Table 1.8c: Other Agencies and Funders

Agencies	Notes
MEITY-TIDE https://meitystartuphub.in	• EIR via TIDE Incubation Centers • Grants via TIDE Incubation Centres
DRDO https://tdf.drdo.gov.in	• Can encumber IP; joint IP requirements
IDEX https://idex.gov.in	• Grants via partner incubators; but against pre-decided problem statements
MoMSME https://msme.gov.in	• Sub-critical; better for micro & small enterprises and NOT start-ups
MoO&G PSUs https://mopng.gov.in/en/refining/start-up	• Can have First Right of Refusal clauses; not ideal for start-ups wanting to raise investor funds
GoM https://www.msins.in	• Government orders; Better suited for companies already in market and with minimal cash flow worries
GoK https://startup.karnataka.gov.in	• Idea2POC Grants; Similar to BIRAC
CSR via incubators	• Type 1: For deployment in the field (more common) • Type 2: Small funds for early-POC, prototype, validation, etc

and high-net-worth individuals who invest directly through their family offices or as part of angel networks such as Keiretsu Forum or facilitated channels such as Lead Angels and Lets Venture, as shown in Table 1.10. In India, individual angels invest in more start-ups than angel networks. Angel investors in India also invest alongside venture capital or private equity funds. In recent years, investments in science-based start-ups have increased, with Ahammune, KB Cols, Ather Energy, Pandorum Technologies leading the way.

Table 1.9: Seed Funding Available via Incubators

Cap	Pre-incorporation	Post-incorporation
< Rs 30 lakhs	• BIRAC SEED • MEITY TIDE • AIM via AIC	https://www.birac.nic.in/ https://meitystartuphub.in https://aim.gov.in/
< Rs 100 lakhs	• NIDHI SSS • BIRAC LEAP • Start-up India Seed Fund	https://nstedb.com/ https://www.birac.nic.in/ https://seedfund.startupindia.gov.in
Others	• Social Alpha (Tata Trust) • Villgro	https://www.socialalpha.org/ https://villgro.org

Venture Capital (VC) and Private Equity (PE) Funding

Venture capital investment in India is made by alternative investment and venture capital funds. Currently, there are more foreign venture capital investors in India than domestic funds. VCs investing in India have a sector preference for real estate, services, IT, industrial products, telecom, media, pharmaceuticals and biotechnology, and invest in later stages of the commercialisation journey. In India, institutional equity funds focus on consumer tech, financial services and industrial goods and services. There is very little PE funding going into sectors such as HealthTech, FoodTech and AgriTech.

Exit Routes

Investors funding start-ups in India realise their return on investments through strategic sales or in secondary markets. However, the recent listing of Zomato on the stock exchange and similar expected listings of other start-ups has rejuvenated interest in public market sales. Although avenues such as SME platforms of public exchanges in India

Table 1.10: Angel Investment Sources in India

Categories	Programme	Link
Angels, in individual capacity	• Successful entrepreneurs • HNI	https://www.fortuneindia.com/long-reads/more-than-just-an-angel/107055
Angel networks	• Keiretsu Forum (Chennai+SG; Delhi + Bangalore; Mumbai) • Indian Angel Network • City based: Mumbai Angels Network, The Bengaluru Angels; Calcutta Angels Network; The Chennai Angels; Hyberabad Angels	https://www.keiretsuforum.com https://www.indianangelnetwork.com
Facilitated angel investments	• Venture catalysts • ah! Ventures • 1Crowd • AngelList India • BITS Spark • CIO Angel Network • Jito Angel Network • Lead Angels Network • LetsVenture • Stanford Angels	https://inc42.com/

https://ventureintelligence.blogspot.com/2017/12/pe-exits-through-ipos-cross-1-billion.html

are available to raise growth capital, the investment raised by start-ups through them is only in the range of ₹10 crore to ₹15 crore. Hence, it may not be a viable option for financing the growth stages of science-based start-ups. Public listing in foreign markets is another viable exit option for Indian start-ups with $100 million or higher valuations.

Based on data from 2017*, rough estimates of returns for VCs

* https://ventureintelligence.blogspot.com/2017/12/pe-exits-through-ipos-cross-1-billion.html

range from 1-14X, with the sweet spot being 10X. Similarly, the average value of a company listing in the public markets is $100M. Irrespective of the multiples, the exit route should provide a high internal rate of return (IRR) for investors. For example, an analysis of investments into Flipkart at the time of its sale to Walmart in Table 1.11 shows that while an early investor like Accel got a multiple of 1260 compared to a late-stage investor like Softbank, the IRR is around 100 percent for both investors.

Table 1.11: Return Multiples to Different Investors of FlipKart at the Time of Sale to Walmart in 2018

	Who	Duration (months)	Investments (m$)	Worth (m$)	Multiple	Speed (m$/m)	Annual Return
Exits	Sachin Bansal or Accel	120	1	1260	1260	10.49	104%
	Ebay	12	500	1100	2.2	50	104%
	SoftBank	8	2500	4000	1.6	187.5	104%

Source: Dr. Premnath Venugopalan, MD, Venture Center

1.2.2 Massachusetts Innovation Hub

The Massachusetts Innovation Hub in the United States goes back 150 years and is known for many successful science-based start-ups. The universities in Massachusetts have had a long-time involvement in research-driven economic development.

Key to the success of this model are the active consulting engagements that academic researchers have had with the industry from the very early days. This model of engagement with industry without violating conflict-of-interest policies created opportunities for professors to identify impactful problems early on and to think about practical applications of

their research. This engagement fuelled a wealth of research that has the potential to catalyse the growth of the economy.

As discussed above, TTOs in academic institutions play an active role in initiating and completing the technology commercialisation process. Having proactive patenting policies and early-stage financing in place as part of the educational institute infrastructure also helped accelerate commercialisation efforts.

Conversely, an example of how poor technology transfer capabilities at university can impact returns to the university is seen in the meagre returns that the University of Illinois in Urbana Champaign (UIUC) made from the invention of the internet and from the founding of Netscape by the inventor.

Eudora, the first email program that could attach documents and Mosaic, the first web browser, were both invented at UIUC. The inventor of Mosaic, Marc Andreessen founded Netscape based on that technology. However, the university only made a total of $8-9 million from these products including a $2 million trademark settlement in cash with Andreessen. Key reason behind this failure was the outsourcing of technology transfer services to a for-profit company by UIUC. The university created an in-house TTO only in 1998.

A similar cautionary tale on how economic impact can leak away from the inventors and the local ecosystem can be learned from the commercialisation of the telephone by Alexander Graham Bell. Bell invented the telephone while working at Boston University. However, neither the inventor, Boston University nor the city of Boston gained any economic benefit from the invention. Most of the financial returns from the manufacturing of the telephones accrued to Chicago.

While the examples of the telephone and the internet demonstrate the powerful impact of academic inventions, they also offer a cautionary tale on how economic benefits can leak away if the right policies are not put in place by the different players in the ecosystem. They also demonstrate that academia can participate in commercialisation without comprising the academic mission.

Realising this, Karl Compton, President of MIT, proposed using academic technologies to create new industries and lead Massachusetts out of the Great Depression. This proposal led to the thriving mini-computer industry based on academic research in Massachusetts. The presence of these start-ups attracted larger companies and investors to the cluster. Massachusetts is the birthplace of organised venture capital that thrived on the ecosystem and the region's proximity to Wall Street.

A similar evolution occurred in the biotechnology space. In 1975 there was just one pharmaceutical company in Massachusetts. Since then, the formation of spinouts from Harvard, MIT, BU, Tufts and other academic institutions and the founding of the Massachusetts Biotechnology Research Park in 1985 changed this completely. Massachusetts offered a diversified skill base in start-ups that developed into the Fully Integrated Pharmaceutical Company (FIPCO) model. These developments were possible due to an academic culture increasingly comfortable with commercialisation and the import of the first generation of management skills that were unavailable locally. The thriving venture capital community and federal grant funding also enabled the growth of these ventures.

Another key component of the Massachusetts ecosystem

is the strong network of incubators. These bring people together and encourage cross-pollination of ideas. They provide start-ups with facilities to do research and work as economically as possible. They also bring in a wealth of business experience in the form of employees and mentors. Even with all these ingredients, it took 25 years for Massachusetts to become a world-leading centre for pharma R&D and biopharmaceutical manufacturing.

Other key ingredients that made this high-tech cluster possible include high quality of life, synergy with local industry and strong cooperation between academia, local industry and government (see Table 1.12).

Table 1.12: Ingredients of a High Tech Cluster

- A major research university
- Quality of life
- Build on local industry
- Cooperation between local university, business and government
- Technology transfer from the university
- Funding sources – state, VC, angels
- Incubators

Dr Suman Bery, VC, NITI Aayog

According to you, what is the role of NITI Aayog in catalysing science-based entrepreneurship?

One of the objectives of NITI Aayog is to create a knowledge, innovation and entrepreneurial support system through a collaborative community of national and international experts, practitioners and other partners. More broadly, we design strategic and long-term policy, programme frameworks and initiatives, and monitor their progress and efficacy. The Atal Innovation Mission (AIM), NITI Aayog, is a one of its kind intervention by Government of India to foster the spirit of innovation and entrepreneurship in India. The AIM-PRIME programme is its strategic initiative to promote science-based entrepreneurship.

What are some of the ways in which NITI Aayog is encouraging science-based entrepreneurship?

Through AIM, NITI Aayog has created an ecosystem of entrepreneurship in universities, research institutions and private and MSME sectors by establishing more than 68 Atal Incubation Centers (AICs) across the country. These AICs support the incubated start-ups by providing technical facilities, resource-based support, mentorships, funding support, partnerships, networks, co-working spaces, and lab facilities. AIM has also launched more than 24 Atal New India Challenges in partnership with different ministries and departments of the central government to create product and service innovations having national socio-economic impact.

What is your message to the scientists interested in creating societal impact based on their research?

India needs indigenously developed technologies that keep it on its path towards sustainable growth while ensuring national resilience. NITI Aayog is working with various stakeholders to define clear policies to accelerate the pace of adoption of new technologies and ensure resource security. As scientists take their research from lab to market, they should engage with us as early as possible to develop the right policy and regulatory environment to facilitate their broader adoption.

I am delighted to share the enthusiasm and energy of these scientists working to developing world-class innovations and look forward to working with them to create a conducive policy environment for their success.

Dr Suman Bery

Shri Amitabh Kant, CEO, NITI Aayog

According to you, what is the role of NITI Aayog in catalysing science-based entrepreneurship?

India aims to be a $5 trillion economy by 2024-25. Nurturing innovation and entrepreneurship is an essential component of achieving this growth target. NITI Aayog has been instrumental in developing pro-innovation, light touch and progressive policies to encourage entrepreneurs to grow and prosper. Since the launch of our Start-up India movement, over 1,600 startups were added to the ecosystem in 2020. By developing innovative strategies and technology solutions, we support India in successfully clinching its leadership in all sectors including healthcare, education, financial inclusion and modernisation of agriculture.

What are some of the ways in which NITI Aayog is encouraging science-based entrepreneurship?

My belief is that the development of world-class start-ups requires skillful application of technology, mentorship and strategy. NITI Aayog supports such start-ups through its various AIM programmes by providing five critical inputs: flow of innovation via ambitious young entrepreneurs, supportive infrastructure, focused outreach, empowering strategies and enabling of the policy environment to encourage such start-ups and help them succeed.

What is your message to the scientists interested in creating a societal impact based on their research?

In a large and diverse country like India, it is it is not only the introduction of new initiatives, but the ability to rapidly execute and to scale up existing programmes to reach out to our 1.3 billion citizens in both local and vernacular languages that will be crucial to achieving success. By bringing together technology and entrepreneurial promise, we must work towards the greater good. Through programmes like AIM-PRIME, we look forward to nurturing an innovative breed of socially-conscious and development-oriented scientists and entrepreneurs to build inclusive solutions that are scalable and available at affordable cost.

"By developing innovative strategies and technology solutions, we support India in successfully clinching its leadership in all sectors."

Shri Amitabh Kant

Dr V K Saraswat, Member, Niti Aayog

According to you, what is the role of science and technology in our economic growth?

Science is a tool for solving our society's problems and has the power to transform civilisations. It can lead to India's long-term global competitiveness and sustained development. However, the goal of application of science and technology should go beyond the generation of knowledge alone. An interdisciplinary approach to learning by combining science and social engineering is essential to develop ethical and sustainable solutions.

What are some of the ways in which the government can encourage science-based entrepreneurship?

Taking science from lab to market needs government funding and support for basic and translational research. Downstream

development needs to be funded by private investments. We should focus on targeted funding in early stages and proactive policy to encourage private investments in later stages. We should also develop strategies for optimal utilisation of available resources and for sustainable development. Given our country's challenges related to access to critical technologies, we should focus on developing an indigenous capacity for innovation in areas that are critical to our nation by building the required specialised human resources, infrastructure, and a conducive environment for innovation. This requires broadening of the national research and innovation system to optimise investment in science, technology, and innovation.

What is your message to the scientists interested in creating societal impact based on their research?

Scientists need to take three sub-leaps to create societal impact in India. This includes traditional approaches to surmount current challenges at an accelerated pace, adopting new or different approaches and technologies that may be developed elsewhere and finally, leapfrogging current generations of technologies to develop next-generation technologies. They should learn ways to exploit their intellectual property and to identify ways in which their high-tech innovations can add value. They should also learn to take their inventions to the market through programmes like AIM-PRIME.

"An interdisciplinary approach to learning by combining science and social engineering is essential to develop ethical and sustainable solutions."

Dr V K Saraswat

Prof. Ajay Kumar Sood, Principal Scientific Advisor (PSA) to Government of India

According to you, what is the role of the Office of PSA in catalysing science-based entrepreneurship?

The Office of Principal Scientific Advisor (PSA) was established in 1999 to provide pragmatic and objective advice to the Prime Minister and cabinet on matters related to science, technology and innovation with a focus on application of science and technology. We play a critical role in defining the research priorities of the country, providing an enabling ecosystem for technology-led innovations and techno-entrepreneurship. We enable effective public-private linkages for driving research and innovation.

What are some of the ways in which Office of PSA is encouraging science-based entrepreneurship?

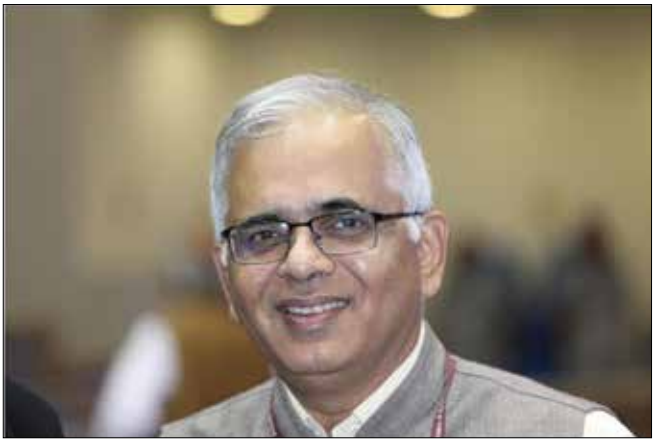
We have worked closely with the Department of Science and Technology (DST) to launch the Science, Technology and Innovation Policy (STIP 2020) to reorient India's science, technology and innovation in terms of priorities, sectoral focus and strategies. Closely coordinating with the New Education Policy launched by the Ministry of Education, STIP provides a roadmap to balance the needs of the research community, industry, and society through sound government policies both at centre and at individual state levels. We have also launched I-Stem, a national portal which assists researchers to locate the specific facilities needed for their R&D work. We are also creating S&T clusters in various cities to create strong linkages between existing academic institutions, national and state research laboratories, and other stakeholders. These clusters will provide a shared ecosystem for the stakeholders to identify regional problems and build on their mutual strengths to become nationally and globally competitive solution providers.

What is your message to the scientists interested in creating societal impact based on their research?

To create societal impact based on research, they need to be interactive and need to take it all the way from research to commercialisation. Industry and academia have different priorities and we need to create interface structures such as technology transfer offices to perform impedance matching. The AIM-PRIME programme and this Playbook will bridge the knowledge gap in our ecosystem to do this.

I wish all the science-based entrepreneurs the very best of luck!

Prof. Ajay Kumar Sood



Dr Shekhar C Mande, Ex-Director General,
Council of Scientific and Industrial Research (CSIR)

According to you, what is the role of CSIR in the science and technology ecosystem?

India has a rich history of science and technology. Our founding fathers have emphasised the importance of science and technology in solving the challenges of our nation. In fact, the importance of developing a scientific temperament has been codified in Article 51A of our constitution as a fundamental duty of every citizen. At the time of our country's independence, India faced several challenges, such as low infant mortality and low industrial growth. CSIR and the 37 labs under its umbrella have played a critical role in addressing several of these challenges and working with the industry to create societal impact. As we celebrate 80 years of CSIR, our vision is to pursue science that strives for global impact, technology that enables innovation-driven industries and nurture trans-disciplinary leadership, thereby catalysing inclusive economic development for the people of India.

What are some of the ways in which CSIR is encouraging science-based entrepreneurship?

CSIR labs are the most prolific patent holders in the country. We have a strong culture of working in close collaboration with the industrial community and transferring our scientific knowledge and skills to the industrial community to create impact and bring about measurable change. We have several incubators, such as Venture Center, Pune, and CSIR-CCMB, Hyderabad, associated with our labs. We recently started an aerospace incubator in collaboration with Social Alpha and NRDC at Bengaluru. These incubators have several programmes to hand-hold science-based entrepreneurs and mentor them.

What is your message to the scientists interested in creating societal impact based on their research?

Scientists are motivated to do research for different reasons ranging from purely advancing knowledge, translating the knowledge accrued to technology and catalysing societal impact. To create societal impact based on research, it is important to have a mindset of creating wealth from research. This requires thorough assessment of societal needs and addressing them using science. It is a process that requires both deep thinking and courage. The scientists also need to collaborate with others to perform market research and raise necessary funds. The start-up policy of India has given a large boost to our entrepreneurs to take innovative technologies to the market. With such proactive policies to support them, these are truly exciting times for scientists and entrepreneurs across India to create real societal impact by taking their scientific innovations and technologies to market.

D. Shekhar C Mande

1.3 From Inventions to Innovations

"Invention is the root of innovation. Innovation is the major force for change in the future"

– Philippe Kahn

The first step in creating impact from science is to translate science into products and services that people can use to solve their problems. This process of innovation is subtly different from the process typically used by scientists to conceive their inventions.

Both inventions and innovations start with a good problem definition. To invent good science, graduate students spend several months going over journal articles, reviewing papers in their field, working with seniors in research labs, and discussing with their supervisors before formulating their thesis topics. The focus of this search is often on finding interesting technology whitespaces where they can make unique contributions. This supervised search for a problem is refined through the years of graduate study as the student develops new hypotheses, designs experiments to validate them and develops new knowledge. In later years, researchers often write proposals to various funding agencies. These proposals are scrutinised for the nature of the problem they are solving and the contribution of their solution to the overall body of research in the field, in addition to any programme-specific goals.

To establish market relevance for the science, the scientist needs to add to this arsenal by expanding both the goal of the search and the methods used to define and solve the problems. Approaches to innovation are broadly grouped, based on whether they are user-driven, analysis-driven or

research-driven. In this section we examine examples of each of these approaches.

1.3.1 Design Thinking – A User-Centric Approach

Design thinking is a method of creating innovative solutions to solve problems that are difficult to articulate or difficult to define by understanding the implicit needs of users. It is especially relevant to situations where the target user is well defined and the market need is immediate. Design thinking also makes the implicit assumption that the technology required to solve the customer's problem already exists.

This technique is especially useful for synthesising a unique solution to users' needs based on existing technologies in science-based entrepreneurship. The emphasis of the method is to go beyond the obvious problems articulated by the customers and understand their implicit or poorly defined, unmet needs. It provides a systematic way to balance the user needs with technical feasibility and economic viability.

While there are several frameworks to implement this method, the broad steps involved in design thinking are as follows:

- **Needs Identification:** The first step of design thinking is to formulate a hypothesis on the broad problem that needs to be solved by doing an extensive literature search and review of secondary sources of data about the user. This step is followed by a phase of intensive primary user research to validate or modify the hypothesis. This includes observations and interviews of the user and immersion in the user environment. Empathy towards the users and their environment

without being prejudicial is crucial to gaining the deep insights required in this phase.

- **Needs Screening:** Dispassionate user research can unearth many potential user needs. These needs are prioritised based on criteria relevant to building a successful enterprise. These include the urgency of the problem and economic feasibility. The prioritised list can be further refined based on further rounds of needs identification and screening and inputs from all the relevant stakeholders of the venture.
- **Ideation and Prototyping:** In this phase, the prioritised set of needs is used to arrive at several product and solution concepts. These concepts are validated based on technical feasibility, usability, time to market and manufacturability, using prototyping and storyboards to converge on a solution that satisfies user needs while creating value for the stakeholders.

An example of this method is the Biodesign methodology developed by the Stanford Byers Center for Biodesign.

1.3.2 Inventive Problem Solving – An Analysis-Driven Approach

Inventive problem solving is a product development approach for creating value for the customer using an insightful idea and successfully taking it to the market. It is especially useful for generating sustaining and efficiency innovations in science-based enterprises. To create insightful ideas, there needs to be clarity on the nature of the problem. The idea should be sufficiently inventive to create technology differentiation and to raise barriers to entry using intellectual property protection. It should also be scalable and empower the user.

Generating ideas of this kind is fraught with challenges, such as loss of focus from factors like changing business priorities, timelines and budget constraints. Generating highly differentiated ideas is an inherently creative process that can be hindered by poor problem definition, experiential bias, real or perceived hierarchy among team members, lack of openness, premature convergence and early judgement.

The Innovation FLOW framework is a combination of several simple tools to generate highly differentiated and insightful ideas. It comprises the following three key stages:

- **Focus:** This is the divergent phase of the framework involving studying the opportunity space, gathering insights and formulating the right problem. The skills required for focusing are the abilities to observe, question, incubate, associate and experiment. Of these, the ability to question is the most important. Examples of simple tools that can enable the formulation of good questions are as follows:
    - **Kipling's questions:** Arising from a fragment of a poem by Rudyard Kipling in the tale *Elephant's Child*, this method involves asking the 5W1H (Who, What, When, Where, Why and How) questions as shown in Table 1.13. Broad insights about the problem can be gained by repeatedly asking these questions to the various stakeholders.
    - **5 Whys:** This is a simple interrogative technique developed by Sakichi Toyoda and used extensively within the Toyota Motor Corporation. It involves repeatedly asking "Why?" to gain deep insights into the causal links underlying a particular problem.

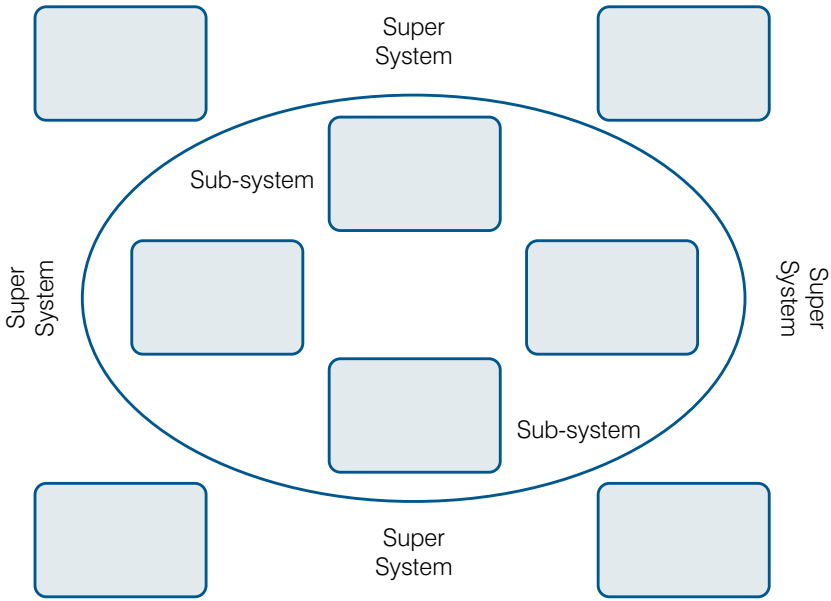
Table 1.13: Kiplings Questions

Questions	Answers
Who is affected?	
What is the problem?	
How is it a problem?	
When is it a problem?	
Where is it a problem?	
Why is it a problem?	
Who is not affected? (Inverse probe question)	
When is it not a problem? (Inverse probe question)	
Where is it not a problem? (Inverse probe question)	

Analysis of the problems identified during the questioning phase can be done using the following structured tools:

- **Innovation Opportunity Map:** This method involves using a systems approach to map the problems identified to the sub-system level of independent components of the product, system or product level and supra-system level that includes all the extraneous factors influencing product performance and usage, as shown in Figure 1.4. This analysis allows the team to focus on the most relevant problems.
- **Nine Windows:** In this method, a temporal dimension is added to the innovation opportunity map to understand the problem from past, present and future perspectives, as shown in Figure 1.5. Analysis of the past enables the team to validate the assumptions made in the past. Similarly, analysing the future will prevent the team from solving problems that may not be relevant in the future, or from adopting soon-to-be redundant technologies.

Figure 1.4: Innovation Opportunity Map



- **Leap and Orient:** In this phase, the team LEAPS past the old ideas and generates new ideas while orienting to next-generation technologies. This phase aims to generate disruptive ideas to create an ideal solution according to the theory of inventive problem solving (TRIZ). An ideal solution (see Figure 1.6) maximises the useful functions while minimising its harmful functions and costs. These components of the ideal solution are used as a starting point to generate new ideas using creativity techniques like CREATE. CREATE involves Combining, Rearranging, Enhancing, Adapting, Turning around (or doing the opposite of conventional thinking) and Eliminating (different components of) existing solutions to generate and refine new ideas over multiple sessions. These multiple sessions are spread

over time to allow the ideas to incubate and mature. These ideas are then prioritised through the design thinking lenses of desirability, viability, sustainability and feasibility to ORIENT the team towards the most workable solutions. (Refer to Figure 5 for more details).

- **What's Next?:** The shortlisted ideas from the previous phases are taken to the market in this phase. In addition, this phase helps the team identify the technology and market transitions on the horizon to identify the next problem.

1.3.3 Competitive Technology and Market Analysis – A Research-Based Approach

One of the major re-orientations that scientists need to make as they become science-based entrepreneurs is to re-frame their contributions from a purely scientific novelty perspective by asking "What problem am I solving with this

Figure 1.5: Nine Windows of Innovation Opportunity

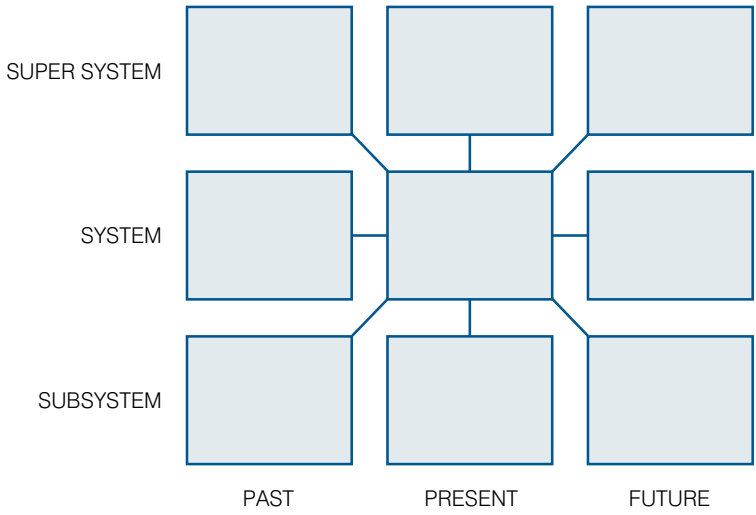
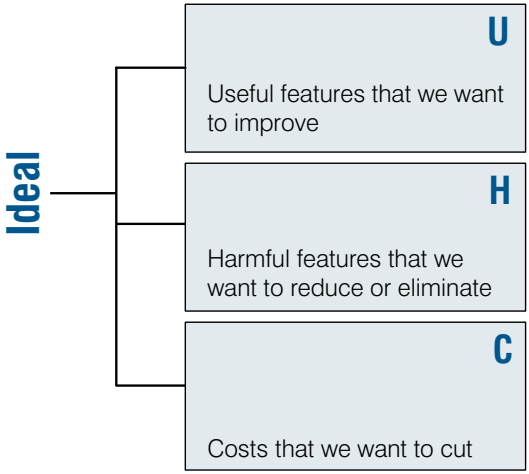


Figure 1.6 : Ideal Solution

$$\text{Ideality} = \frac{\sum \text{Useful effects}}{\sum \text{Harmful effects} + \text{Costs}}$$



science?" and "Will I be able to create tangible real-world impact by solving it?". Where the problems and impact are immediate, the techniques discussed in Sections 1.3.1 and 1.3.2 can be used. However, just as science stays ahead of today's needs, science-based entrepreneurship stays ahead of the immediate problems faced by consumers. So the problems addressed by the scientists in their labs today should create a tangible real-world impact in the future. To do this, scientists need to understand the evolution of the technology and competitive landscape around their science. In addition, they need to have a broad understanding of the evolution of the market. Here we will incorporate these long-term technology and market trends to identify an impactful problem to solve.

- **Time to Market:** The first parameter to set as part of this analysis is the time horizon over which scientists want to develop and commercialise their inventions.
- **Long Term Trends:** Once the time boundaries are set, the next step is to understand the macro trends related to technology. In addition, the scientist should be aware of the socio-cultural, demographic, legal and economic trends that impact the significance of the problem being addressed, or the diffusion of the technology down the road. For example, when the first synthetic plastic material bakelite, was first invented at the beginning of the last century, it was the miracle material of that time. The same invention today or any invention to make plastic material based on fossil fuels is unlikely to be commercially successful at that scale, as it doesn't align with the current priorities of the world such as reduction of global greenhouse gases, global warming and material pollution. Sources of information for this analysis are technology roadmaps and future trends reports created by think tanks, funding agencies, strategy consultancy firms and professional societies.
- **Technology Landscape:** A thorough literature search is routinely undertaken by scientists before starting any new research. To identify a scientifically novel and technically and commercially impactful problem in the real world, scientists need to expand on this by including a prior-art search of patents related to their field. An additional review of the field's intellectual property (IP) landscape can help unearth technology whitespaces. It can also help identify key research

groups and start-ups doing cutting edge research in their area. However, this data is likely to be at least 18 months old, as patent applications are only published 18 months after the initial filing. Hence, this data needs to be supplemented with a close watch of conference papers and poster presentations from these key groups and direct professional communications with the scientists. Apart from paid resources like SCOPUS, ScienceDirect, PubMed, and Clarivate, free sources of information for this data are Google Scholar, Google Patents, the Lens, WIPO's PatentScope, Espacenet, US PAIR and similar patent information sites from different countries.

- **Market Landscape:** Once the whitespaces in their field are identified, scientists need to be aware of the major headwinds that impact the future success of their invention. Similarly, they need to understand the major drivers that can enable a successful enterprise based on the science they develop. If the time horizon for going to the market is less than five years, data to make this call will be available in the form of market reports and techno-commercial reports by industry and trade associations. In situations where the horizon is likely to be longer than five years, this analysis needs to be made based on long-term macro trends (discussed above) and several well-articulated assumptions that are validated over time as the research progresses.
- **Industry Analysis:** This step involves understanding the characteristics of the industry the scientists are targeting with their invention. These include understanding where the industry is on the innovation

S-curve, typical profit margins, readiness to adopt new technologies and concentration of incumbents across geographies and supply chains. The S-curve describes how mature the industry is and how open it will be to new solutions. A sector that has many players with marginally differentiated products is likely to be a mature, highly competitive, low-profit margin sector with little scope of high impact science-based innovations. New inventions in this industry must be directed at driving the next S-curve to create a major impact. An industry where the supply chains are tightly integrated will have a significant barrier to entry for new start-ups. In these industries, commercialisation by the formation of a start-up will be very challenging. An analysis of the geographical concentration of the industry players will give a good indication of the ability to reach and collaborate with them during the various stages of evolution of the invention from lab to market.

- **Boundary Conditions:** Other boundary conditions to keep in mind are considerations like access to the required instrumentation and lab facilities, the availability of talent to both develop the invention and to later commercialise it, ability to get access to any data that is required and availability of financial resources to perform the research to develop the invention.

By evaluating all potential ideas along these dimensions, a scientist can identify an impactful idea. In addition, it will give visibility into potential show stoppers and assumptions that need to be tackled and validated as the research progresses towards innovation and the market. This journey from lab to market is discussed in more detail in Chapter 2.

Case Study: Idea Stage Analysis

Ananth is doing his PhD in sol-gel processes and is interested in tackling sustainability challenges of the cement industry. After some literature review, he was convinced that the best way to address the problem is to reduce the amount of cement in concrete by sand and cement-based sol-gel. He quickly ruled out desert sand, procured sand samples from different river banks and ocean beaches around the country, and started to experiment with formulating the sol-gels, making blocks of the materials, and testing them. The initial results in the lab were very encouraging. He filed the appropriate patents and started to explore ways to commercialise them. As the scale of the experimental processes increased, his team found it challenging to scale up the multi-step process. He also found that the government had banned quarrying the specific sand that gave them the best results. Consistent sourcing of other types of sand became a challenge as various factors such as shoreline erosion and local protests led to restrictions of sand quarrying in different locations. Questions around the environmental impact of sand quarrying put a pall over the sustainability claims of the technology. In addition, difficulty securing a stable raw material source and challenges around process scale-up made it challenging for the team to find investors. By systematically analysing these challenges at the idea stage or at least before exploring commercialisation options, Ananth could have saved significant time and effort on the project.

Key Takeaways

Before starting research on a commercialisable idea or, at the latest by the time an initial proof-of-principle of the technology is established in the lab, the team should understand potential challenges related to scale-up, raw material availability and regulation that can constrain the ability of the team to successfully take the idea from lab to market.

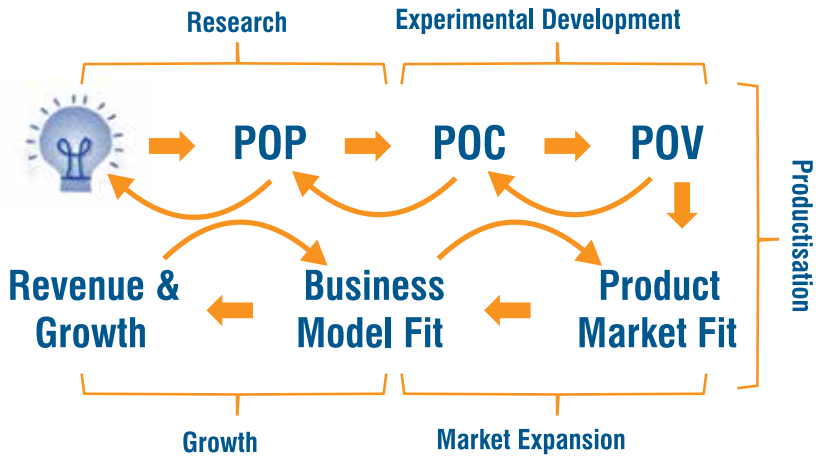
2. From Lab to Market – The Commercialisation Journey

"If you can provide value and societal impact with your technology, that's a great mission to have"

– Christina Pellicane, Lignolix

The journey of science from lab to market is about translating the invention into products and services that create value to customers in different markets. The stages of this journey, shown in Figure 2.1, are as follows:

Figure 2.1: → Stages of the Lab-to-Market Journey

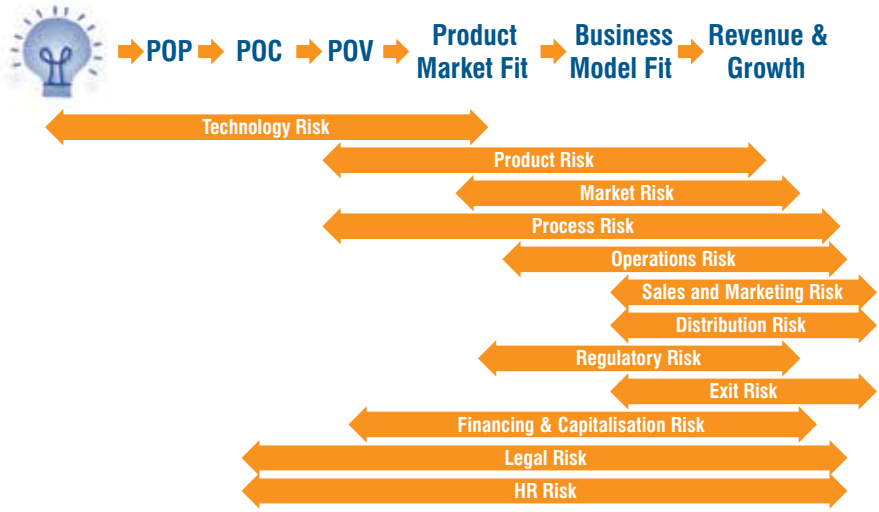


- **Idea Generation:** This is the first stage of the journey where an impactful problem is identified.
- **Proof-of-Principle (POP):** A solution that in-principle solves the problem is demonstrated in the lab at this stage.
- **Proof-of-Concept (POC):** A scaled-down but realistic prototype is demonstrated in controlled conditions that reasonably replicate potential use cases encountered in the real world. This prototype demonstrates the technical feasibility of a potential product.
- **Proof-of-Value (POV):** A realistic prototype is demonstrated in real-life environments to validate the potential value that the technology can provide to customers. This demonstration also provides a good indication of customers' willingness to pay for and use the product.
- **Product-Market-Fit:** At this stage of the journey, a product that delivers a clear, demonstrable and measurable value proposition to customers is developed and validated by users. Sales primarily happen through organic channels like word-of-mouth and repeat orders from existing customers.
- **Business-Model-Fit:** A business model to penetrate the market, generate revenue and enhance shareholder value is developed and validated.
- **Revenue and Growth:** At this stage, the business model is scaled to reach a wider customer base and grow revenues.

This journey is filled with different risks at different stages, as shown in Figure 2.2. There is high technology risk in

the early part of the journey, market and product risk in the middle, and scale-up risks such as operations, sales and distribution, and exit risks in the later stages of the journey.

Figure 2.2: Risks in Lab-to-Market Journey

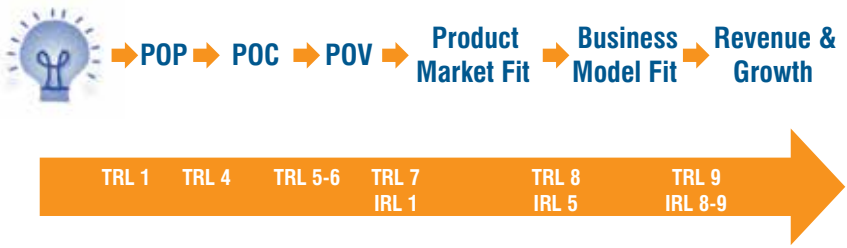


The progress of this journey can be measured using different milestones such as Technology Readiness Levels (TRLs) and

Figure 2.3: Description of Technology and Investment Readiness Levels

Technology Readiness Levels		Investment Readiness Levels	
TRL1	Basic Principles Observed and Reported	IRL1	Complete First Pass BMC
TRL2	Technology Concept and Application Formulated	IRL2	Market Size / Competitive Analysis
TRL3	Initial Experimental Validation	IRL3	Problem / Solution Validation
TRL4	POP Demonstrated in Lab	IRL4	Low Fidelity MVP
TRL5	POP Demonstrated in Relevant Environment	IRL5	Validated Product Market Fit
TRL6	POC Demonstrated in Relevant Environment	IRL6	Validate Revenue Model
TRL7	POV Demonstrated in Operating Environment	IRL7	High-Fidelity MVP
TRL8	Commercial System Ready for Sale	IRL8	Validated Value Delivery
TRL9	Ready for Full Scale Deployment	IRL9	Identify and Validate Metrics that Matter

Figure 2.4: Readiness Levels at Different Stages of Lab-to-Market Journey



Investment Readiness Levels (IRLs), shown in Figure 2.3. TRLs were developed by NASA and adopted by European Union Horizon 2020 projects. IRLs were developed by Steve Blank, who pioneered the lean launchpad methodology for commercialising research. Figure 2.4 shows how these readiness levels align with the different stages of the lab-to-market journey. While the milestones are similar for different inventions, the specifics of the journey are unique to the team and the combination of the invention, markets and their local ecosystem. This section describes the details of each stage of this journey.

2.1 Idea to Proof-of-Principle

In the idea generation stage of the Lab-to-Market journey, an impactful research problem to solve is identified using the process discussed in Section 1.3.3. This step is followed by a divergent research phase, where various hypotheses are formulated and tested to characterise the problem and develop potential solutions. These potential solutions are tested in the lab on a limited scale to validate that the candidate solutions can, in principle, solve the problem. The candidate solutions that pass this POP stage of the journey are inventions that can be potentially commercialised. At

this stage of the journey, the team—primarily consisting of researchers—has developed some IP that may be protected using various methods discussed in Section 3.6, and some know-how that only team members possess. This first stage of the lab-to-market journey is invisible to most private investors and corporate partners.

The next stages of POC and POV are part of experimental development, where the readiness of the invention to solve real-world problems is validated. These stages are especially important to validate inventions where technology risk and investment required to commercialisation are high and time to market is potentially long. The technology risk may arise from unknowns related to commercial parameters such as cost of commercialisation, cost of the solution, switching costs, cost of integration, deployment and maintenance of the solution, life-time performance and reliability of the solution, and scalability of the solution. It can also arise from uncertainties related to the time taken to address these unknowns.

The performance of an invention in the lab is often characterised by a quantitative measure called 'figure-of-merit'. For example, the performance of a battery can be characterised based on figures-of-merit such as energy density, power density, stability and recharge time. While a new battery material synthesised at the POP stage might demonstrate superior performance against one or two of these metrics, it needs to perform well against all metrics of importance to the different markets and applications of interest. The translation of these figures-of-merit to the other commercial parameters discussed above is not always obvious. In addition, the time taken to gain this clarity is

often difficult to estimate. Since the investment requirements for development and deployment are high, the burden of proof required by investors and potential customers is also high. The POC and POV stages of the journey address these concerns.

2.2. Proof-of-Principle to Proof-of-Concept

During this stage of the journey, the team has to gain deeper insight into the commercial parameters that need to be validated and how the invention can be further developed to address unknowns in translating the figure-of-merit to those parameters. Based on secondary market research, review of techno-commercial magazines and advice from industry experts, the most critical uncertainties to be addressed are identified. One or more scaled-down versions of prototypes are built and tested in a lab to generate data required to validate commercial performance. The sophistication of these prototypes and the ability to replicate industry standard test conditions in the lab depends on the availability of testing infrastructure and financing.

These prototypes and data can be great conversation starters with industrial players and end users to conduct primary research on test conditions, protocols and performance metrics that matter to them. In addition, feedback from the different players and performance data collected from the POC prototypes can help the team identify the next set of critical parameters to validate in the commercialisation journey. Well-designed POC prototypes can reduce the technology risk substantially by resolving the most critical uncertainties on the path to commercialisation. It can also help the team secure

financing and identify collaboration partners to further develop the technology towards the market.

However, the validation provided by the POC prototypes may often be inadequate, since they are scaled-down prototypes working under a limited range of test conditions that may only partially replicate real-world conditions. Hence, further validation of the solutions in the real operating environment may be required.

2.3. Proof-of-Concept to Proof-of-Value

Building and testing a POV prototype that validates the value of the technology in real life is often expensive, resource-intensive and time-consuming. For solutions targeting consumer markets, the POV stage involves building a robust enough version of a deployable product and signing up first customers who are willing to use it on a trial basis and provide feedback on performance. The team should be able to produce enough number of these units to offer to the first customers for testing. This may require partnering with existing manufacturers who are willing to produce the product in low volumes or access to facilities to produce the product in low volumes. For solutions that need to be integrated with other systems, the POV stage involves getting access to the larger system into which the solution needs to be integrated and testing its performance. This requires either substantial funding to acquire the larger system or access to test bedding facilities or working with collaborators who can provide that access. For example, POV stage testing of a new EV motor suitable for trucks involves either the ability to buy or access a standard truck which the team can retrofit

with the new motor, or working with an end user or truck manufacturer who can provide the team with this access. For POV stage of a new process related inventions or a new material, this may require close collaboration and partnership to co-develop the system based on the core invention, and test it.

Hence it is very important at this stage to identify the general outlines of the value proposition to customers and partners. The team should also be aware of similar competitive offerings and find a way to differentiate their solution. It is also important at this stage to identify commercial parameters that are most valued by customers. The process starts with identifying broad target markets, potential solutions that can be built in these markets using the invention, and customers for each solution. This identification is done through in-depth interviews of key stakeholders in the target markets and understanding the fit between the invention and stakeholder needs. These opportunities are further vetted based on the following:

- Potential value creation opportunities including the invention's competitive advantage, potential market size, expected growth rates and preliminary financial viability. At this stage of the journey, understanding of the value creation opportunities is primarily based on secondary sources of data such as market reports and preliminary interactions with stakeholders.
- Potential challenges to value capture include time-to-deployment and implementation obstacles like scalability, integration, reachability of the market and resource availability.

- Potential external risks include changes to the regulatory environment and competitive landscape.
- Network effects that may lead to delay or loss of value creation opportunities.

Opportunities where the potential value creation outweighs the challenges identified above are used as a basis for building POV prototypes. The commercial parameters that are most relevant to these opportunities and overlapping technical requirements that need validation are identified. Examples of such requirements are reliability, lifetime performance, maintenance, installation and end-of-life disposal. These technical requirements are then prioritised for validation based on the sophistication of the invention, available resources, existing IP portfolio, access to complementary technologies, practical implementation issues, time-to-market considerations and technical and business competencies of the team. These prioritised technical requirements are demonstrated in the Proof-of-Value prototype. Ideally, the POV prototype targets customers who satisfy the following criteria:

- They have a problem that the invention is trying to solve.
- They feel the urgency to solve it and have been actively looking for solutions.

A good Proof-of-Value prototype provides dynamic, real-life validation of the invention by reducing the uncertainties around different commercial parameters and time to market. It identifies areas for further improvement and demonstrates potential use cases for value creation. It also helps identify potential scale-up issues and business models for wider deployment.

The key assets created after the successful POV

Case Study: Market Opportunity Identification

Sri developed a new fluorescence material that could absorb ambient light and emit it for several hours after exposure. The process for making the materials was scalable, and the material was non-toxic. One of the early applications that Sri's team explored was incorporating the material as an additive in paints. They saw the value in using such paints for lane markings and signs on highways, indoor walls, etc. But after some initial pilots, the paint manufacturers found that the unit economics did not favor the material. Sri's team then pursued the researcher market by distributing it to other labs, but it was a small market, and the business was not scalable. During one of her trips to Europe in late fall, she saw large domes of what appeared to be plastic covering the fields, and her travel companion from the region informed her that the plastic covers saved the crops from frost. They also kept the heat in to help the crops grow. She realised that there could be a potential application for their materials there. After successfully solving the challenges of incorporating their material into the plastic sheets by working with the plastic manufacturers and running experiments with her collaborators in Europe, her team demonstrated a substantial increase in crop yield from using her material for that application. This clear value proposition provided the first viable path for the successful commercialisation of the material.

Key Takeaways

Finding the right market fit can be a trial-and-error process that can be consume precious time and resources. The team can manage this process by doing a systematic analysis of all potential opportunities for value creation and assessing the challenges and risks by talking to different stakeholders before exploring the opportunities.

demonstration are different forms of IP assets and the know-how related to the invention, data and reports from the demonstrations at different stages of development, working prototypes that demonstrate value creation and testimonials from successful deployments. While the IP and know-how are central to the value created during the commercialisation journey, the other three outputs provide supporting evidence. By establishing the POV for the technology, the technology

risk inherent in the journey is substantially reduced, and the team starts to address the product risk. As the team continues towards the next stages of the journey, focus shifts from technology development towards product development and gaining deeper market insight to address the product and market risks.

2.4 Proof-of-Value to Product-Market-Fit

An invention which has low uncertainties associated with commercial parameters and time-to-market can be commercialised by either licensing the technology to third parties or by building a tangible product and taking it to the market. Key considerations that go into this evaluation are as follows:

- **Packageability:** This is the extent to which the invention can be transferred through explicit means such as drawings, prototypes, data, algorithms, specifications and bill-of-materials. The more this information can be captured explicitly, the easier it is to license the invention.
- **Absorption Capacity:** The ability of the licensee to successfully commercialise the invention depends on the licensee's ability to understand the explicit and implicit nuances of the invention and the licensee's resource availability. A well-funded licensee with the right team to accept intangible IP assets and convert them to tangible deployable solutions in the market has the absorption capacity to commercialise the invention successfully.
- **Value Chain Positioning:** Inventions that fit into existing

value chains are easier to commercialise via licensing. Inventions that require the creation of new value chains or change interaction among current players need to be taken further along the commercialisation journey by taking them to the market directly.

- **Comparative Performance:** Inventions that can demonstrate better performance than incumbents along significant metrics used in markets can be licensed successfully. In comparison, those with better performance along dimensions that are not immediately significant in the market are harder to license.

Once the team decides to deploy the invention in the market directly—either exclusively or in combination with a licensing strategy—a formal business venture with a full-time team to take the commercialisation journey forward is usually created. This team then reviews value creation opportunities identified in Section 2.3 based on learnings from the POV deployments to identify potential customers and sharpen the value proposition to each of them.

2.4.1. Estimating Market Potential

At this stage of the commercialisation journey, potential opportunities, customers and their characteristics as identified in Section 2.3 need to be further analysed to estimate the potential size of the different opportunities, in order to identify opportunities that can grow. This estimation can be done by starting with an assessment of the Total Available Market (TAM), the portion of the market that presents an opportunity for the team—the Serviceable Addressable Market (SAM)—and the share of that opportunity that the team can capture through its offerings—the Serviceable

Obtainable Market (SOM). One approach to this estimation is the 3M framework introduced by Babson University, which assesses the following:

- **Market Demand:** Assessing market demand involves identifying the target audience and its reachability, durability of the product and customer perception of the product's value proposition.
- **Market Size and Structure:** This step involves analysing the nature of the market, barriers to entry and exit, and stage of the market along the technology S-curve.
- **Margin Analysis:** An analysis of the strengths of the venture and its competitive advantages is performed to assess profitability of the opportunity.

Estimation of the potential within consumer markets can be done along different dimensions, such as geographies, demographics, psychographics and behavioural attributes, or based on how the market is targeted or how it evolves.

Another approach, especially for B2B market segmentation, is the RIFLE Framework, which provides a rigorous quantitative decision-making method to prioritise similar options. The process involves a two-step process in which the first step of screening is to screen all market segments with minimum time, effort and expense. Markets that seem potentially profitable and have no significant obstacles are chosen for detailed analysis. At this stage, the analysis is done at the sales accounts level of large companies or mid-size companies, or actual target customers. Execution-related constraints are analysed all the way to the commercial deal with the customer, and markets that provide the best opportunity with minimum restrictions

are chosen based on clear criteria that are measurable, accessible, durable, substantial and unique, to identify target segments.

Sources of Information for Market Estimation

Accurate estimation of the potential market for different deployment opportunities involves collecting and analysing data from primary and secondary sources of market data. Secondary market analysis provides a great starting point to understand the market and its dynamics. It is especially relevant in the early stages of the lab-to-market journey. It involves reviewing data from sources such as market analysis reports, start-up databases, annual reports of listed companies, regulatory filings, government reports, industry consortia and trade associations, regional development agencies, start-up funding announcements, LinkedIn and academia. Analysis of information from these sources helps the team estimate the order-of-magnitude size of the opportunity and helps identify the variety of assumptions to be aware of and validate. These assumptions are validated using primary market research techniques such as field testing and observations, customer interviews, focus groups, surveys, trade shows and conferences, and social media. A good starting point for conducting this primary research is definition of the product or service and the unique value it provides to target customers.

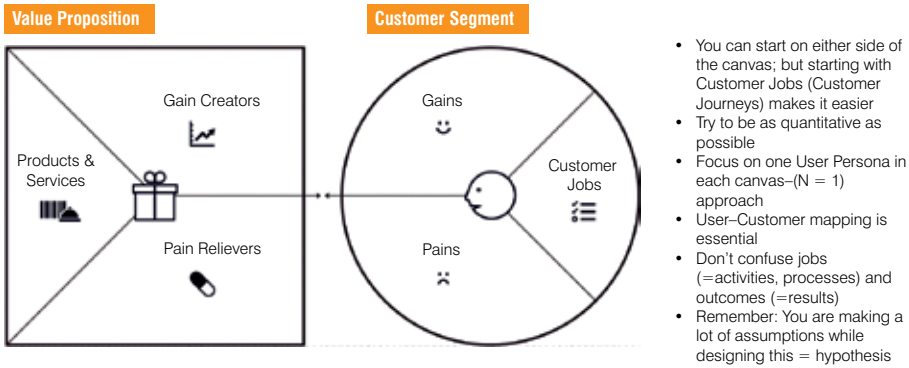
2.4.2. Defining and Articulating Value Proposition

The value proposition of a product or service is defined as the difference between perceived benefits and costs incurred by the customer. It can be designed using the

'Value Proposition Canvas' (Figure 2.5) developed by Alexander Osterwalder. The canvas provides a framework to match value of potential deployment of the invention in a product or service with customer needs. The process of building a value proposition canvas involves the following steps:

- Starting with a customer persona, the team identifies all the jobs that the customer wants to perform and prioritises them in order of importance of the job to the customer.
- The second stage is to identify a prioritised list of pain points that customers want to eliminate. These are factors that stop the customer from accomplishing their jobs or the customer's negative outcome. This stage also involves identifying a prioritised list of customer gains – aspects of their jobs that customers want to do better, or product features that will delight them.

Figure 2.5: Value Proposition Canvas



Source: Strategyzer, Innovation Scaleup Advisories

- Next, the expected features of the product are mapped to potential benefits provided to the customer. These benefits are then grouped into gain creators that add value to the customer and pain relievers that reduce customer pains. Then they are mapped to pains and gains identified in the second stage.

This evolution of the Value Proposition Canvas is iterative as shown in Figure 2.6 and involves deep thinking and brainstorming. A separate Value Proposition Canvas should be created for each deployment opportunity and customer profile. The different value propositions offered to the customer by the product need to be further refined based on offerings from competitors. These iterations help the team identify the unique value proposition of their product to the customer.

The next step is to articulate this unique value proposition such that it can form the basis for developing the product and communicating with potential customers. The format of the value proposition statement is as follows:

This value proposition is a hypothesis at this stage of the journey and needs to be validated by developing the product and testing it in the market. This validation is done by identifying the riskiest assumptions inherent in the hypothesis and building a minimum viable product to test them.

Case Study: Value Proposition Canvas

Keshav is an undergraduate student interested in creating social impact with technology. After spending several weeks in the urban slums of India, he decided to build a machine to increase the productivity of women who were rolling incense sticks manually. After several months of product design, development and prototyping, he was close to a product that the women could use. Field testing of the machines showed a substantial increase in women's productivity. However, it was considered too expensive to be purchased by them.

By studying the value chain of incense sticks, he understood that the women got the raw materials to make the incense sticks from intermediaries between them and larger companies. The intermediaries paid the women a very small amount based on the number of sticks they rolled. The intermediaries would sell the incense sticks they purchased from the women to larger companies that took care of the packaging, marketing and sales. He also understood that most women worked at rolling the incense sticks for only three or four hours a day.

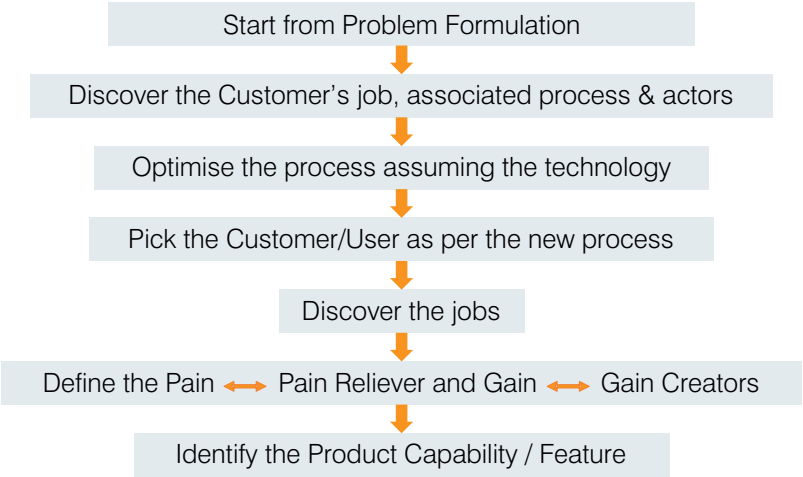
In short, the customer gain based on the technology was increased production of incense sticks by each woman. However, a major customer pain was low bargaining power in the value chain, which translated in the productivity increase to only a marginal increase in their revenue. This marginal benefit made the high cost of the machine unsustainable for the women.

An alternate value chain that increased the revenue per unit produced by the women involved non-profit organisations interested in providing income generation options for disadvantaged women. These organisations had the resources to procure the machines for the poor women. However, since the machines enabled the women to produce a large number of incense sticks, the key challenge of access to markets for the incense sticks remained. Creating a new brand in the crowded space of incense sticks is an expensive affair, and the non-profit organisations had limited scope in their programmes to develop it. So Keshav created a separate division to buy the incense sticks from these organisations and sell them by building a new brand. This solution helped him articulate a clear value proposition to the underprivileged women whose lives he wanted to impact.

Key Takeaways

While developing a value proposition, it is not just enough to understand the customer gains from technology solutions. Start-ups should also understand their pains and create an offering that creates value for the customers. This process involves a deep understanding of the value chain, evaluating the solution from the customer's perspective and potentially working with other stakeholders in the value chain.

Figure 2.6: Process of Evolving Value Proposition Canvas



Source: Innovation Scaleup Advisories

2.4.3. Solution Engineering

Building and testing a product based on the unique value proposition defined in the previous section uses a structured design process, shown in Figure 2.7. The process starts with identification of existing prior art on addressing customer needs. Apart from patents and academic papers, this includes reviewing past and current products in the market to understand their shortcomings and reasons for failure in the past. Other resources

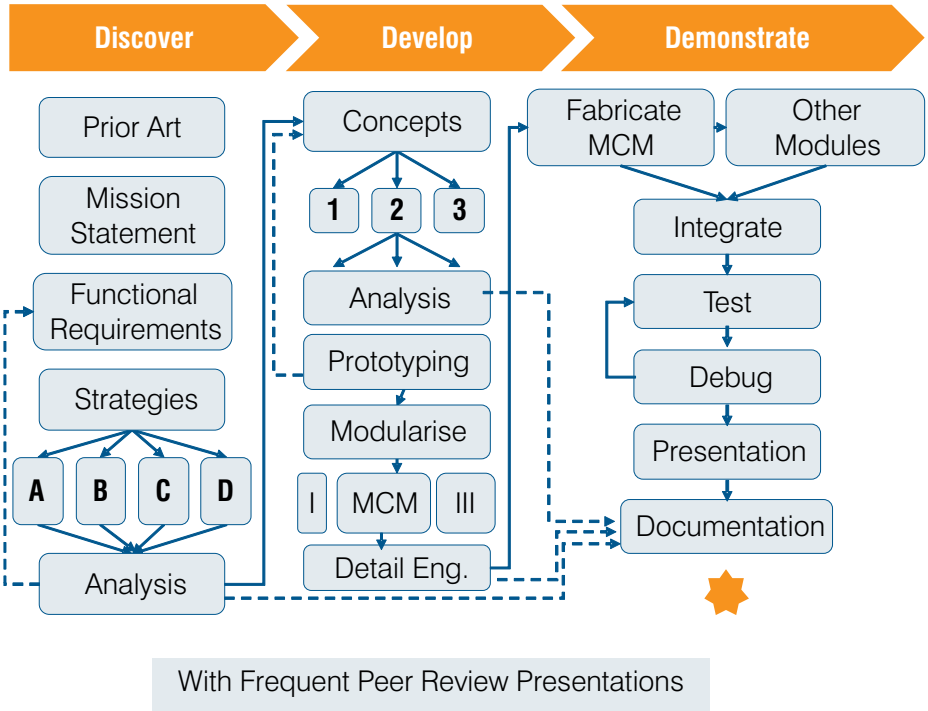
For *<ideal customer profile>* **Who** *<needs/ suffers>*, *<Product>* **is a** *<solution description>* **That** *<state the key benefit>*. **Unlike** *<competing alternative>* *<Product and differentiation>*

include in-depth presentations on specific industries and discussions with the authors of such presentations to gain deep insight into the existing state of the art. Based on insights gained from studying a prior art, the value proposition is recast as a mission statement.

The next step is breaking down the mission statement into broad functional requirements and adding design parameters against each. Design parameters define the broad aspects of different components of a product that are needed to meet functional requirements. The next step is arriving at various strategies to meet design parameters and rapidly evaluate their technical feasibility. A Pugh chart, shown in Figure 2.8, is then used to assess candidate strategies and pick the best design to meet functional requirements. In this chart, each of the strategies is given a subjective score based on how well it meets each of the functional requirements, and a strategy with the highest score is taken forward to develop design concepts. Several design concepts are generated and sketched based on the strategy. For each concept, one or two most critical modules (MCMs) needed for the product to work are identified through analysis and a literature search. These MCMs determine the functional range of the product and may narrow down target customers. Regulation and standards can add other constraints on how the concept is actually realised.

As the concept is analysed further, the team should also identify key risks such as components failing, product abuse or misuse. The team should identify each of these risks and devise countermeasures to deal with them. The information about functional requirements, design parameters, analysis of the concepts, references to literature, standards and regulation, risks and mitigation strategies can be captured

Figure 2.7: Structured Design Process



in a tool called FRDPAARC by Alex Slocum (see Figure 2.9) that is iteratively updated as the design progresses. It can also become part of the design history file. Apart from the engineering risk, the product has market risk associated with its ability to deliver the unique value proposition identified in

Section 2.4.2. The MCMs and value proposition are tested using prototypes with just enough form and function to be checked internally and in the market. The objective is to build them with a minimum budget and rapidly, to get actional feedback. This process requires devising a test protocol that clarifies how the prototypes will be tested, identifying key metrics that help the team validate the design and value proposition, and making decisions to help move forward.

The processes discussed in Sections 2.4.2 and 2.4.3 are refined iteratively to validate a product-market fit for each of the opportunities identified in the previous sections. The different opportunities to commercialise the invention can be validated for Product-Market-Fit either in sequence or in parallel, depending on the resources available to the team. At this stage of the lab-to-market journey, the key outcomes are IP assets and know-how gained through these stages, a tangible product or service, and revenues from early customers willing to pay for development and give referrals.

Figure 2.8: Pugh Chart

Assign scores: 1 = good, 0 = OK, -1 = bad
Sum the results – discussion more important than results

Mouse Elimination	Kill	Capture	Repel	etc.
Detect	0	0	0	
Deal	0	0	0	
Clean	-1	0	+1	
Safe	-1	0	+1	
Complexity	0	0	-1	
Score	-2	0	+1	

(varying Pugh Chart versions exist)

By the end of this stage, the technology uncertainty is almost eliminated, product risk is substantially reduced and the team has started to address market risk.

2.5. Product-Market-Fit to Business-Model-Fit

Establishing a viable business model that creates value for all stakeholders and positions the team for rapid growth is critical to the endeavour's success. To develop such a model, the team needs a deeper understanding of their market and incorporate knowledge of the competitive and regulatory environment. The definition of the customer from Section 2.3 should be further refined as the commercialisation team gains a deeper understanding of the customers. This deeper understanding of the customers will also help refine how customer segments are prioritised. As it receives and responds to customer feedback, the team should package the product and identify how it can be delivered, deployed and serviced more effectively. Simultaneously, the team should use customer inputs, revenue and costs to review manufacturing of the product, how quality and

Figure 2.9: FRDPARRC

Functional Requirements	Design Parameters	References	Risks	Countermeasures
Detect	0	0	0	
Deal	0	0	0	
Clean	-1	0	+1	
Safe	-1	0	+1	

This tool is iteratively updated as the design progresses.

yield of the product can be improved, how each link in the supply chain is working, and how it can optimise working capital requirements, logistics, channels and distribution networks. As the team works on all these aspects, it will be able to articulate a business model to create and deliver value to customers while capturing the revenues and costs associated with the business. A well-articulated business model explains how the business creates, provides and appropriates value. A concise way to capture the business model is using the Business Model Canvas (BMC), shown in Figure 2.10, developed by Alexander Osterwalder, which comprises nine building blocks.

2.5.1. Business Model Canvas

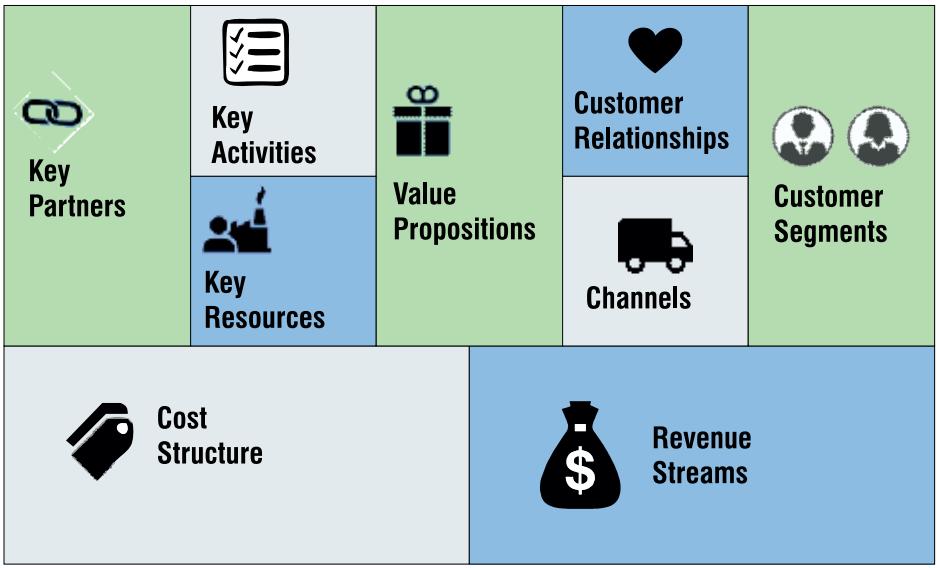
Populating the BMC starts with **Customer Profiles** and the respective **Value Propositions** that we identified in Section 2.4. The next step is to identify the various **Channels** used for distribution, marketing, sales and after-sales. The venture should choose channels and partnerships by carefully analysing their offerings and the role of the venture vis-a-vis partners. This analysis includes reviewing the role of the venture along all stages of the purchase cycle, including packaging, pricing, promotion, sales, distribution, revenue collection, after-sales service and maintenance.

Of these, positioning explains the competitive advantage of the value proposition offered by the venture to customers. This competitive advantage can be communicated using different methods such as 2-by-2 matrices, feature comparison tables, spider diagrams and positioning statement templates. A more customer-friendly approach to positioning is to translate the features of a product or

service to customer benefits and communicate them to grab the customer's attention as illustrated in Figure 2.11. The most important part of this promotion is the messaging, which emphasises loss aversion, social proof, deference to authority, or a sense of commitment. Science-based start-ups can use proof-points like customer case studies, customer testimonials and referrals, industry awards and recognition, and customer growth rate as part of their promotional efforts.

They can also use peer-to-peer marketing when marketing to professionals like the medical community. There is a marked tendency among professionals to rely on the experience of their peers and to trust their opinions when it comes to the adoption and use of products. The opinions of first adopters among peers, also known as key opinion leaders (KOLs), are valued and respected. They command a following amongst their peers, and others emulate their recommendations.

Figure 2.10: Business Model Canvas

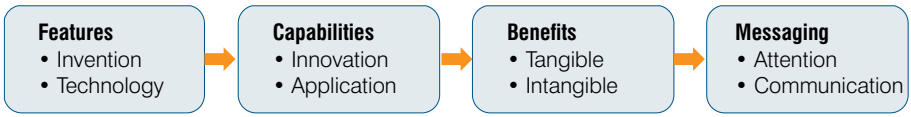


Therefore, they can influence the community of target customers. So start-ups should identify and connect with such peer networks and KOLs to position the venture and its products in the market.

Any business needs to build and maintain a positive relationship with the customers to sustain and grow. The **Customer Relationship** block of the BMC defines strategies such as providing customisable products and reliable, timely and hassle-free services. It can also include providing several channels of engaging with customers such as user communities, social media channels, user conferences and access to co-creation opportunities. These activities lead to more customer engagement with the business.

The last block on the external-facing right side of the BMC identifies **Revenue Streams** and reflects the pricing models adopted by the venture. These revenue streams include usage fees, asset sales, subscription fees, brokerage and

Figure 2.11: F → C → B → M Positioning



rents on leased assets. While price is a function of demand and supply in simple economic terms, pricing in a venture is not always intuitive. It depends on the business, economic and industry context within which the venture operates. Different types of customers require different pricing strategies, as customers differ based on parameters such as the number of maximum potential customers, the quantum

of the order placed, decision-making processes, after-sales support expectations, and sales and payment cycles.

Other business considerations that determine the price are the nature and ownership of IP, ownership of the customer and the monopolistic power exerted by the business. Technology adoption is a non-linear process and goes through boom-bust cycles. Pricing should consider these changes in the technology landscape and factors such as economies of scale, economies of scope of the venture and its competition. Similarly, industry context such as position along the value chain, revenue and profit distribution along the value chain will also influence pricing decisions.

Based on the contexts discussed above, a venture can adopt three broad pricing strategies: the most common cost-based pricing, competitive benchmarking and customer value.

- **Cost-based Pricing**: Cost-based pricing should consider not just the cost of the offering but costs incurred for development, competition, customer acquisition, testing, customer support, service, warranty, payment terms and risk management.
- **Competitive Pricing**: Pricing strategies based on the competitive landscape should be aligned with the growth strategies of the business. It should also strike a balance between growth of revenue, profits and number of customers. This balance varies depending on the stage of commercialisation journey. Creative techniques such as bundling, premium pricing and price skimming can bolster the competitive position of the venture in the market.
- **Value Pricing**: These strategies are based on the extent

to which the team understands the value proposition of the offering to customers and how easy it is to quantify and capture a share of the value created. Pricing strategies such as pay-per-use, percentage of revenue generated by the customer or share of savings realised by the customer and payment of royalties based on the number of users are examples of such pricing strategies.

Moving to the left side of the BMC, the next blocks to consider are **Key Partnerships** that the venture wants to build and **Key Activities** that the start-up intends to keep in-house. Partnerships are crucial for the success of a science-based venture. The type of partners and the nature of the partnership change as the team progresses along the commercialisation journey. In the earlier stages, these partnerships involve doing joint development projects to further the technology development process. As the team moves towards POV, this takes the form of customer-as-a-partner to co-develop or validate the value delivered by the invention. In the Product-Market-Fit stage, the start-up needs to partner with multiple stakeholders while evolving its understanding of the market and effective deployment of the invention in the market. Hence, managing partnerships at this stage can be very complex.

As the team moves towards the Business-Model-Fit stage and evaluates different potential business models, the start-up should structure the partnerships to ensure maximum flexibility and rapid change of direction. Key considerations on which activities to engage partners—especially for ventures developing hardware—are technology scaling, process innovation, and integration and logistics.

Operations and its subsets, manufacturing and supply chain management, are especially critical to delivering value to customers. The start-up should have access to enough manufacturing capacity to deliver quality products to its customers promptly and provide reliable after-sales support to them. Manufacturing processes and equipment can vary with scale and volumes. They are also capital intensive. In addition, setting up a manufacturing process or expanding existing capacity can take time. While having excess capacity can tie up critical financial resources in underutilised capital equipment, not having enough capacity can lead to loss of revenue and damage the burgeoning reputation with its customers. This lost revenue can also impact the venture's relationship with existing investors and affect its ability to raise new investment. The company can manage this dilemma by outsourcing part or all manufacturing, assembly, supply chain and logistics.

While comprehensive or manufacturing outsourcing can provide flexibility, it can be expensive and dependent on the partner's reliability. It might also be challenging to find a single partner, especially for comprehensive outsourcing. On the flip side, doing any of these activities in-house requires strong sourcing, vendor development and robust processes. Irrespective of who performs these activities, the venture is responsible for all aspects of the products and services delivered including quality and reliability, regulatory compliance and customer satisfaction. The decision on in-house manufacturing is also dependent on the IP strategy of the company and aspects of the product and process that provide the venture with its competitive advantage. Other considerations in decisions on **Key Partnerships** and **Key**

Activities performed in-house are factors such as positioning the start-up in the market, the competitive landscape, availability of **Key Resources** and the **Cost Structure.**

Key Resources include physical, informational, financial and human resources. These are the resources accessible to the venture to deliver on the value and revenue streams described on the right side of the BMC. The **Cost Structure** block of the BMC captures the important costs inherent in the business model. These include the cost of acquiring and retaining a customer, fixed and variable costs related to the business, and opportunities for taking advantage of economies of scale and scope based on decisions related to **Key Activities** and **Key Partnerships**.

By iteratively modifying the different elements of the BMC, the venture arrives at the right business model to deliver the right value proposition to the right customers, and capture the value via increased revenues with the right mix of in-house activities and partnerships that maximises its resource utilisation and enables a sustainable cost structure.

Case Study: Business Model Canvas

SvacchTarang is a company that makes affordable gravity-driven, small water purifiers that are low maintenance and require low recurring costs. The start-up team at SvacchTarang comprises researchers with expertise in advanced materials and membranes. They have limited experience in manufacturing. Their market research showed that major players like Eureka Forbes, HUL, and Kent dominate the high-end urban household market. So they are targeting households at the bottom of the pyramid comprising three customer segments – urban, peri-urban and rural households. These customers use groundwater accessed through borewells as a source of raw water. The key value propositions of SvacchTarang's product, such as its ability to run without electricity based on a non-piped water connection and its affordability in terms of initial costs and recurring maintenance, are attractive to these segments.

One of the key challenges in targeting these segments is that the customers are not sensitive to the benefits of drinking clean water. These customers prefer to buy through people they know. They also trust their neighbours' testimonies instead of traditional advertisements when making a purchase. Hence the company is building a network of key opinion leaders in different communities to increase awareness about the need for clean drinking water and the benefits of their products. They are also recruiting local agents from the communities to encourage the customers to purchase and use their products. These local agents will also work with the customers to get the products serviced regularly. To make the products affordable to wider parts of their customer segments, the team is partnering with micro-financing institutions and non-governmental organisations. Based on these models of building customer relationships and channels, SvacchTarang has two revenue streams from the sales of purifiers and consumables.

The team wants to grow its expertise in research and development required for making the purifiers internally and is outsourcing component manufacturing and final assembly to third parties. To continue their R&D activities, they need a state-of-the-art laboratory and pilot testing facility and need to recruit high-calibre researchers. They need to recruit an experienced operations manager to manage the manufacturing and delivery of the products. They also need to recruit a senior member of the management to work with NGOs, microfinancing organisations and BOP customers, and manage their marketing and sales activities. Based on these key partnerships, resources and activities, the primary costs of SvacchTarang are for R&D (including maintaining the patent portfolio) and those related to manufacturing and marketing. SvacchTarang also has to partially bear the cost of educating the customers about the benefits of clean drinking water and financing the water purifier for the households.

Key Takeaways

While developing a business model, it is necessary to understand both the current internal competencies of the start-up and the potential gaps. These gaps can be filled by recruiting the right talent, or forming key partnerships. This decision is driven by the costs and revenues of the company. The start-up should also have a deep understanding of the customers, their purchasing process and usage patterns to create a strong relationship with them. This understanding helps the company increase its sales and deliver the right value to the customer.

2.6. Business-Model-Fit to Revenue and Growth

When the business model stabilises with steady growth in revenue and profits, and a strong team that can manage day-to-day operations, the venture is ready to explore growth opportunities. The Ansoff Matrix is a formal framework that can be used to analyse and prioritise potential growth strategies. These strategies include:

- **Market Penetration:** This strategy focuses on increasing sales of existing products in existing markets. It can be done by gaining a deeper understanding of customers and users to fine-tune product specifications and market positioning. It can also be done by acquiring competitors to achieve economies of scale.
- **Market Development:** Here, the focus of the venture is on entering new markets based on existing products. These new markets could be the same target customer segment in a new domestic or international market with similar behaviour as the existing market. It could also be expanding by catering to a new target segment in existing geography.
- **New Product Development:** This growth strategy focuses on growing the company by developing new products to cater to an existing market and achieve economies of scope. A science-based start-up could expand its product portfolio by developing complementary technologies, or acquiring companies that offer complementary products to the same market. The venture can also grow by forming strategic partnerships to gain access to new assets to expand its offering. These additions can help the company increase

its value proposition to customers. This expansion is especially useful when the venture has a strong understanding of its existing market and needs.

- **Related or Unrelated Diversification:** Ventures can also take a more high-risk growth route by offering new products to a new market. For example, a science-based start-up that owns the rights to a platform technology with applications in different markets could develop new products based on the same technology to enter new markets. Depending on the synergy between existing and new products and markets, the level of risk with this approach can be significant.

Irrespective of the strategy adopted, the company needs to sustain its competitive advantage as it grows. A venture's competitive advantage can be broadly classified based on either a cost advantage or differentiation. To maintain the cost leadership position, the company needs to invest in opportunities that increase its economies of scale or scope, integrate across its supply chain and invest in technologies that improve resource efficiency and reduce costs. A venture that adopts the differentiation strategy needs to invest in superior training, customer engagement and education, quality control and after-sales support. It should also invest in technologies that enhance differentiation. A growing venture should also be mindful of shifts in technology S-curves and disruptive technologies that could potentially change market dynamics and adversely impact market position. The venture should use its market position and innovation capabilities to proactively adapt to those changes on the horizon.

2.7 Data-Driven Model for Lab-to-Market Journey: The Triple Chasm Model

Phadke and Vyakarnam analysed the behaviour of science and technology firms at different stages of maturity across different sectors and geographies to develop the Triple Chasm Model that describes the factors that impact their evolution. Central to their model is the rate at which the number of customers for a single definable product or service grows over time. Based on this metric, they define 'modified TRLs' (mTRLs) (see Figure 2.12) to measure the progress of the journey. They also demonstrated the presence of three chasms where this growth stalls.

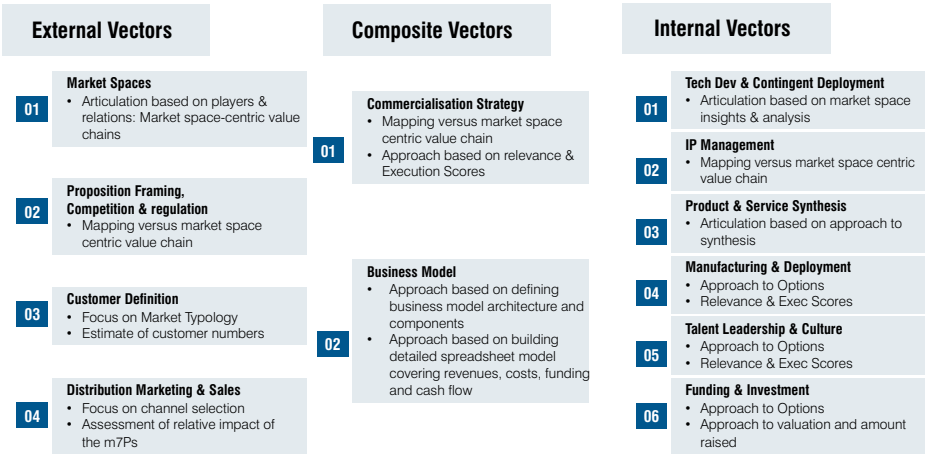
- **Chasm 1:** Transition from concept to a working prototype. This chasm exists between POV and Product-Market-Fit.

Figure 2.12: Modified Technology Readiness Levels (mTRLs)

- **Chasm 2:** Transition from early product to fully functional product with a commercially sustainable business model. This chasm exists between the Product-Market-Fit and Business Model-Fit stages of the journey.
- **Chasm 3:** Transition from early customers to main body of customers as the firm scales significantly. This chasm exists between Business Model-Fit and Revenue and Growth stages of the journey.

Their data also demonstrated that the early part of the lab-to-market journey takes much longer than previously thought. The shape of the commercialisation journey is governed by the following 12 'meso-economic vectors', shown in Figure 2.13:

Figure 2.13: 12 Meso Economic Vectors of Triple Chasm Model



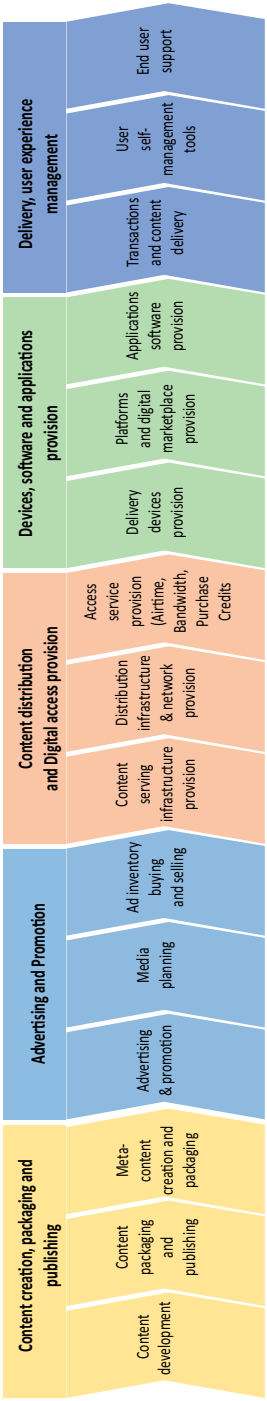
Source: The Scale-up Manual, Phadke & Vyakarnam, WSP, September 2018

External Vectors

- **Market Spaces:** This vector helps the team define the target market by understanding the overall market space and its market-centric value chain. Figure 2.14 illustrated the market-centric value chain in media and entertain market.
- **Proposition Framing:** The market-centric value chains developed above are analysed to understand the key market and its technology and regulatory drivers. They are also investigated to understand potential ways in which the new invention can impact it. The new invention can potentially impact parts of the value chain, entire value chain or change interaction between players in the value chain. Based on this, all potential opportunities to deploy the invention in the market are identified. The analysis also helps the team identify collaboration opportunities, potential competition and barriers to entry. Figure 2.15 shows the market, technology and regulatory drivers of the media and entertainment market space.
- **Customer Definition:** The Triple Chasm Model identifies the following types of customers based on how they decide to use the product or service, how they benefit from it and how they pay for the product.
    - **Business Customers:** These are firms or businesses that buy and use a product or service offered by a venture. These firms can incorporate these offerings into their product or service at a system level or sub-system level. They can also use these offerings to run their businesses.

      These business customers can be further

Figure 2.14: Market-Centric Value Chain in Media and Entertainment Market



Source: The Triple Chasm Company 2021

Figure 2.15: Composite view for Media and Entertainment Market Space

Content creation, packaging and publishing			Advertising and Promotion			Content distribution and Digital access provision			Devices, software and applications provision			Delivery, user experience management		
Content development	Content packaging and publishing	Meta-content creation and packaging	Advertising & promotion	Media planning	Ad inventory buying and selling	Content serving infrastructure provision	Distribution infrastructure & network provision	Access service provision (Airtime, Bandwidth, Purchase Credits	Delivery devices provision	Platforms and digital marketplace provision	Applications software provision	Transactions and content delivery	User self-management tools	End user support

Market Drivers	New content players	New intermediaries	New entrants Pricing pressures	Potential lockout from majors	Pay per view
Technology Drivers	Content format management; Cross-channel EPG	Ad inventory management	Fixed mobile convergence; FTTC and hybrid devices	Multi-device O/S	Upper management tools; Subscription manager
Regulatory Drivers	Sports rights; Navigation for premium content	ASA compliance	Release window management; Spectrum licensing	Third party carriage requirements	Transaction handling

Source: The Triple Chasm Company 2021

segmented based on firm size, average contract value or technology sophistication. They can also be segmented based on how the business uses the venture's offering or based on strategic importance to the venture.

- **Governments:** They buy a product or service for use in their activities. This segment is characterised by a large disconnect between buyers and end-users. This segment also involves long sales and payment cycles and complex decision-making processes.
- **Consumers:** These customers are individuals who buy and use a product or service in various ways.
- **Members of knowledge or affinity-based groups or communities:** These customers make buying decisions based on group affinity or access to specific shared knowledge.

- **Distribution, Marketing and Sales:** This vector defines the maturity of the start-up's go-to-market strategy. The Triple Chasm Model identifies 15 variables, shown in Figure 2.16, grouped into five areas to define the channels, customer relationships and revenue streams. The relative importance of these variables varies depending on the stage of the commercialisation journey, customer profile and value proposition. As the team gains a better understanding of how the product is being deployed in the field, the model provides a modified 7P toolkit (see Figure 2.17) to gain visibility into the relative importance of the various factors that influence customer purchase decisions and evolve the technology deployment strategy. This understanding

Figure 2.16: Variables Relevant to Distribution, Marketing and Sales

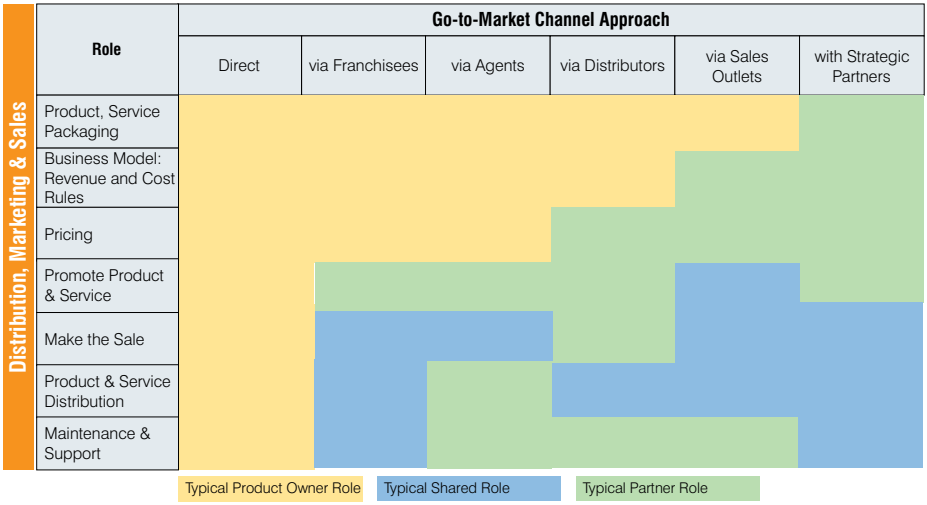
Product & Service Management	Category Management
	Portfolio Management
	Life-cycle Management
Pricing	Pricing Strategy
	Pricing Tactics
	Dynamic Pricing
Product Marketing & Sales	Positioning & Branding
	Marketing & Promotion
	Demand Generation & Sales
Channel Management	Channel Mix
	Resource Management
	Performance Management
Post-sales Management & Support	Customer Support
	Customer Management
	Product & Process Improvement

Source: The Triple Chasm Company 2021

Figure 2.17: The Modified 7Ps model

Source: The Triple Chasm Company 2021

Figure 2.18: Strategic Channel Options



Source: The Triple Chasm Company 2021

drives the type of channel partners sought and their role in delivering the value to the customer as seen in Figure 2.18.

Internal Vectors

- **Technology Development and Deployment:** The Triple Chasm Model defines a hierarchy of technology deployment as shown in Figure 2.19. The commercialisation team has first to determine where the invention fits in the hierarchy. Based on the starting position, they can define the key characteristics of their solutions that add the most value to customers while delivering them efficiently. This decision is based on the evaluation of attributes such as depth of technical expertise required, need for complementary technologies, need for broader commercial expertise, cost of technology deployment, time to market, desired

Figure 2.19: Technology Characterisation

Technology Layer	Characteristics
Base Technologies	Fundamental 'Building Blocks' with applicability across multiple market spaces
Application Technologies	Aggregation of different base technologies
Platforms	Integration of different application technologies to enable new functionality
Application & Tools	Functionality aimed at end users based on application technologies and platforms
Products	Integrated functionality for users based on base and application technologies, data, meta -data and application & tools
Services	Integration of products and associated services, including on-boarding, usage and support

Source: The Triple Chasm Company 2021

flexibility in business models and the overall complexity of deployment. Based on these attributes, the team determines the right level within the hierarchy at which to position the offering to customers in a particular market. This evaluation will also help identify the right partners to talk to and the right corporate division to target for the partnership engagement.

- **IP Management:** This vector measures the team's progress in defining and managing the various sources of IP.
- **Product and Service Definition and Synthesis:** This vector defines progress towards defining a product and corresponding service that delivers clear, demonstrable and measurable value to the customer.

- **Manufacturing and Deployment:** This vector addresses issues related to the scale-up of technology, manufacturing and supply chain. It also addresses the challenges related to deployment and data integration to enable dynamic decision making.
- **Talent, Leadership and Culture:** This vector measures the quality and effectiveness of the commercialisation team across the different stages of the journey.
- **Funding and Investment:** This vector assesses the form and timing of different forms of financing during the commercialisation journey.

Composite Vectors

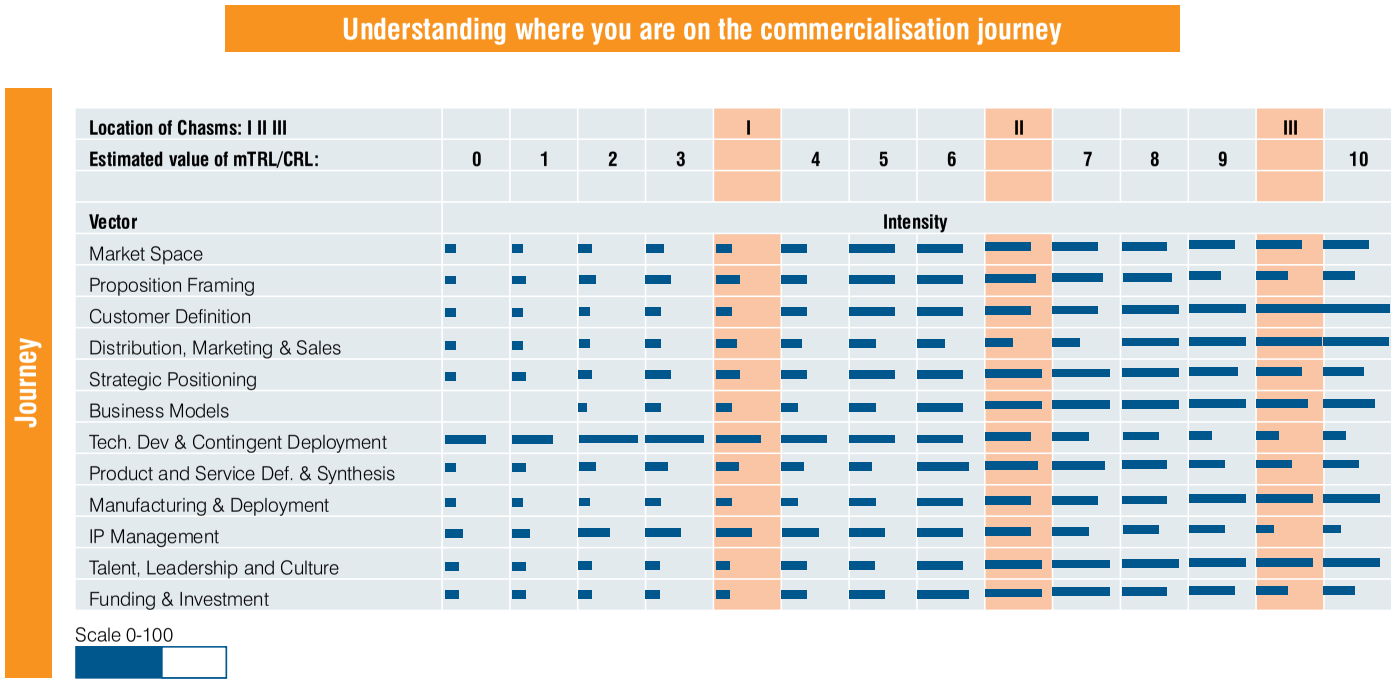
- **Commercialisation Strategy:** This vector addresses the trade-offs between the internal and external vectors while developing a commercialisation strategy during the early stages of the lab-to-market journey.
- **Business Models:** Depending on the technology deployment strategy, the business model for delivering the product and services to customers while sustainably growing the business requires several iterations. According to this model, pricing varies depending on the nature of the offering, where it fits in the technology deployment hierarchy and where the team wants to focus. This vector helps the team define business model priorities.

The relative importance of these variables varies based on the stages of the commercialisation journey. The most important vectors when crossing Chasm 1 are Proposition Framing and Technology Deployment. While crossing

Chasm 2, although the Technology Deployment vector is less important, all other vectors need to be addressed parallelly. When crossing Chasm 3, Customer segmentation, distribution, marketing and sales activities are the most important. Combining all these components, the Triple Chasm Model uses a 'Commercialisation Canvas', shown in Figure 2.20, to systematically explore and calibrate key drivers affecting the commercialisation journey.

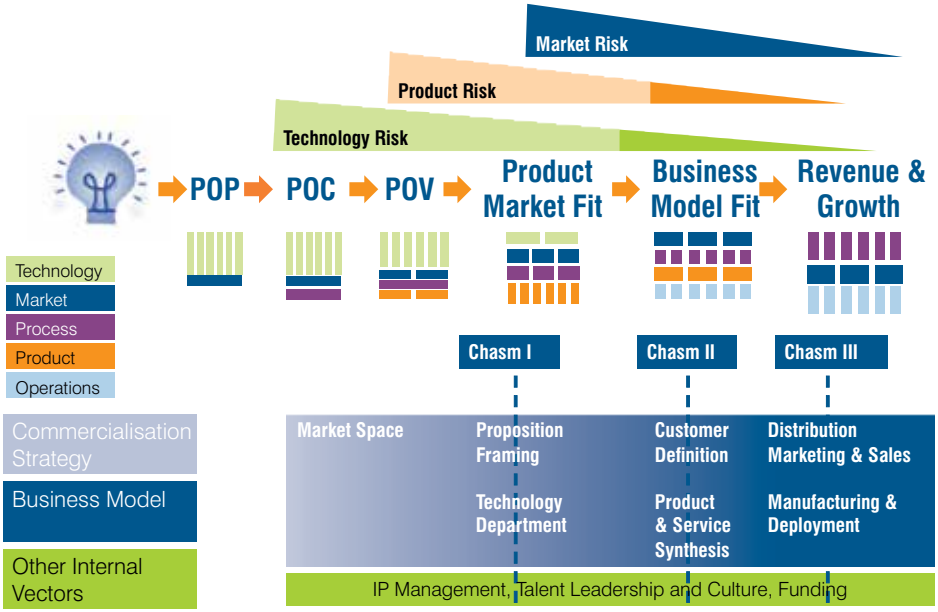
Figure 2.21 shows the mapping of the overall lab-to-market journey discussed in the previous sections to the Triple Chasm model discussed here. The commercialisation team needs to deepen its understanding of the market by starting with broad market spaces (external vector 1) and progressing towards framing a proposition (external vector 2). After crossing Chasm 1, this understanding of the market should be deepened by understanding the customer (external vector 3) and progressing towards establishing distribution, marketing and sales (external vector 4) channels. Simultaneously, the the team must move from technology deployment (internal vector 1) as it crosses Chasm 1 towards product and service synthesis (internal vector 3). As they cross Chasm 2, members need to scale the manufacturing and develop the capability to successfully deploy (internal vector 4) their offering in the market. During the initial stages of the journey, the market spaces, proposition framing and customer definition need to be aligned with the technology and product development through a sound commercialisation strategy (composite vector 1). In the later stages of the journey, the customer definition, along with distribution, marketing and sales needs to be aligned with the product development and

Figure 2.20: Commercialisation Canvas



Source: The Triple Chasm Company 2021

Figure 2.21: Mapping Lab-to-Market Journey to Triple Chasm Model



manufacturing to develop sustainable business models (composite vector 2). The remaining three internal vectors of IP management (internal vector 2), talent (internal vector 5) and funding and investment (internal vector 6) are activities that need to be managed carefully throughout the commercialisation journey. They are discussed further in Chapter 3.

3. Management Essentials for Science-Based Entrepreneurs

"Effective Management is Discipline"

– Stephen Covey

The commercialisation team needs to set up a legal entity as the team size grows and resource requirements increase. They need a variety of management skills to build and grow this science-based business. Apart from managing teams, IP and tasks, the leadership team should also be equipped to deal with the legal and financial aspects of the business. A few of these essential skills are discussed in this section.

3.1 Legal Structure and Compliances

In India, a business entity can be structured as a private limited company, a limited liability partnership (LLP), a one-person company, a non-profit organisation (NPO), a partnership firm or a sole proprietorship firm. A business that plans to raise funds from external investors or issue stock options to its employees has to be structured as a private limited company. If the team is planning to bootstrap the venture and not raise external investments, a LLP may

be an option to consider, as the compliance requirements for LLPs are lower than those for private limited companies. It is possible to convert a LLP structure to a private limited company structure later, when the venture becomes more profitable. However, compliance requirements on LLPs are increasing, and the cost of changing legal structure is twice the cost of starting a private limited company from scratch. Hence, if the team plans to build a highly profitable venture, a private limited company is the best option. Even when the team plans to build a social enterprise to commercialise the technology, it is advisable to set up the venture as a Section 8 private limited company instead of a NPO.

The next decision for the team is the location of the venture. This decision is driven by the nature of the team's offering, its markets and the availability of key resources – especially human capital. Other factors to consider in deciding on the location include intellectual property protection, tax incentives, subsidies, access to grants, maturity of the regulatory framework around the target markets, public listing of companies and transfer pricing. In considering tax rates, the team needs to evaluate rates for the business, independent of the tax rates of individual shareholders who may not reside in the same country as the business. In India, moving a business from one location to another within a city is less cumbersome than moving it between states. Therefore, the decision on the place of business within India has to be made with some care. Start-ups with more than 50 percent foreign shareholding are also ineligible for grant funding, equity funding from the Indian government, or Indian government-supported incubators. While it is possible to maximise opportunities for public funding and subsidies

by creating a complex web of legal entities across different countries, the advantages quickly erode as compliance costs and time involved in managing them increase. A complex structure also makes it difficult for start-ups to pivot or change the course of their commercialisation journey.

If the team registers a business entity in India, they must file several mandatory registrations like PAN, TAN, Shop Act and Profession Tax (PT) licenses. The company may also need optional registrations such as GST, ESIC, PF, IEC and Start-up India registration. Depending on the markets and nature of operations, the business may also need optional licenses such as a DSIR license, factory license and FSSAI registration. In addition, the company is required to appoint an auditor and obtain a certificate of commencement of business within the first few months of its registration. Also, the company should draft and implement management policies for HR, purchasing and finance to give a structure to the operations. These policies are especially crucial as the business scales.

Apart from registering a legal entity and getting the different registrations and licenses required, the team should sign a co-founders' agreement. While this is not a legal requirement, the co-founders' agreement provides a formal framework to deal with uncertainties arising from changes in roles and responsibilities of individual founders and their specific circumstances that happen in expected and unexpected ways. It also formalises the relationship between founders by specifying the ownership and voting structure. First time teams usually split the founder equity equally. However, not everyone in the team makes equal contributions to the company at every stage. So the team should aim for an

equitable share split that takes into account factors such as relative expectations of salary, individual contributions of in-kind and cash contributions from each founder. In addition, the co-founder agreement should also specify the organisational hierarchy for different decisions and set rules related to the transfer of founder shares, financing and intellectual property.

3.1.1 Compliance Related to Equity Allotment

When the commercialisation team registers a company in India or overseas, the members need to decide on the equity split amongst different members. This split is formalised as part of the co-founder agreement discussed above. While the team has significant flexibility to choose the equity structure at this stage, members should avoid splitting the equity in a lopsided manner. A key contributing shareholder who gets less than 10 percent equity will not be able to take any direct action to correct the course of the organisation and has to rely on derivative action only. On the other hand, a shareholding of more than 50 percent and less than 75 percent provides majority rights and control over matters requiring ordinary resolutions. Those with more than 90 percent shareholding have effectively full control. Table 3.1 shows the default levels of control of available to shareholders based on the percentage ownership. These rights can, however, be overridden by means of contracts. One way to ensure equitable shareholding is to adopt 'reverse vesting', where the co-founders hold a percentage of shareholding in the company that vests in them, based on the individual contributions over time. Any unvested shares for co-founders are distributed to other co-founders, new employees or the ESOP pool.

Table 3.1: Default Shareholding Percentage Vs. Level of Control

Shareholding	Level of Control
< 10%	Derivative action on behalf of a company against a third party
10% - 25%	Minority protection rights for relief against oppression and mismanagement
25.01% – 49.99%	Can block matters requiring special resolution which include alteration of Charter documents, M&As, preferential issue of shares, other rights stipulated in the Articles, etc.
50%	Can block all resolutions requiring approval of shareholders by ordinary resolutions
50.01% – 74.99%	Majority rights and control over matters requiring ordinary resolutions (simple majority), which include appointment of directors, declaration of dividends, appointment of auditors, rights issue, etc.
75% – 89.99%	Has the ability to pass both ordinary and special resolutions
> 90%	Has effectively full control since minority protection is generally available to shareholder's holding 10% or more shareholding

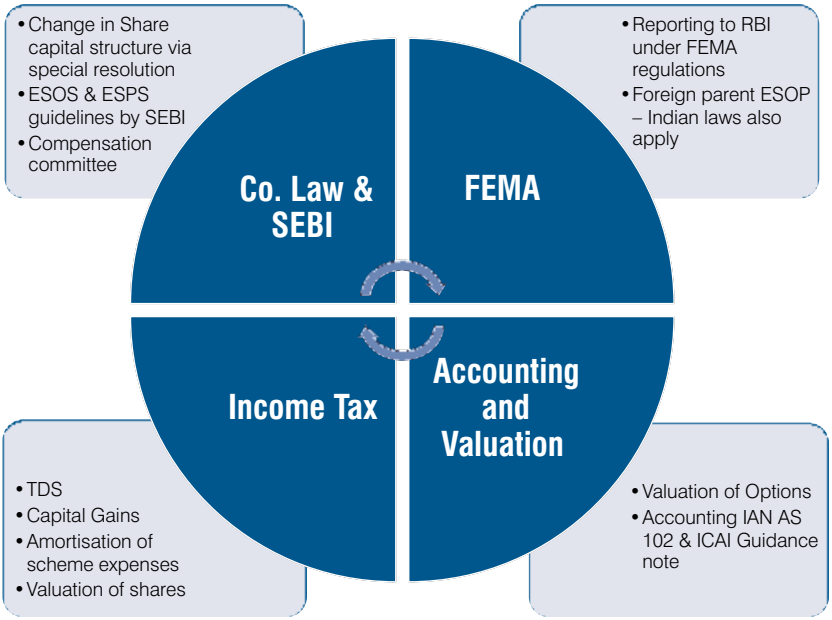
As the team progresses along the commercialisation journey, a start-up might need to issue shares to external stakeholders such as incubators, accelerators, advisors, mentors and consultants in exchange for their tangible and intangible services, or in lieu of cash payments. An incubator or accelerator in India typically takes 2 to 5 percent equity in the start-up. A private limited company cannot directly issue shares in lieu of cash in India. Hence, any equity paid in

such circumstances is transferred from the founders. This may subject the transferring founders to taxation if the value of the shares at the time of transfer is higher than the value at which they got them. If the shares are valued at less than fair market price during the transfer, the transferred shares might be subject to tax in the hands of the recipients. In addition, if the shares are transferred for intangible services, a valuation report for such services is required. However, estimating the fair market value of shares and intangible services is expensive and time-consuming and may have implications for future funding rounds.

As discussed in Section 3.2, ESOPs is one potential way of employee compensation. These are attractive methods to motivate and retain employees but can be expensive and difficult to execute. Hence, the team should evaluate the advantages of such a scheme to the company and employees, its tax efficiency and ease of administration. They should also set aside a budget for administering the compensation scheme. An ESOP scheme can be administered by a private trust or by creating an option pool by earmarking a percentage of authorised share capital for issuing fresh shares to employees as needed. The second method is easier and less costly.

Standard issue of shares under ESOP is regulated by SEBI in India (see Figure 3.1). While most of the regulations apply to listed companies, unlisted companies must comply with a few watered-down provisions to reduce the compliance burden. However, it is good to align ESOP plans with SEBI regulations if the team aims to provide an exit to its investors by listing on the primary or secondary stock exchanges in India. Apart from SEBI regulations, the Companies Act

Figure 3.1: Regulatory Agencies of Relevance to Private Companies in India



has some stringent implementation and disclosure rules for ESOPs. These include shareholder approval for rolling out an ESOP plan and compulsory ROC filings where the complete details of the ESOPs are disclosed in the director's report and the notes to accounts annexed to the financial statements. In addition, granting options worth more than 1 percent of the company's paid-up capital to a single employee requires additional shareholder approval in India. The cost of shares issued under ESOP is based on an option pricing report certified by a CA at every granting stage and the end of the financial year. Under the income tax rules, the company must deduct TDS on the difference between the fair market value (FMV) determined by a merchant banker and the exercise price.

In situations where the Indian entity is a subsidiary of an overseas entity, the company needs to seek advice on regulations of both jurisdictions. While FEMA in India allows employees of the Indian subsidiary to be eligible to receive stock options of the overseas parent, any exercise or liquidity event related to the options has to be reported by the Indian subsidiary to RBI within 30 days of such event. Non-compliance with these provisions will invite significant penalties for the company.

An alternative method to compensate employees based on their contributions to the company's growth is to issue Stock Appreciation Rights (SARs) – also known as Phantom stocks. SARs are cash-based incentives linked to the value of the equity share and grant the employee a right to get the cash equivalent of the share price gains over a pre-determined period. A key advantage of SARs is that they are not regulated and can be used to pay employees and external stakeholders such as mentors and consultants. The holder of SARs does not have any rights associated with a shareholder, and there is no payment by the employee to exercise them. When exercised, the employees get paid a cash bonus equivalent to the appreciation of the shares during the holding period. However, it is not a tax-efficient mechanism for the recipients, as it is subject to income tax.

While each method of offering equity-based compensation has its advantages, disadvantages and associated costs, the team should have a clear strategy around building such a compensation scheme. The strategy should include clarity on the type of scheme, employees receiving such compensation, guidelines for quantum, frequency, timing, pricing and vesting schedules and exit route. Care

should be taken in promising equity-based payment to employees and external stakeholders before it is fully implemented, as rolling out such schemes is regulated and can be potentially delayed.

3.2 Stakeholder Management

Eric Ries defines a start-up as a human institution designed to bring something new [to the market] under conditions of extreme uncertainty. It is also a team sport that requires active contribution from various stakeholders at different stages of the commercialisation journey. These stakeholders include an internal team comprising founders and employees actively involved in the commercialisation journey, and external stakeholders like investors, external board members, consultants, advisors/mentors, suppliers, customers, partners, and the government. Each of these stakeholders plays a specific role in building the start-up, as described below:

- **Promoters** – These are the stakeholders who incorporate the business and nominate the first board of directors and auditor for the company. In India, they take on obligations under SEBI regulations.
- **Founders** – Founders are people who establish the business. Not all founders need to be promoters, and not all promoters need to be founders. As the new venture evolves, the founders should act reasonably and in the company's best interests, individually and as a group. They should also sign a co-founders' agreement discussed in Section 3.1.
- **Employees** – These stakeholders and the full-time founders driving the commercialisation effort form

the heart of a venture. These stakeholders have an employment contract with the company. Some of these employees form part of the management team. Members of the management team who are not founders may be recruited by the Board of Directors (BOD) directly. Some members of the management team like the CEO and CFO may have reporting obligations to the board.

- **Shareholders** – These are stakeholders that invest in the company in exchange for a share of the equity. Some of these shareholders may take on promoter obligations. Early shareholders include full-time and part-time founders, incubators and accelerators, technology owners and early-stage investors. These early shareholders become part of the company when there is significant uncertainty and high risk. Hence, they should have a 'trustee orientation' towards the company and be willing to do whatever it takes to make the company successful. These early shareholders should also be flexible and provide freedom to full-time founders to make the right decisions required to build the company rapidly. They can also provide critical inputs such as defining the vision for the business, general strategy and early aggregation of essential components. Credibility, access to business networks, vital services and facilities, intellectual property, funds, guidance and mentoring are the other forms in which an early shareholder may add value.
- **Members of the Board of Directors** (BOD) – A registered company should have a BOD to set its strategic direction and supervise its activities. A board can

include executive directors, nominees of shareholders representing their respective interests and independent members who have no direct stake in the company. The members of the BOD are collectively responsible for taking care of shareholder interests and ensure discipline and good practices in governance and overall operations. They add to the company's credibility and reputation and can help the management team with referrals, access to business networks and funding sources. The management team of a company has a fiduciary responsibility to report to the BOD and implements the policies created by the board.

- **Consultant/Advisor** – These are individuals or organisations that provide advice and services on a contractual basis. They may be part of an Advisory board that the company constitutes for seeking non-binding strategic advice.
- **Pro-bono Advisors, Mentors** – These individuals provide their support and services without seeking any commercial arrangement.

It is not uncommon to have a single person playing the role of different stakeholders in a venture. For example, a founder could be a promoter, shareholder, board member and employee. Similarly, an employee could be a director of the company.

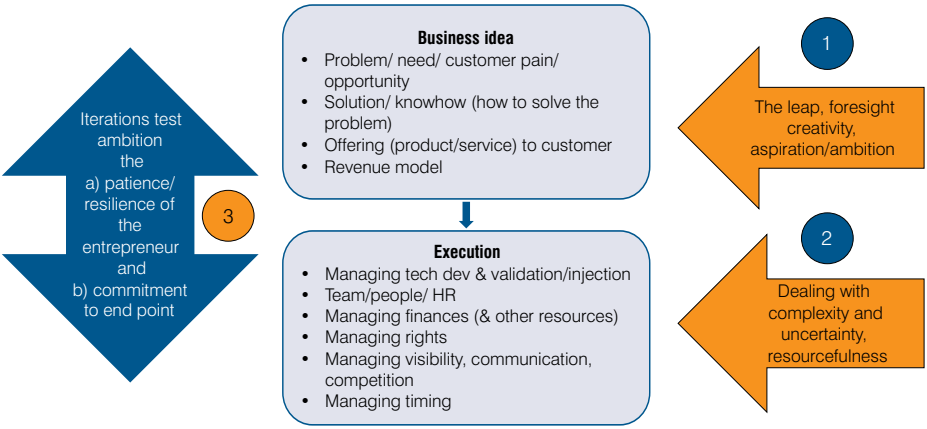
As discussed above, the full-time founders and the employees form the heart of a start-up team. As shown in Figure 3.2, the full-time founders are entrepreneurs and go through two phases of the entrepreneurial journey iteratively. In the first phase, they conceptualise the business idea

and take a leap of faith to exploit a potential opportunity they have identified. This ideation phase requires creativity, aspiration and ambition. In the second phase, they execute the idea by managing technology development, teams, finances, communication and market entry. In this phase, the entrepreneurs need to have grit, perseverance and the ability to make decisions in the face of uncertainty, and limited resources to move the company forward. Iterating over these phases requires patience, resilience and commitment towards the broader vision and goals of the company. The entrepreneurs should also have a sense of responsibility towards all stakeholders and appreciate the value of a team. As the company grows, they should also learn to trust their team and delegate responsibilities.

The early leadership team of a technology-based start-up comprises the following three primary roles:

- Business lead (or CEO) responsible for the business strategy and opportunity identification. This individual

Figure 3.2: Two Phases of Founder's Entrepreneurial Journey

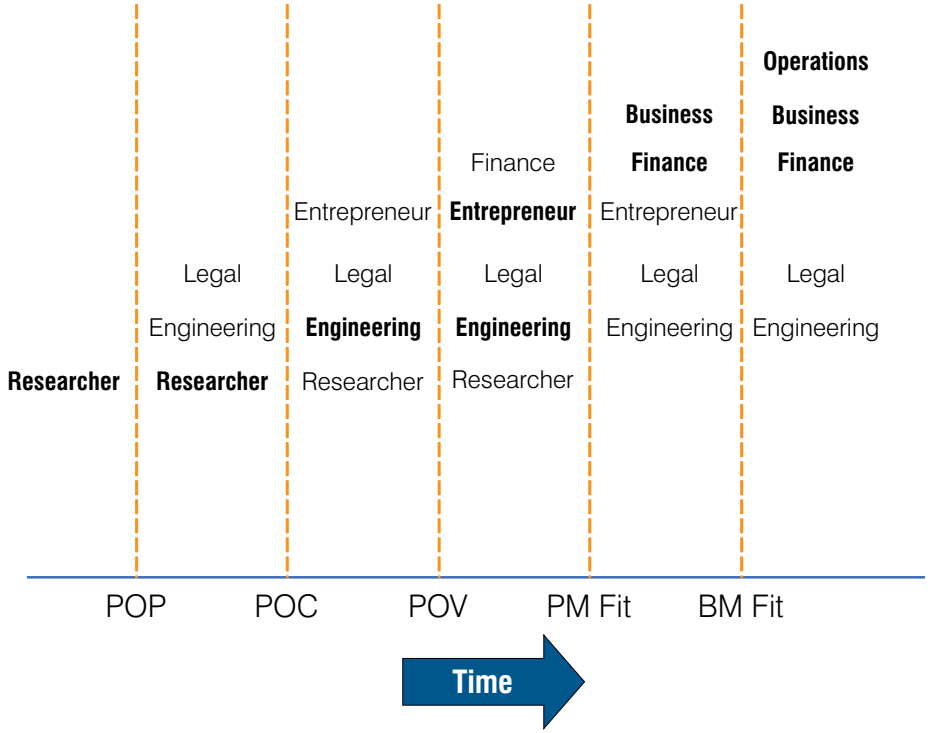


is the final decision-maker inside the company and reports to the board. The individual is also the external face of the company handling relationships with investors and key external stakeholders.

- Technology lead (or CTO) responsible for technology strategy, its execution, intellectual property management and scientific partnerships.
- Operations lead (or COO)—which can be a part-time role to start with—is responsible for all operations, administration, finance, HR and compliance. This individual is responsible for partnership agreements, certifications and regulatory approvals and the physical facilities used by the start-up.

As the team progresses along the commercialisation journey, the composition of the team and the key skills required change significantly, as shown in Figure 3.3. In the early stages of idea development, the team comprises almost entirely of researchers working in labs. Once a POP is demonstrated in the lab and the development process moves towards POC, the team must be multi-disciplinary. Apart from the researchers, it will include engineers and legal consultants who can do patent drafting and contracts. Beyond the POC stage, a dedicated entrepreneurial team should be added to the engineering and research teams to take the idea forward. At this stage, the teams need to have techno-commercial synthesis skills to understand and integrate a range of technologies and couple technology capability with the market's needs. This entrepreneurial team will define the target market, identify early target customers, address scaleup issues and estimate financial resource requirements.

Figure 3.3: Changes in Team Composition along Different Stages of Commercialisation Journey



Legal expertise to make strategic decisions on IP protection is also required as the team starts collaborations with external partners and customers. As the team moves beyond the POV stage, the role of the researcher reduces, and entrepreneurship and engineering drive the development process. As the team seeks external funding, expertise in financing and related legal contracts becomes critical for the success of the effort. Beyond the Product-Market-Fit stage, the team looks more and more like a large business venture with business, operations and finance driving developments.

Apart from the changing nature of the team composition and skills, the leadership team needs to focus on the completeness of the team and assess if the existing skill sets within the team match the critical success factors of the business at any given time.

While the rapid changes in the team's skillsets and the way they are organised around the leadership evolves, it is important to ground the venture with a strong culture and a compensation structure that aligns with its goals. Start-up cultures are typically characterised by flat structures which empower people to take on multiple roles and make rapid decisions. It is based on a clear understanding of the vision for the venture and individual contributions towards achieving it. The compensation structure should align with this dynamic, empowering culture. Apart from the intangibles—such as opportunities to realise one's full potential, having a sense of purpose and being part of something bigger than the individual—a start-up can provide tangible benefits such as flexible work arrangements, opportunities to broaden one's network, mentor others and acquire new skills. A formal compensation package can include a fixed component, a variable component linked to individual and overall venture performance, and an opportunity to participate in the company's growth via instruments like stock appreciation rights and ESOPs. While equity-linked compensation is not appropriate for all employees—especially those who do not influence the company's direction—it is a great way to motivate the leadership team and employees who are emotionally vested in the venture's success.

One of the critical challenges for the leadership team as they progress along the commercialisation journey is scaling the

organisation by adding new people, processes and structure. As the team grows, roles become less fluid and access to the leaders becomes restricted. People also become more specialised and are organised into a hierarchy. This shift can be disorienting and disempowering for employees, especially those who went beyond their duty from the early days. Effective communication about the importance of the transition for the company is essential to make this transition successfully. The leadership team should also involve early employees in shaping the new processes and structures to get their buy-in. The team should also be trained to mentor and coach the next level of leadership. As the team and activities grow, a structured process for managing and prioritising the activities of the venture is also required.

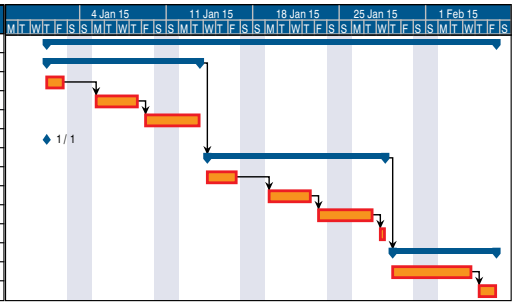
3.3 Project Management

A start-up team is simultaneously working on several projects related to different items in the business model canvas discussed in Section 2.5.1, and fundraising. They typically manage these projects using simple tools for task management and Excel spreadsheets. They do not spend the necessary time to break down the projects into individual activities and do not set intermediate milestones based on interdependencies between projects. Due to this lack of attention to project management, the team is scrambling to meet the next impending external deadline. Instead of this unstructured approach, the team can effectively manage projects, such that they have higher visibility into resource allocation and staff deployment. It also helps identify bottlenecks, prioritise activities and estimate completion timelines more accurately.

A GANTT chart, shown in Figure 3.4, is a bar chart that captures the project schedule and dependencies among project activities. It is used to plan and track the progress of projects. Each activity on the GANTT chart is represented by a bar. The length of the bar represents the duration of the activity, and the position of the bar represents its start and end date.

Figure 3.4: Example of Gantt Chart

	Name	Duration	Start	Finish
1	Business Plan	27 days	1/1/15...	6/2/15...
2	Phase 1	9 days	1/1/15...	13/1/1...
3	Define Scope	2 days	1/1/15...	2/1/15...
4	Revenue Plan	4 days	5/1/15...	8/1/15...
5	Evaluate	3 days	9/1/15...	13/1/1...
6	Helpful Links	0 days	1/1/15...	1/1/15...
7	Phase 2	11 days	14/1/1...	28/1/1...
8	Define	3 days	14/1/1...	16/1/1...
9	Identify Needs	4 days	19/1/1...	22/1/1...
10	Evaluate	3 days	23/1/1...	27/1/1...
11	Confirm	1 day	28/1/1...	28/1/1...
12	Phase 3	7 days	29/1/1...	6/2/15...
13	Develop Design	5 days	29/1/1...	4/2/15...
14	Describe	2 days	5/2/15...	6/2/15...



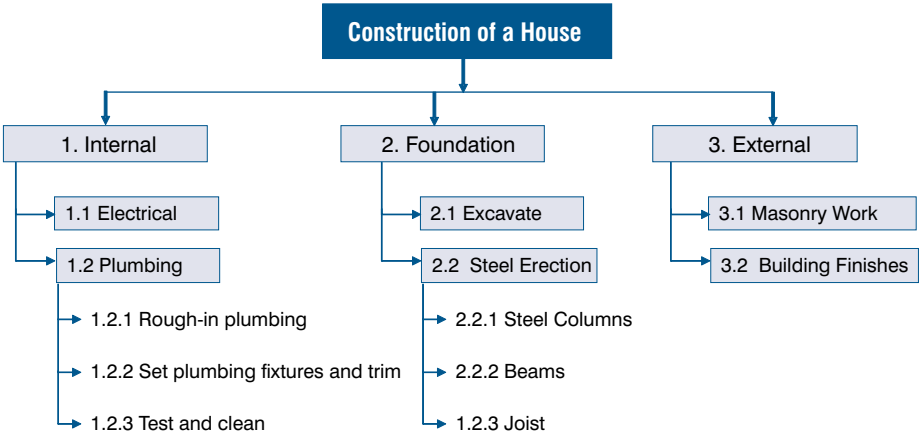
Examples of paid project management information systems (PMIS) include MS Project, Smartsheet Business, Mindview 7 and Mind Manager 2019. Start-ups that are strapped for resources can use open-source tools such as Project Libre.

Irrespective of the tool used, project management in a start-up starts with strategic goals, key metrics to track progress and expected timelines as set by the BOD. The start-up leadership team is responsible for reporting progress against these goals to the BOD. These strategic goals are broken down into individual projects and target timelines for achieving them. A work breakdown structure – WBS, as shown in Figure 3.5, outlines the hierarchy of activities and

tasks required to complete the project. It breaks down the project into manageable deliverables with more tractable timelines and resource requirements. Based on the WBS, details of each project such as activities and their task break-up, resources and staff and costs are identified. Staffing is expressed as a mix of core competencies and units of time. This analysis will help the team identify dependencies and requirements for procurement and outsourcing requirements. The project planning is then iterated based on available resources, procurement timelines and potential outsourcing opportunities to develop the GANTT chart for the projects.

As the projects advance, the project teams and leadership team should have periodic meetings to track progress against the plan and make course corrections. These meetings enable communication amongst the project team

Figure 3.5: Work Breakdown Structure (WBS)



and ensure discipline in project execution. It also helps the leadership team communicate progress and show-stoppers to the BOD in a meaningful manner.

3.4 Financial Management

A successful commercialisation journey from lab to market involves efficient management of resources. Apart from identifying the appropriate legal structure and compliances, effective project management, and compensation mechanisms to motivate the teams, managing the financial resources is key to growth and resilience. Effective financial management involves the following components:

- **Good Record Keeping:** The start-up should keep a good record of financial transactions to enable visibility into the company's financial health. It should keep track of business-related expenses in a timely and accurate manner using online tools like ZohoBooks or QuickBooks. Personal expenses must be separate from business expenses and the company should be aware of applicable taxes and incentives. It should also be mindful of the compliance and regulatory requirements, since non-compliance is expensive and can hamper growth.
- **Management Accounts:** Timely record of financial transactions enables the team to generate an accurate set of management accounts periodically. Specific financial statements that help the leadership team make effective business decisions are as follows:
    - **Balance Sheet:** A balance sheet is a snapshot of the assets and liabilities of a business at any

given time. A company's assets include cash and cash equivalents that can be quickly liquidated to generate cash, equipment, property or any other long term investments held by the company. It also includes Accounts Receivables, which specifies the amount due from customers for products sold and services rendered by the company. Liabilities include short term and long term debt taken by the company and Accounts Payables. Accounts Payable is the cash due to be paid to suppliers for products delivered and services rendered to the company. A balance sheet also lists shareholders equity and any portion of the company's profits that are reinvested. The team should pay special attention to the cash and cash equivalents. They should also scrutinise Accounts Receivables, Accounts Payable and Inventories to understand the portion of their assets tied up as working capital. A well-managed company uses a very small percentage of its assets on working capital.

- **Profit and Loss (P&L) Statement:** A P&L or income statement summarises the company's revenue, costs and expenses over a period. Revenues are the amount of cash expected or received by the company in exchange for the products and services delivered by it. Cost of goods sold (COGS) indicates the costs incurred by the company to provide products and services to customers. The difference between revenue and COGS is the gross profit, and is tied to the firm's pricing strategy. Hence, it is an important metric that the team should

track. Expenses include costs such as research and development, sales and general administration costs. The difference between the gross profit and these expenses is the EBITDA (earnings before interest, taxes, depreciation and amortisation). EBITDA is a key parameter useful to the team to compare profitability relative to competitors' and industry benchmarks. The start-up team can also compare the different line items of their P&L and their ratios against industry benchmarks to take strategic decisions on resource allocation and deployment.

- **Cash Flow Statement:** This statement summarises the cash inflows and outflows from operations, investment and financing activities. It is very important to manage the company's cash flows, especially during the pre-revenue period, as a company that runs out of cash cannot survive for a long time. It provides visibility into the liquidity, working capital needs, burn rate and financial health of the company. It also helps the team project future cash needs, plan repayments of loans and make investment decisions. A cash flow statement can also help the team determine the projected cash breakeven point and duration before it is likely to run out of cash at the current burn rate.

Together, these three financial statements and other operational metrics such as customer growth rate, average revenue per user (ARPU) and cost of customer acquisition (COCA) can help the team monitor the company's performance and make informed decisions.

- **Unit Economics:** As the company launches its products or services in the market, the team needs to understand unit economics. Unit economics includes revenue per unit sold, cost of the unit and contribution margin per unit. A unit of sale can be defined based on a per customer or per piece of product, or per service user. Understanding unit economics gives visibility into profitability and helps the team develop strategies to optimise costs. While it is possible to reduce unit costs with economies of scale and bulk ordering of raw materials, the team should ensure that the working capital requirements are manageable and that the strategy is compatible with the rate of evolution of the technology and dynamics of the market. It also helps the team identify products or services most valued by customers and make course corrections required to create a financially sustainable business in the long run.

Good financial management, a good grasp of unit economics and an understanding of the market can help the team make detailed forecasts of the revenues and costs over the immediate future of 12-18 months. This operating budget is useful for day-to-day planning of the business, including activities such as procurement, HR and production. Beyond this period, there is increased uncertainty, and financial forecasts can be made at a macro level on a quarterly or half-yearly basis. This financial planning is essential to provide a strategic direction to the company, as it incorporates the founding team's vision. The exercise is also useful to identify key assumptions of the team and risk factors impacting the long term success of the firm. Hence, it helps the team evolve strategies to manage these uncertainties.

3.5 Financing

The financial resources needed to grow a business are generated from internal revenues or external sources of equity, debt and grant funding. A science-based start-up which needs to make large investments into research and commercialisation long before revenue generation needs access to a variety of external sources of funding to sustain itself and grow. These include government research and commercialisation grants from idea generation to POC/POV stages of the journey, private investments from POV to Business-Model-Fit stage, and public markets in the stages beyond. Science-based start-ups can also attract corporate partnerships and investments at different stages of the journey, starting from the POV stage. Other sources of funding in the early stages of the journey are friends and family. In the later stages of the commercialisation journey, pre-paid customer orders, revenue from sales and debt financing from venture funds and banks are additional sources available to the venture. Raising funding from these external sources is a long drawn and time-intensive process. Hence, the leadership team responsible for commercialisation should plan fundraising activities well in advance of needs.

Private investors are primarily interested in scalable entrepreneurial businesses that increase in value rapidly. Start-ups building valuable assets like intellectual property that have inherent value will also attract investment, as investors can make good returns on investment. Potential exit routes—by which these investors can get returns—include mergers and acquisitions, sale to private equity or strategic investors and listing in public markets via initial public offering (IPO). Visibility towards these possible

exit routes is an important criterion for investment by private investors.

Corporate investors are primarily interested in companies that offer several strategic and tactical advantages. The start-up may provide products and services that indirectly grow the corporate's cash flow, or become potential acquisition targets. Similarly, a corporate invests in companies that offer it an option to stay informed about potential disruptions on the horizon. It may also invest in a start-up to own its technology and supplement its own, or kill competition. So when talking to an investor, the start-up team needs to position the start-up based on the type of investor, the potential value the investor expects to gain through the investment and the likely exit route. It is also important to target investors who can invest in the start-up's domain and within the target range of funding of the start-up. The investor should also be willing to accept the growth multiples and risks projected by the start-up.

A start-up that decides to raise private capital has to plan the fund-raising activity at least 12-18 months in advance and set aside necessary resources and leadership time to pursue it. The start-up should also clean up its capitalisation 'cap' table that shows the total market value of the company and its components. The cap table lists all the stakeholders who have a claim on company equity and the terms associated with their claims. A clean cap table builds the credibility of the start-up and makes it easier for the team to attract investment. A well-managed cap table can help the leadership team make informed decisions on the company's equity position, ESOPs and equity allotment to new hires. Common problems encountered with early-stage start-ups

raising the first round of equity funding from private investors are as follows:

- **Too many small investors:** The first external money that most start-ups receive is from friends and family, who invest small amounts. These investments are often undocumented and without any clear agreements. Start-ups may also have issued equity to suppliers and partners instead of cash. A start-up may also have raised angel funding from multiple small angels. These investments result in too many small or missing investors on the cap table who may stake a claim later. Missing investors is potentially risky for new investors. It is also logistically challenging to get a shareholder agreement with a large number of shareholders involved.
- **Unreasonable terms in early rounds:** Inexperienced founding teams may have given up too much or too little equity in earlier financing rounds. They may also have agreed to unreasonable terms from these early investors. Giving up too much equity in the early stages can result in significant premature dilution of the founder's share of the equity and demotivate the founders. Giving up too little equity may lead to unreasonable valuation expectations in later rounds that new investors may not be able to match.
- **Loan from founders:** During the early days of a start-up, founders spend their personal money on start-up related activities and account for them as 'loan from founders'. Investors will insist on the conversion of this loan to equity before they invest. The founder may pay a significantly higher than par value for that

conversion, as it is close to the next round of funding. The conversion will also change the founder equity ratios and may lead to conflict among founders.

- **Equity ownership of external stakeholders:** Significant ownership of equity by external stakeholders like inactive founders and advisors may be perceived as risky by investors, as the interest of these stakeholders may not be aligned with that of the investors.

A start-up with a clean cap table should have majority equity ownership by active founders, leadership team, employees and investors. The leadership team must negotiate with the other shareholders to transfer their shares to clean up a cap table. As discussed in Section 3.1.2, this has tax and regulatory implications. In addition, unsecured debt on the balance sheet may discourage investment in the start-up, as debt has a higher liquidation preference over any form of equity. It means that the debt holders receive their dues before any equity investor and this increases investor risk.

3.5.1 Due Diligence

Investors perform thorough due diligence of start-ups in which they potentially want to invest. Some of this is done after the pitch deck (See Section 4.2), initial discussions and a high-level review of the finances and cap table. Based on this preliminary review, the investor might issue a non-binding term sheet that specifies valuation at which the investment may be made, the type of instrument used, size of the board and the composition, liquidation preferences, lock-in period for the founder's shares, reserved rights and affirmative rights of the investors. Deeper due diligence of the start-up is done after the start-up team accepts the term sheet. Due diligence

of science-based start-ups is done along technical, legal, financial, compliance and economic dimensions.

- **Technical Due Diligence:** Technical part of the due diligence involves ensuring that (1) the technology works as disclosed by the start-up, (2) the technology is scalable, (3) ownership and quality of the intellectual property are well established, and (4) the intellectual property position of the company affords it freedom-to-operate.
- **Legal Due Diligence:** This includes reviewing the incorporation documents, co-founders' agreement, shareholder agreements with existing investors, lease and debt agreements, IP licensing, assignment and collaboration agreements, employment contracts, partnership agreements and company policies.
- **Financial Due Diligence:** This includes a review of annual returns filed by the company, auditor reports, details of company accounts and tax filings. The start-up's financial policies, control systems and key metrics used to make financial decisions are also reviewed.
- **Compliance Due Diligence:** A compliance review examines the start-ups' compliance to various regulations such as Shop Act, PT licenses, PF, ESIC, POSH. The existing governance structure, meeting records of BOD and shareholders and ROC filings are also examined as part of this review.
- **Economic Due Diligence:** This part of the due diligence reviews the ability of the start-up to create and deliver value to customers while generating expected returns to investors. It involves understanding the size of the

market, competition, market access, current traction, operations and unit economics. As part of this due diligence, the investors also review the team's capabilities, completeness and ability to deliver on the business. This analysis also helps the investors identify potential exit scenarios for the start-up.

Depending on the seriousness of the issues identified during the due diligence process, if investors decide to proceed with the investment, they will offer definitive agreements with revised valuation and detailed terms of the investment. The investors may also include conditional precedents that require the start-up to resolve key issues identified during the due diligence. The investors may also require the start-up to indemnify them against any liabilities associated with shortcomings identified in the due diligence report.

3.5.2 Valuation

Valuation is one of the key terms often negotiated as part of new investment into the start-up. Early-stage pre-revenue companies are hard to value accurately as the valuation depends on each party's perspective on the risks associated with the venture. Apart from the outcomes of the due diligence process, the valuation also depends on the number and diversity of investors available to invest at the stage and in the domain of the start-up. A large number of investors in a particular space will lead to better valuation for the start-up.

Start-ups should also remember that the valuation offered by more reputed investors is lower than that offered by other investors. These reputed investors have a larger pool of

start-ups to choose from, and provide additional intangible benefits such as added credibility to the start-up, and wider networks. These provide additional value to the start-up beyond the cash invested. The greater this value-add of the investor, the lower the valuation offered to the start-up.

Investors primarily use valuation of comparable companies or rules of thumb or industry metrics to value pre-revenue early-stage start-ups. They may also estimate the current value of the company based on the expected value of the start-up at exit and their target multiples. When the start-up raises equity financing in Business-Model-Fit or later revenue generating stages of the commercialisation journey, valuation is calculated based on discounting the projected free cash flows at a rate commensurate with the risk associated with the start-up. Each of these valuation methods introduces different biases, and the valuation offered by the investors may be based on a combination of these approaches and their internal valuation processes. Market timing and location of the investors also impact the valuation. An investment environment like current times with spectacular exits like Zomato's tends to lift the valuations of all start-ups.

Negotiations on valuation can be very charged due to all the factors discussed here. An unreasonable valuation at early stages can potentially jeopardise the start-up's chances of raising the next rounds of financing. A higher valuation in the early stages may also reflect investors' unrealistic expectations about the start-up's performance, which may be detrimental to the company. Hence, the start-up team should go beyond the valuation number and review the type of security used to invest in the company and key terms

associated with them to understand the implications of the agreement and negotiate appropriately.

3.5.3 Equity and Equity-Linked Securities

Private investors make equity investment into start-ups using broadly three types of securities – convertible debentures, preference shares and ordinary shares, in decreasing order of liquidation preferences. Ordinary shares are irredeemable shares issued by the company to the founders, friends and family and early investors such as accelerators, incubators and angel investors. Shares allotted or given under employee share option programmes or employee share purchase programmes also fall into this category. While ordinary shares have the lowest liquidation preference, they have voting rights and may receive a dividend.

Preference shares are a type of shares that have a fixed coupon or interest attached to them. These shares have a higher liquidation preference to ordinary shares. They do not generally have voting rights and may be convertible to ordinary shares under mutually agreed circumstances between the investor and the company. However, investors who invest in these types of securities can ask for voting rights commensurate with their investment. The Companies Act allows a private limited company to issue the following three types of preference shares:

- **Redeemable preference shares:** These shares cannot be converted to ordinary shares and need to be purchased back by the company at the option of the company by paying the purchase price and coupon rate agreed upon at the time of issue.

- **Compulsorily convertible preference shares (CCPS):** These are the most commonly issued securities to angel investors and institutional investors. They are convertible to ordinary shares at a predetermined date or when a pre-identified event like the next investment round occurs. In India, until a few years ago, CCPS had to be issued at a premium if the start-up was valued higher than the par value. While this rule is no longer applicable, a company intending to issue a large number of CCPS at par value will have to increase its authorised capital and consequently pay higher stamp duty. Hence, the decision on the issuing price of CCPS depends on the cost of the valuation report required to determine the premium price versus the increase in stamp duty associated with increasing authorised capital.
- **Optionally convertible preference shares (OCPS):** These securities offer the investor a guaranteed return of the funds invested with an option to participate in the company's growth at their choice. While these securities are not popular with institutional investors, they are used by strategic investors.

Companies Act and Income Tax Act require a company issuing ordinary or preference share to get a valuation report. In addition, the company should issue shareholder notices and do ROC filings to reclassify shares. Hence, issuing shares is an expensive exercise for a company in India.

For investors who are investing small amounts, a cost-effective alternative is to use one of the following convertible debt instruments:

- **Convertible Debentures (CDs):** These are debt instruments that convert to equity. If the conversion happens at a pre-determined time or when a pre-identified event occurs, these are called Compulsorily Convertible Debentures (CCDs). If this conversion happens at the option of the investor, then they are called Optionally Convertible Debentures (OCDs). These debentures can be converted at the option of the investor, just like OCPS. As debt instruments, the holders of these securities receive a fixed interest, but do not have any voting rights. Like OCPS, OCDs are more popular with strategic investors than institutional investors in India.
- **External Commercial Borrowings (ECBs):** This form of debt became available to start-ups registered under the Start-up India Scheme in 2016. Start-ups can do ECBs of up to $3 million per financial year, in any freely convertible currency, in Indian rupees, or a combination of both. ECBs should have a minimum maturity of three years. While compliance requirements are heavy, these instruments are freely convertible to debt and are ideal for start-ups with foreign collaborators or incurring foreign currency expenditure.
- **Simple Agreement For Future Equity (SAFE) Notes:** SAFE notes are warrants that started in the US over a decade ago. They are regularly used for small rounds of investments as they are designed to be easy, inexpensive and less procedural. The notes include only basic terms such as the discount applied on fair market value to the investor or valuation cap when converted to equity. The noteholders do not have the right to appoint directors, liquidation preference or affirmative rights.

In India, only eligible start-ups registered with DPIT under the Start-up India Scheme can issue SAFE notes. The issue is subject to a minimum of ₹25 lakhs per investor in a single tranche. Unlike in the US, these instruments are treated as equity in India, and investors insist on a valuation floor or a valuation cap, information rights, liquidation preference and indemnity rights. Since they are treated as equity in India, issuing them to investors is subject to the Companies Act and FEMA rules. While the Companies Act allows companies to issue CCPS and CCDs at par value, FEMA rules prohibit the issue of shares to foreign investors at below fair market value. Therefore, the start-up will need a valuation report issued on the date of investment to issue SAFE notes to foreign investors. This process of issuing SAFE notes nullifies the simplicity and cost-effectiveness of the instrument. A start-up incubator registered as a Section 8 non-profit company enjoys an exemption under the Section 11 and 12 to own equity in incubatee companies. However, whether this exemption includes acceptance of convertible instruments like SAFE notes is contentious. Hence incubators should exercise caution while accepting SAFE notes from incubatees.

3.5.4 Key Investment Terms

Apart from the type of equity or equity-linked security that the investor wants to use, the investment documents also include several key terms that the start-ups need to understand. A few of these key terms are discussed below:

- **Pre-Money and Post-Money Valuation:** Pre-money valuation of the company is the value of the start-up before the new investment from external sources

is added to the company and represents its current valuation. Post-money valuation is the sum of the pre-money valuation of the start-up and the new investment amount. The percentage ratio of the investment amount and the post-money valuation represents the percentage of equity that accrues to the new investors. The ownership of the existing shareholders is diluted from 100 percent to the percentage ratio of pre-money and post-money valuations. Creating an ESOP pool dilutes the ownership of existing shareholders further down without diluting the ownership of new investors if the investors want the start-up to create the ESOP pool before their investment.

- **Anti-Dilution:** New equity investment dilutes the shareholding of existing shareholders in proportion to their current holdings. Existing shareholders may not want their ownership to fall too low, especially when the new equity comes at a lower price than the price paid by them. So they ask the company for an anti-dilution clause that compensates them for the lower price of the new round by getting new shares without any additional investment. It further dilutes the other existing shareholders who do not have the anti-dilution clause. The number of new shares is calculated using two approaches:
  - **Full Ratchet:** The existing shareholders will receive new shares as if they invested at the lower price of the new investment. In this case, the full burden of lower price is borne by the shareholders who do not have the anti-dilution clause.
  - **Weighted Average Pricing:** The price at which the

existing shareholders will receive the new shares is calculated by taking into account the price at which the original investment was made (OP), number of shares currently issued on a fully diluted basis (A), number of shares issuable for the amount raised in the new round at OP (B) and number of shares issuable for the amount raised in the latest round at new price (C) to calculate an adjusted price as OP*(A+B)/(A+C). The existing shareholder will be issued new shares based on the adjusted price. This approach distributes the burden of lower price among all current shareholders and is hence more acceptable.

Anti-dilution is a form of insurance for venture capitalists and ensures that the start-up team meets the agreed-upon targets at the time of investment.

- **Liquidation Preferences:** As discussed above, all forms of debt have a higher liquidation preference to any form of equity. Preference shareholders also get their pay-out before ordinary shareholders. This pay-out could be a multiple (1X is standard in India) of the initial amount invested by the investor. Preference shares can also be participating and non-participating. Participating preference shareholders get a multiple of their initial investment and get paid pro-rata of the remaining proceeds on an as-converted basis. This double-dipping can lead to ordinary shareholders like founders and employees receiving a very small pay-out if the start-up raises multiple investment rounds. Start-ups can manage this by putting a cap on the returns to investors in terms of multiples of the initial

investment. A waterfall model captures the pay-out to different equity holders based on their liquidation preferences and class of shares. The start-up should build a waterfall model to fully understand the pay-outs under different exit scenarios and the implications of the terms.

- **Governance:** In addition to the other terms, investors also ask for information and affirmative rights, and board seats. Ideally, the structure of the board should reflect the shareholding. As the start-up goes through multiple funding rounds, the board structure will shift from a founder-controlled board to a shared-controlled board and later to an investor-controlled board. Start-ups should review the affirmative rights granted to the new investors as they could lead to potential deadlocks in decision-making.
- **Investor exit and guaranteed return:** An investor might include other clauses such as pre-defined exit horizon, guaranteed return and exit. Science-based start-ups should not agree to terms that demand a guaranteed return with an aggressive, pre-determined exit horizon. They should also not guarantee buy-back and only commit to best efforts to provide an exit to the investors.

When negotiating the terms of the investment, the team should balance the interests of the company, existing shareholders and new investors. They should be especially careful about accepting any non-standard clauses that might set precedence for later rounds of investment. The team should hire legal counsel and consult mentors and investees of the new investors to ensure they can get the

best terms possible. They should also ensure that all terms are included in the final shareholder agreement and that the agreement is fully executed. Once executed, the start-up should ensure that they satisfy the conditional precedent as rapidly as possible. The round is fully closed after the investor transfers the money to the start-up's bank account. Closing an investment round is just the beginning of the relationship with the investor, and start-ups should manage their relationship with the investors professionally, as discussed in Section 3.2.

3.6 Intellectual Property Management

Science-based start-ups are based on large upfront investments in science and technology. Early research and development of the invention used by the start-up may be developed at an academic institution. The start-up invests further to develop the technology towards the market. It may also have to acquire the rights to complementary technologies or collaborate with other players to build a marketable offering. As the start-up moves towards the market entry, it might work with different partners for manufacturing, system integration and sales. Along the way, the start-up also develops business models, builds know-how about the customers and partners, and establishes its reputation. All these form components of the start-up's intangible assets collectively known as intellectual property (IP) Parts of this intellectual property can be registered with the government to establish ownership. These include utility patents, copyrights, design patents and trademarks. Other forms of intellectual property like business models, customer databases,

experimental data and other forms of know-how and trade secrets are not registerable. Hence, ownership of these assets is established only by possession. In the early stages of the commercialisation journey, the team's most valuable assets are the registered patents that may be owned by the academic institution and the know-how related to them that resides within the team.

3.6.1 Patents

A patent is an exclusive right granted by the government to the owners or inventors of the invention in exchange for disclosing it in a legal document called patent specification. A patent gives the owner the right to exclude others from using the invention for a limited time of 20 years. As it is a right granted by the government, the right is territorial. So any patent granted in one country—say India—doesn't give the patent holder the right to exclude others to use the invention in another country like the US or vice-versa.

The patent specification includes the background of the invention, summary or object of the invention, detailed description of the invention, including examples, drawings with explanations, and claims. The scope of claims establishes the boundaries of the rights offered by the patent, and the start-up team should aim to get the broadest possible claim coverage for their invention. Once the specification of a patent application is filed, nothing new can be added to it when the patent office assigned by the government is reviewing it. All the claims in the patent are interpreted based on the specification.

Case Study: IP Strategy

Aditya Technologies was a start-up developing new materials for converting near-infrared light to visible light. The team's market analysis showed an untapped opportunity in making transparent solar windows that could replace glass panes on building facades. They evaluated the pathway from their new material to the glass facades and identified the need for the following technology needs: (1) a scalable process to make transparent thin films from the material, (2) a scalable process to integrate the thin films with existing thin-film solar cells, (3) a scalable process to integrate the solar cells with glass panels, (4) methods for collecting the electricity generated from multiple panels and (5) a scalable process for the production of the new materials.

The team had several options to raise grant funding to develop POC and POV prototypes and test them. After exhausting these grant funding options, they still had to deal with scale-up issues and make sufficient progress in raising funds from private investors. To reach that stage, the company entered into a collaboration agreement with an existing thin-film solar cell manufacturer to integrate their technologies and develop high-efficiency transparent solar cells. Eventually, the company's IP portfolio, the POC and POV validation, and collaboration with a major thin-film solar company were sufficient to help it raise a major round of funding. This funding enabled it to exclusively in-license a technology from a local university. It also helped the company outsource the development of a system for charge collection and real-time monitoring of the energy generation from multiple panels, while retaining the rest of the technology development in-house.

Key Takeaways

A company needs to fully analyse all the development needs to go from the core technology they own in-house to the products they want to develop. Then they need to map the different grant and private funding sources they can access in their ecosystem and carefully plan their development path and fundraising efforts to progress the technology towards the product.

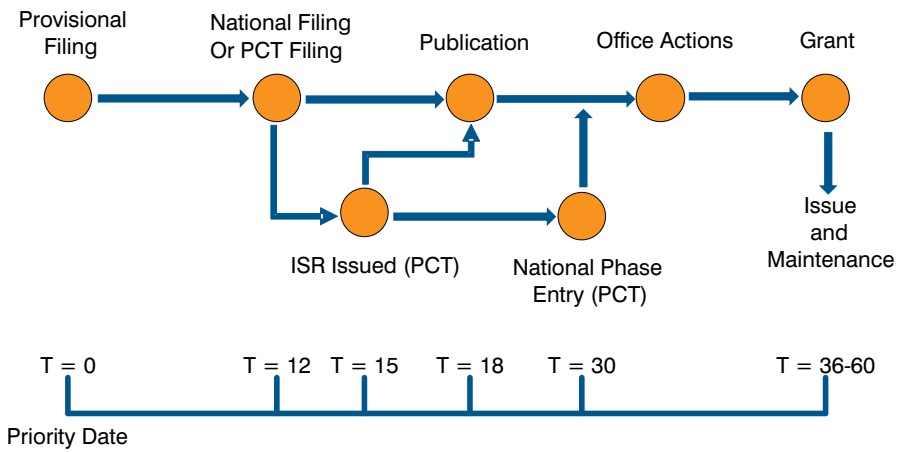
Once a patent application is filed with a patent office, a patent examiner evaluates it on three criteria.

- **Novelty:** Is the invention new?

- **Inventiveness (non-obviousness):** Can someone "skilled in the art" easily invent the disclosed invention based on the existing state of the art? If the answer is no, then the invention is considered inventive or non-obvious.
- **Utility:** The invention has an industrial application. This criterion is usually not a major hurdle for patents at the core of a start-up.

As shown in Figure 3.6, the typical timeline for filing a patent starts with a provisional filing – a basic document describing the invention's key aspects and may include only rudimentary claims. The day of initial filing is called the priority date. The team may also choose to file a national application directly without filing a provisional application. The provisional filing or national application gives the owners 12 months to file an application under the patent cooperation treaty (PCT), to which most countries of the world are signatories. If a PCT application is filed, an international search report is issued within three months of filing. This preliminary report identifies

Figure 3.6: Typical Timeline for a Patent Application



any relevant publicly available information before the priority date, or 'prior art' as it is commonly known, that disallow the patent's claims.

Whether the patent is filed with the national office or under PCT, the application is published 18 months after the priority date. Within 30 months after the priority date or 18 months after the PCT filing, corresponding applications in any national office can be filed using the priority date of the first filing. In the context of the science-based start-up, these 18 months are crucial to review the various risks associated with the commercialisation and decide on countries to file corresponding patent applications without losing the priority date. Upon reviewing the application, patent examiners in different countries send out 'office actions' which outline their reasons to disallow claims listed in the patent application. These objections could be based on lack of novelty, inventiveness or utility. The inventors, along with their patent agent, can then respond to them or modify the claims based on the documents cited.

After this phase of patent prosecution, which lasts at least two to three years after the national filing is made, if the examiner is satisfied with these responses, the patent may be granted based on the latest modifications to the claims proposed by the applicants. The time between the filing and grant depends on the patent office's workload, the application's claim scope, the number of office actions and how quickly the inventors respond to office actions. While it is possible to pay extra fees to accelerate the examination or get the patent granted quickly by narrowing the claim scope, these are not desirable for science-based start-ups. Narrow claims make for a low value of the patent. A poorly

written patent application could be rejected, despite the invention being valuable. This rejection could prematurely demotivate the team. Also, the standard patent examination schedule affords the team the time required to validate their technology and identify key applications and markets. This extra time can help them fine-tune the patent specifications during national filings and conserve cash. The start-up could also potentially have new investors who may provide the resources to improve the quality of the national filings.

Once the examiner agrees to grant, the applicants must pay an issue fee to get the patent issued. The process doesn't quite end there. Once the patent is issued, the applicant must maintain it by paying a periodic maintenance fee. The process and timelines for the different activities may vary slightly depending on the country of filing. It costs anywhere between ₹55,000–₹120,000 to file and prosecute a patent in India. Maintenance fees of an Indian patent over its lifetime are ₹384,000.

Determinants of Patent Value

The value of a patent decreases as it ages, especially in areas that are evolving rapidly. In technology areas with significant patenting activity, the likelihood of a patent getting invalidated is very high. So the patent activity under the different classification codes assigned to a patent impacts its value. As the age of the patents increases, issues like non-payment or late payment of maintenance fees or the inability to respond to office actions on time are more likely to occur in resource-constrained environments such as start-ups. These lapses will have an impact on the validity and value of the patent. An older patent with a low number of forward

citations (excluding self-citations) is another indication of the poor value of the patent.

The quality of a patent can be assessed by the number of claims included in the specification. However, it is not the only factor that matters. The number of classification codes used by the examiner to classify these claims and the types of claims made in the document are strong determinants of its strength. Since patent rights are territorial, the geographical coverage of the corresponding applications and alignment with the start-up's major markets is another determinant of its value.

Freedom to Operate

Patents are exclusionary rights. Hence, a patent gives the owner the right to exclude others from using the invention disclosed in the patent document. As the start-up tries to develop new products or processes, or set up their operations, they might infringe on the exclusionary rights of other patent holders. To avoid infringement, the start-up must work around these blocking patents by finding an alternate route to commercialisation, or license the blocking patents. This situation is a typical example of not having 'freedom-to-operate'. This freedom-to-operate is specific to each application and geography. The start-up team should conduct preliminary freedom-to-operate for their critical applications and markets and develop strategies to circumvent any freedom-to-operate issues.

Competitive Intelligence from Patent Analytics

Patent databases like PatentScope and Espacenet, which capture information about patent families and

their prosecution, can be a great source of competitive intelligence. Single dimensional patent analysis can give the following insight:

- Examining the geographical coverage of the patents related to the team's inventions can help the team identify key geographies of importance.
- The distribution of patents across the different classification codes gives insight into the nature of developments in the technology space.
- The distribution of the patents over time indicates the level of maturity of the space.
- Analysis of assignees indicates organisations developing competing technologies that could be a starting point to understand potential domains and applications for the invention.
- Analysis of inventors helps the team identify experts in the field to engage with or to monitor.
- As discussed above, the number of forward citations is a good indicator of the value of a patent. Examining the forward citations gives insights into freedom-to-operate issues arising from a patent and how they can be overcome.
- Single dimensional analysis based on keywords used to describe a patent can help a non-patent expert understand the areas of patenting activity in the field. However, since keywords do not have any legal significance, an analysis based on classification codes or using a combination of classification codes and keywords is more robust.

These single-dimensional analyses can be done over time to understand the evolution of the competitive technology landscape and identify whitespaces.

Analysis can also be done across two dimensions as follows:

- **Assignee vs Classification codes:** This analysis helps the team understand the core offering and position of the different players in the value chain.
- **Assignee vs Geography:** This helps identify how the different countries fit across the value chain.
- **Keywords vs Keywords:** This analysis can give deeper insights into the competitive landscape and identify potential white spaces based on deep domain expertise. Doing such custom analyses or a deeper review requires paid tools and deeper analytical engines. In contrast, the single-dimensional and temporal analysis discussed above can be done using free databases like Google Patents, PatentScope, Espacenet or The Lens.

3.6.2 Partnership and Licensing Contracts

Partnerships related to acquiring, building, protecting, evaluating and commercialising IP are very important for successfully commercialising scientific inventions. As discussed above, effective information controls are essential to protect the start-up's IP effectively. Forming good partnerships or establishing good information controls starts with doing due diligence on the potential partners and employees by leveraging networks and asking for referrals. The venture and its leadership team should build credibility and create excitement in the partners and

potential employees to have an opportunity to participate in the venture's success. Building relationships with them over time, treating them fairly and giving them credit where it is due are all very important to help them sustain the relationship. The parties should also clearly understand their rights and responsibilities and how any exceptions and changes in circumstances will be handled. Contracts are legal documents that capture this understanding. A few examples of such contracts are discussed next.

Confidentiality or Non-Disclosure Agreement (NDA)

These contracts cover sharing ideas and information with value because it is known only to a few people and kept confidential. This confidential information could be details of a new invention or know-how related to it. NDAs are typically part of employment contracts. NDAs protect the information disclosed not only during the term of the contract, but well beyond that. For example, an employee leaving a competitor and joining the start-up may still be governed by NDAs signed as part of the employment contract with the competitor. So the start-up should ensure that it does not infringe on competitors' IP rights while hiring its employees. Similarly, the start-up's employment contract should have strong non-disclosure clauses to prevent the start-up's IP from leaking out of the company when employees leave.

NDAs are also among the first contracts signed when exploring partnerships that impact the start-up's IP. Apart from the survival of confidentiality beyond the term of the contract discussed above, NDAs with partners should clarify the nature of the confidential information, how the

confidential information is exchanged and how the receiving party will protect it during and after the contract term.

Collaboration Agreements

Collaboration agreements are the heart of building effective partnerships to develop the invention and validate it in the early stages of the commercialisation journey. These can be simple agreements for consulting and equipment use, or complex agreements for sponsored research, collaborations or consortia. They are also important for developing the product and scaling its production in later stages of the commercialisation journey.

The most important part of a collaboration agreement is the statement of work and schedules included in the annexes of the agreement. They outline the key objectives of the project and the scope of work covered by the agreement. In addition, it outlines the contributions of the collaborating parties. These include the background IP each party is contributing to the project, the resources they are bringing in and any materials exchanged between them, and a schedule of when each party is expected to contribute these to the project. They also specify the expected outcomes or deliverables of the project, including reports, data, other forms of foreground IP and any tangible materials created. In addition, the annexes specify the timeline of when each of these deliverables is expected. Once the statement of work and annexes are negotiated, they become the basis for the other points of negotiations related to the agreement.

First among these is the decision on who owns the results of the collaboration. While joint ownership—either in equal shares or in proportion to each party's contributions—

might seem equitable, the implications of joint ownership need to be carefully assessed. Joint ownership of any asset can be as joint owners, or as tenants in common. If this is left unspecified in the contract, it can be interpreted differently in different countries. In addition, joint ownership of registered IP like patents isn't treated the same as joint ownership of copyrights. So the path to internal use and external commercialisation of the IP generated from the collaboration can become quite complicated and consequently expensive if the parties want joint ownership. Apart from ownership, the parties need to agree on how registered rights for the IP, such as patents, are acquired and maintained, as each party has different interests in different fields and geographies. So the form and structure of the IP protection and responsibilities concerning the administration and costs need to be negotiated. The next item for negotiation is how the IP will be exploited and how the proceeds from the exploitation will be shared. Depending on the timeframe of collaboration and effort required for exploitation, this can be a very long way off in the future. Since there is considerable uncertainty in the deliverables of the collaboration and its value, it is often hard to estimate the costs associated with and revenues from such exploitations. However, delaying this discussion till after the collaboration project is complete can lead to significant uncertainty in the value of the project to the parties. A reasonable approach is to limit the discussions regarding exploitation to only broad outlines of the commercialisation terms, with bounds on revenue and cost shares to address the collaborating parties' key concerns and outline a process to arrive at the details later.

As collaborations can span several months to even several years, circumstances can change for the collaborating parties. As the partnership evolves and the parties involved learn more, things may get done faster or slower than predicted, or both parties may abandon parts of the project altogether. A formal process to incorporate the consequences of these changes and modify the contract should be integral to the document. Due to the long duration of the engagement and considerable uncertainty of the outcomes, good collaboration agreements can take substantial time and effort to define and execute.

Instead of a single project, if the start-up plans to do many different projects with the same partner at different times, it can be quite tedious to negotiate the agreements for each new project, as any good or bad experiences from one project could have a detrimental effect on the negotiations. The start-up can negotiate a master agreement to define algorithmic ways to resolve the most sticky issues in this scenario. Specific projects can then become subordinate to it and outline the specifics. This way of structuring is especially useful for strategic collaborations and requires commitment from the leadership of the start-up and the partner.

Licensing Agreements

A license grants one party access to the intangible assets of the other party in return for financial considerations. The party that controls the asset and has the right to grant access is the licensor. The licensor maintains ownership of the licensed assets and can impose terms and conditions on the licensee in return for the access. This access can be provided exclusively to only one party, or non-exclusively to

multiple parties. Both exclusive and non-exclusive licenses can be further limited based on the field of use that restricts the access rights to a subset of potential uses of the asset or territory.

Typical IP assets that are licensed are trade secrets, know-how, registered IP like patents, design and copyrights, test data and reports and tangible assets like materials. A licensor might license the IP assets because taking it further along the commercialisation journey does not fit with its mandate, or due to lack of funding and other resources needed to commercialise it. A licensee who acquires access rights from the licensor can save both resources and time by acquiring them. It can help the licensee create new products or strengthen existing products. It can also enhance the licensee's IP position in the market space.

From an entity perspective, licensing activity can be classified into three categories:

- In-licensing: This is the process by which the entity acquires the right to IP assets of another entity.
- Out-licensing: This is the process by which the entity grants rights to its IP assets to others.

In-licensing and out-licensing can be further categorised into enabling licenses or licenses for freedom to operate. An enabling license lets the licensor use the asset. Hence, it includes access to the know-how associated with registered assets such as patents and patent applications. This license is offered in the early stages of the commercialisation journey, when the patent application may still be pending. It may also include collaboration between the parties to enable its further development. A freedom-to-operate license provides

the licensee with the right to get past the blocking patents of the licensor and have freedom-to-operate. This category of licensing activity is done when the product is close to launching and patents are issued.

- Cross licensing: Cross licensing is a hybrid form of licensing where both parties have IP assets of relevance to the other party. They trade access to them to eliminate their respective roadblocks to market. Companies might acquire such licenses for defensive purposes and other strategic reasons.

One component of the financial considerations paid by the licensee in exchange for the license is upfront payment – a one-time fee paid when the licensing agreement is signed. These upfront fees include patenting costs incurred till the agreement's date and reflect the initial value of the technology being transferred. In some cases, especially for a transaction between a research organisation and its spin-off, the license is granted in exchange for equity in the spin-off.

In addition, the licensee may be required to pay a royalty on licensed products that incorporate or use the licensed assets. These royalties are calculated by multiplying a royalty base with a royalty rate. The royalty base measures the licensee's return from the licensed assets. Typical measures used as royalty bases are net sales of the licensed products, number of users and number of units sold. The royalty rate is the portion of the licensee's return that accrues to the licensor. The licensor could choose to use a single flat rate irrespective of the licensee's return, or a tiered rate that varies with the level of the return. For calculating this rate, a rule of thumb is that 25 percent of the

licensee's return should accrue to the licensor. Therefore, if economies of scale and scope can improve the unit economics, the royalty rate will be adjusted upwards using a tiered rate. Another parameter related to royalties is the royalty term – the period over which the royalties are charged. Universities as licensors charge royalties until the expiry of the last patent, on a country-to-country basis. Commercial companies charge royalties based on the longer of the expiry date of patents, or ten years from the first commercial sale on a country-to-country basis. If the license is offered on a non-exclusive basis, the licensees can include a 'most favoured nation' clause that ensures that the licensor does not provide other non-exclusive licenses at a lower royalty rate than offered to them.

The financial considerations may also include a share of revenue generated by the licensee from sub-licensing. The licensor can reserve the right to review the terms of the sub-license to ensure that the licensee does not game the licensor by using sub-licensing to short-change the payments due to the licensor. Sub-licensing revenue can be shared between licensor and licensee using three potential models.

- **Pass-Through:** Licensor gets the same royalty on sub-licensee's sales as if the licensee sold the product in addition to a pre-negotiated percentage of every payment received by the licensee from sub-licensee.
- **Allocation:** Licensor gets a pre-negotiated percentage of every payment the licensee receives from the sub-licensee, including royalty payments.
- **Tiered Allocation:** Licensor gets a lower percentage of payments received from the sub-licensee before

commercialisation and a higher percentage of royalties after commercialisation. The rate may also be based on the timing of the sub-licensing agreement after the license agreement or stage of the commercialisation journey.

Grant fees are other fees that the licensor can include when the licensed IP assets are pending patent applications. This fee is due when the patents get granted in different countries. The licensee may also be required to share the cost of patent prosecution, especially in the case of exclusive licenses.

In addition to the financial terms, licensors may include several contractual terms in the licensing agreements to safeguard their interests. The first of these is the right to audit the licensee accounts and sub-licensing agreements to ensure that the licensor's interests are protected. In addition, the licensor reserves the right to approve any transfer of the rights under the license agreement from the licensee to other parties. So, if the licensee is involved in an M&A activity, for example, the licensee doesn't automatically change. Any change in licensee needs to be approved by the licensor.

Licensors may also include clauses to ensure that the licensee seeking an enabling license is, in fact, diligent in commercialising the IP assets licensed. These include minimum payments, periodically. The licensor will want this minimum amount to be paid regardless of whether the licensee makes money on the licensed assets. In addition, the licensor will include milestone payments like the grant fees discussed above. These milestones can also be based on revenue generated, or the number of downloads or users. An interest rate on the payments is also added to the terms to ensure that licensee payments are made on time.

Licensors will also include clauses to limit their liability and ensure that the licensees will indemnify them against third party claims and infringements. If the licensee is a start-up, the licensor may demand that the start-up has sufficient insurance to ensure its ability to indemnify the licensor. In the worst case, the licensor reserves the right to terminate the license agreement in case of a lack of diligence on the part of the licensee to commercialise the technology, or non-payment of agreed-upon fees, or non-compliance with the terms of the agreement.

Licensees can also include certain safeguards to protect their interests as part of the licensing agreement. First of these is the incorporation of warranties. If the licensor is an academic institution, this is often difficult to get. However, at the minimum, licensees will want to ensure that the IP asset being licensed is unencumbered and that the licensors have the right to license it to them. Another way that licensees can protect their interests is to register the license with the relevant government agencies. This registration is especially important for registered IP assets like patents. Licensee can also include clauses to potentially withhold or delay payments in case of non-compliance with the licensing terms by the licensor.

Apart from these clauses, the licensing agreement should include exclusions that cover fields of use related the intellectual property being licensed that are either included in previous granted licensing agreements or expected to be included in future licensing agreements. It should also include dispute resolution mechanisms such as mediation, arbitration, and legal action in courts as a final resort. When the licensing agreement is between

entities residing in different countries, it should also include explicit mention of system of law that governs the agreement and which courts will have jurisdiction in the event of dispute. This clause is usually included to take care of differences in the interpretation of the agreement under the laws of different countries.

3.6.3 IP Strategy

A science-based start-up may start its journey by licensing an invention from an academic institution. Ideally, the start-up would want to get the IP assets assigned to the start-up to reduce the uncertainty around IP access to secure funding. However, due to the lack of resources and risks associated with the start-up, this may be challenging during the start-up's early days. The start-up can manage this risk by incorporating an option to acquire the IP assets at pre-negotiated terms, based on the quantum of funding secured and commercialisation milestones reached.

Similarly, the start-up may also want to secure the rights to the improvements made by the academic institution to the licensed IP assets to ensure sustained competitive advantage. This right can be guaranteed by including a pipeline agreement as part of the licensing agreement. At the minimum, this pipeline agreement should give the start-up a right to information on the improvements and the first right to negotiate a license. While academic institutions are reluctant to offer this in general, by defining the scope of the inventions included as part of the pipeline agreement and the option's duration narrowly, the start-up and academic institution can arrive at a feasible way to incorporate this provision.

Apart from in-licensing IP, the start-up will also develop

intellectual property in-house or in collaboration with other parties. As discussed above, protecting intellectual property in the form of a patent is a ladder with escalating expenditure as we move through the different stages of the process. Key inventors who are part of the start-up team have to spend a significant portion of their time to help draft strong patent applications and respond to office actions promptly, to enable the start-up build a strong patent portfolio. However, a strong patent portfolio can return several times these costs and time by creating effective barriers to entry for competitors. It can also provide the start-up with the freedom-to-operate and work around the barriers erected by their competitors. Patents can also help the start-up to build valuable partnerships without fear of losing its competitive edge. They are also assets that can help the team create leverage in negotiations with investors and provide them alternative paths to commercialisation in the face of a changing competitive landscape. A start-up with a strong patent portfolio also has a reputational advantage to help with fundraising efforts and credibility with customers. It can also help attract the best talent available.

A start-up can build a strong patent portfolio by patenting strategically while keeping costs and efforts manageable. A decision on whether to file a patent is based on several key considerations, including the following:

- **Public Disclosure:** If the start-up is disclosing the invention to external parties, relevant patent applications must be filed before such disclosures. These disclosures include roadshows, product demonstration to third parties, installation of the product at a customer site, sending samples of the product for evaluation and

collaboration or co-development agreements with partners.

- **Replicability:** If an invention can be replicated easily with minimum resources, then a patent application must be filed as soon as possible.
- **Discoverability:** An invention that is discoverable based on the various attributes of the product should be patented.
- **Enforceability:** The cost of a patent that is not enforceable is something very few start-ups can afford. So the legal infrastructure to enforce a patent should be evaluated before filing a patent application in that territory. If the legal infrastructure exists, the start-up should assess how easy it is to demonstrate infringement. A patent that requires access to potential infringers facilities or internal data to confirm infringement is difficult to enforce, as it is hard to gain access to infringer's facilities without establishing reasonable doubt. While there might be other strategic reasons, the choice has to be made based on challenges to enforcement.
- **Cost vs Benefits:** In addition to the cost of filing, prosecuting and maintaining the patent, the start-up should also evaluate the risks associated with the public disclosure of the invention. The team should also assess how the cost of infringement by competitors compares with the cost of pursuing patent protection and enforcing it. In general, there is less urgency to file the patent application on breakthrough inventions, as it is hard to reinvent and the cost of public disclosure may be higher than the benefits.

- **Internal Controls:** A start-up with sophisticated information control systems such as non-disclosure agreements, access control and traceability can keep the invention a trade secret without significant risk of public disclosure or loss of competitive position.

Once the team decides to patent an invention, they can optimise the filing based on the company's broad business strategy and markets. If the team intends to form partnerships to develop their products or market them, the company should prioritise collaboration agreements and protect its background IP. If the team plans to build the product in-house and take it to market themselves, they should prioritise strong employee agreements and internal controls. In addition, they should have strong licensing contracts. Irrespective of the business strategy, the team should do a competitive analysis of the patent landscape and file related patents to provide them with the freedom-to-operate and sustain their competitive advantage. These defensive strategies can be complemented with a defensive publication strategy, where the team can make public disclosures and file patents, to prevent their competition from filing blocking patents in their space. More aggressive strategies include filing blocking patents related to competitive technologies and doing proactive broad patenting in the technology whitespaces identified during competitive patent analysis.

The team should also time patent filings to align major developments related to patents with major business milestones, such as pilot testing and market entry, and fundraising. Patents related to inventions that form the background to major collaborations should be done before

entering into them. In a very crowded technology space, an un-granted patent application leads to much uncertainty that may impact valuations and partnership agreements. In these cases, the company could opt for accelerated prosecution to clarify claim scope and allowance as soon as possible.

One of the best strategies a science-based start-up team can adopt to protect their inventions is to ensure the quality of the patent applications they file, by hiring a good patent agent and ensure that the inventors are involved deeply in the drafting and prosecution of the patent application. The technology lead should ensure that sufficient backup positions are included in the specifications to modify the claims during the prosecution phase. The claims should include all potential workarounds to the invention. The application should have sufficient details of the invention with supporting data and examples covering the range of values used in the claim scope.

While these are broad general strategies, the specific strategies adopted by the start-up depend on its domain and stage of growth. In general, companies in the materials and biotech space focus on filing a few high-quality patents, while in ICT related domains the number of patents plays a significant role in a company's reputational value. Young companies whose main assets are related to IP tend to emphasise IP filings more than larger companies with stronger information control systems that can help them maintain their know-how as trade secrets for longer.

Licensing IP Assets

Apart from developing products and selling them, the start-up may also license the IP assets directly either to monetise them

directly, or as part of a co-development effort. Before starting to license the IP assets, the company should develop a clear licensing strategy and set aside a budget to ensure compliance. Choosing the right licensee in a crowded market with several potential licensees can be challenging for the licensor. As discussed in Section 2.4, truly revolutionary inventions are likely to be licensed by start-ups with a high risk of failure but a potentially higher reward, if successful. Conversely, incremental inventions are likely to be licensed to established companies that can provide a stable source of revenue.

If the licensed IP assets can be used to develop multiple products in multiple markets, the start-up should modify the claims to align the patent claim scope with all the potential products and markets. The start-up should also evaluate the potential licensee's capabilities across all potential opportunities and likely limit the license scope to a field of use and territories that fit the licensee's capabilities. The start-up may also consider the risks and benefits of granting an exclusive or non-exclusive license to the licensee. If the IP assets provide all the necessary IP to develop a commercialisable solution fully, the start-up should structure the licensing agreement such that the licensee has maximum incentive to invest in commercialising the technology and taking it to the market.

Once the start-up decides on the type of licensee and the strategy around exclusivity or limited licensing, the start-up has to structure an enabling license by clearly understanding the stages of the commercialisation journey and the resources needed to traverse the different stages to a commercialisable product. This information can be used to structure the developmental milestones.

4. Essential Soft Skills

"85% of one's success at the work place is attributed to soft skills"

– Harvard Study

In the previous sections, we discussed several management skills to help the teams deal with different aspects of building and growing a successful science-based business. While these hard skills are important, personality traits and social skills are equally important. Examples of important personality traits from an entrepreneurial perspective include an ability to identify the right problem, a passion to drive the effort and an ability to bring people from different backgrounds and the resources they need together. One of the major reasons for failure among start-ups is conflict among co-founders and between co-founders and investors. So an ability to resolve conflict and stay focused on the larger vision is an essential skill for scientists aspiring to build entrepreneurial ventures. While many of these abilities come naturally to scientists, they need to become comfortable with new types of risks we discussed in Section 2.

They also need to develop an ability to listen to the various stakeholders and align the path of the business without losing sight of the larger vision. Most of all, it means having

Traits of a Good Entrepreneur

- Foresight; 'Nose' for an opportunity; comfort with uncertainity
- Compassion/ passion; caring for a cause/ problem/purpose; empathy; finds joy and satisfaction in 'building' and end results; commitment
- Ability to convince oneself; build conviction; confidence in one own ideas; do enough homework/research/ thinking to convince oneself
- Courage to walk alone; courage to be the last man standing
- Resilience; patience; health toleration for frustration
- Ability to 'sell', to communicate, to touch the 'heart and mind'; ability to build/ project credibility
- Resourcefulness; find and arrange resources; do not get stuck or whine.
- Willingness to 'do everything necessary for the goal'; not be too fussy and picky
- Frugal and ability to be frugal as needed; can slide down the burn whenever needed; but not 'penny wise, pound foolish'
- Sense of responsibility to all stakeholders; investors; employees; customers; trustee orientation
- Appreciation of the value of a team; trust to delegate; trust but verify; importance of other 'value contributors'

a beginner's mind and getting comfortable with hearing 'No' from people who may not necessarily have the same technical background as the scientists. It also means being prepared to accept failure and adopt a culture of learning. In addition, they should learn to delegate responsibilities and build a leadership team with diverse skill sets. In short, the personality traits of successful science-based entrepreneurs are passion, perseverance, generosity, integrity and resilience.

4.1 Networking

Building a successful business is based on access to the right people and tacit knowledge. The process of finding

and building enduring and long-lasting relationships with different people to enable this access is networking. As social beings, all humans need networks to thrive in their personal and professional life. Great networks are built by being outgoing and actively interacting with people and their surroundings. It involves active exposure to unfamiliar and uncomfortable situations and learning to deal with them. It also involves getting comfortable with talking to new people, being an observant and active listener. Most importantly, it is a skill that requires a lot of practice.

Luis Miranda, in his talk at Venture Center, discussed a PHORCE framework of networking as follows:

- **Positivity:** Successful networking requires the ability to get beyond one's inhibitions and be positive in the face of potentially being ignored or rejected. By negotiating against themselves, people tend to lose opportunities that could otherwise have helped them.
- **Hard work:** Successful networking involves a lot of hard work behind the scenes. It includes doing background research, finding common touchpoints and remembering the name and personal details of the people from previous meetings. Every positive interaction should be treated as an opportunity to build a relationship by communicating regularly and seizing opportunities to give back in meaningful ways.
- **Openness:** Human beings have multiple layers to them, and the ability to be open to new ideas and new perspectives is essential to build good, lasting relationships.
- **Reliance (Trust):** Active networkers trust their gut instinct

about people and look for the good in everything until proven otherwise. This ability to give people the benefit of the doubt is important for sustaining relationships.

- **Consequences:** With risk comes the possibility of failure, and when trying to work with people, there is a potential for adverse effects. Instead of blaming people or circumstances for these negative consequences, one can use it as an opportunity to learn from them.
- **Empathy:** A good networker is a good human being who genuinely cares for others. A relationship formed without any specific agenda—like those formed during college days—is likely to endure longer, because it is based on genuine liking for each other. This ability helps build enduring relationships from a single transaction.

Great networks help the teams get referrals and connect to advisors who can help them gain credibility. Networking with like-minded people will help with validation of ideas. It helps avoid costly mistakes by talking to the right domain experts. Hence, networking and building social capital is an essential skill for scientific founders and entrepreneurs.

Scientists regularly network with their colleagues at academic conferences or during expert visits. However, scientists who are intent on commercialisation should go beyond these academic forums and attend industry forums. They should also engage with investors early on, so that funding is available to commercialise the science when it is ready. Breaking into these new networks of potential investors and industry players requires referrals or introductions by people who already have access to that network. Scientific

entrepreneurs can access such networks by requesting a mentor or a board member for introductions. When making such a request, the team should have clear questions, and be able to think and act independently. While the advice from the mentor or connection may not always work out, it is important to close the loop and keep the mentor updated. Most importantly, the team should follow up on introductions made by the mentor without any delays.

Introductions are important even when approaching new contacts via email or LinkedIn. Team members can help the introducer by being specific with the request and even drafting an email that the introducer can forward to the new contact. It can be followed up by a short email with a sharp subject header of seven words and a body text that would take no more than a couple of minutes to read, with a specific and quick follow-up. When speaking with a new contact over Zoom, it is important to ensure the right lighting and audio quality, keep eye contact with the camera and use the right background.

If approaching a new contact in person at a networking event, it is important to have a compelling elevator pitch. Table 4.1 shows the typical elements of such a pitch. Before the event,

Table 4.1: Typical Elements of an Elevator Pitch

- Your introduction
- The business and value to the customer
- The uniqueness
- The opportunity
- The team (and any other point for credibility)
- The ask

the team should prepare a list of people to talk to and a few icebreaker questions. At the event, where possible, the team should approach the new connection with the help of an introducer. During the conversation, they should be present and speak with conviction about the nature of the problem they are trying to solve, the solution they have developed and the action they are seeking from the new contact.

It is also important for team members to be visible on social media channels where their stakeholders congregate. In India, a presence on Twitter is critical. It is also important to be part of several physical and virtual networks outside of the start-up and contribute actively to them. A start-up team can position themselves as opinion leaders by writing blogs or white papers on topics impacting their sector, or organising webinars. The start-up can also bring together like-minded people by organising networking sessions in person, or creating groups on Clubhouse and WhatsApp platforms.

4.2 Pitching

While networking can help the team access people who can help them build the start-up, communicating the potential value and risks associated with the venture accurately and effectively to the new connections is also equally important. Pitching is the process used to present an idea concisely and convincingly to others so that they are willing to take the desired action. It is the art of communicating an idea or a story with conviction and passion. Effectively conveying the story of their commercialisation journey is important for the founding team to convince investors and all the other stakeholders discussed in Section 3.2.

Pitching doesn't always mean a formal presentation in person.

It could be done via video calls or one-on-one meetings, informal conversations at conferences and networking meetings, or social media platforms. It could also be a presentation or document that is sent to someone via email. A good pitch involves the following four basic building blocks:

- **Homework:** This is the most important part of pitching, where the team maps out the desired outcome. It starts with a clear understanding of the strengths and weaknesses of all aspects of the proposal. The presenting team should know every aspect of their proposal, including technology, solution, market and financials. Similarly, they should clearly understand the pitch recipients – their problems, motivations and constraints. It also helps to understand the recipient's performance metrics and any organisational and positional constraints that would prevent them from acting favourably in response to the pitch. As discussed in previous sections, the team should make first contact with new connections based on a warm introduction from someone within their existing network, to increase their chance of a successful pitch outcome. If this is not possible, the presenting team members should invest the time to get to know the recipient before the pitch. They can do this more formally through informational interviews, or via informal means – like talking to them in networking meetings and connecting on social media platforms. Where possible, the presenting team should try to get an idea of the expected duration of the presentation and practice the delivery multiple times so that they can present a strong pitch within the specified time. The final part of the homework is to be prepared

for unexpected events that may impact the pitch at the last minute. These include small issues such as loss of internet connectivity or the demo failing to work, to larger issues like sudden announcements of possible changes to the regulatory framework and new funding announcements that can impact the value of the pitch to the recipient.

- **Content:** The content of the pitch has to be clear and void of too much detail. It should capture the venture's vision and unique value to the recipient. It should provide high-level details of how the venture will create value and deliver it to the recipient. Since different recipients come with their own unique sets of requirements and opportunities, the message and the pitch have to be personalised for the particular recipient to maximise the possibility of the pitch translating into the desired action. The presentation team should also prepare backup information that could be used to supplement the presentation during the discussions that potentially follow the pitch. Preparing this backup information would require scenario planning, listing possible questions and creating the answers.
- **Delivery:** Being able to deliver the pitch either in-person or via videoconferencing is a great opportunity. When possible, the team should aim to do this rather than send the pitch deck via email. Here, the most important thing is to be authentic. Opening the presentation with a personal story or using humour is a great way to build rapport during a presentation. However, it may not work for everyone and every audience. If the team delivers the pitch in person to multiple people, the presenter should

interact with the audience by making eye contact or finding friendly faces. It is also important to notice body language and adjust the delivery. When using humour, it is important to keep it professional and sensitive.

The message should be delivered using simple words, without using mathematical equations or scientific jargon. Similarly, it should not be over-simplified to the extent that the uniqueness of the venture is lost. The emphasis of the pitch is on the strengths of the venture and the value it can create for its audience, and the desired action the presentation team wants them to take. The pitch should be delivered to appeal to the heart and mind and create enough excitement and urgency to result in immediate action.

Where possible, the presentation team should 'show rather than tell' by using accessible multimedia tools. Instead of describing their vision, the team can show their audience using case studies and personalised stories. Instead of describing the product, they can show the audience a physical or a simulated prototype and interact with it. They should include testimonials from early customers to showcase the value of their venture.

While this kind of delivery is not easy, everyone can get better at it through a lot of practice. If something unexpected—like shortened pitching time or a product demo failing—happens, the team can use it as an opportunity to showcase their ability to stay calm in unforeseen circumstances. And where possible and appropriate, the presenting team should try to get the names and contacts of all the key people present in the audience.

- **Follow-up:** Follow-up is an important part of the pitching process. The team should send out a thank you note and a summary of key points discussed during the pitch. The note should also include the next steps, with time-bound actionable items. If the pitch is not successful, the message should try to keep the door open for a follow-up meeting to address the concerns raised by the recipient. Even if the follow-up meeting doesn't happen with the recipient, the team should proactively review any negative feedback and identify opportunities for improvement.

If the team is sending the pitch deck by email, then the objective is to create enough excitement in the recipient to get an opportunity to pitch directly. It should use case studies to convey the team's vision and showcase the best parts of the venture such as team, product, market or financials. It should be self-explanatory and use standard fonts and colours. Table 4.2 shows the typical contents of this first deck sent to investors. The file should also be small enough so that it can be sent and reviewed without specialised software. The email included with the presentation should be drafted as discussed in Section 4.1.

4.2.1 Investor Pitch Deck

The investor pitch deck is a presentation prepared by a start-up to secure funding from an investor. The homework for this presentation starts with collecting investor information from databases such as CrunchBase, going through their investment portfolio, reviewing their partner profiles and talking to analysts at the investment firms to understand their investment preferences. The start-up team should also

match the quantum of funding that the team is raising with the minimum equity ratios of the investors. This exercise helps the team generate a list of potential investors to target. While it is possible to target international investors at any stage, fundraising from them depends on the nature of the problem the team is trying to solve. If the problem has a strong Indian context, international investors may find it difficult to evaluate and contribute to the venture. International investors may be appropriate when seeking investment for a business that has a global context. It may also be relevant when internationalising the company after gaining traction in the domestic market. The quality, safety and user standards are different and international investors can help with gaining global traction.

The next step is to get introduced to the partners through alumni networks, mentors, advisors and incubators. While some institutional investors entertain direct approaches, they generally have a low success rate, as these direct emails reach analysts in the firm instead of the partners.

Table 4.2: Typical Contents of First Pitch Deck to Investors

1:	About the (planned) company – what it will offer to whom
2:	The unmet need/problem being addressed, the opportunity for business, financial success and potential impact
3:	The solution, the envisioned product/ service, its most important features and consequent benefits to the customer
4:	Value proposition, comparison with alternatives, positioning
5:	Niche market where the product-market fit is strongest
6:	Revenue model – how money will be made?
7:	Technology, core competency, edge, IP, etc
8:	Team and other assets that make it possible
9:	Current status, progress made, traction
10:	Next steps and future path expected

Table 4.3: Pitch Deck

- Company overview (usually with elevator pitch)
- The problem/need and the opportunity being eyed by the business
- How and why it will tap the opportunity? Solution
- Revenue model
- Technology and IP
- The risks/ threats and plans to deal with them. Competition
- The development and execution plan
- The team that will execute and deliver
- The resources needed to execute the plan
- The investment proposal/the ask
- Appendices: Resumes | technology details | Gantt chart | financial simulation

The content of the pitch deck as shown in Table 4.3, should include the following:

- A well-formatted slide deck with clean bullet points and easy-to-read fonts.
- A title slide with the start-up name and a tag line to capture the attention of the investor.
- A slide to give a broad context to the business when the context isn't obvious to the general public.
- Scope of the problem described in simple language. If the problem faced by each segment of the target market is different, then the problem presentation can be segment-specific.
- The size of the opportunity, including TAM, SAM, SOM.
- If the start-up is based on deep science and is IP-intensive, then a brief and precise description of the science and how it relates to the solutions developed by the start-up is useful.

- Description of the solution portfolio highlighting the uniqueness without using scientific jargon. It can include pictures of the solutions and short videos.
- The uniqueness of the solutions and the value it provides to the target customers.
- Team pedigree and execution capability.
- Comparison of the solutions with competition.
- A brief description of the business model and unit economics.
- Information on traction including customer testimonials, purchase orders received, order pipeline and funds raised from different sources. While raising early rounds of funding, this slide can be replaced by potential traction.
- If the deck is targeted at impact investors, then the deck should include a slide on traction, along with impact parameters.
- Operating plan for next 18 months to two years. In a market with high regulatory and policy uncertainty, the team can present the plan based on potential scenarios based on available supporting data.
- Potential exit routes to the investor and any information about recent deals and exit valuations to support it.
- The ask – quantum of funds the team is trying to raise in the round.

While the entire deck is expected to be presented in 15-20 minutes, the team should aim to give the most important information about uniqueness, market size and the team's capacity to execute in the first three to four minutes.

If the presentation is made for a grant application, then the emphasis of the presentation should be on technical aspects of the solution and market size to convince a panel—that typically comprises of scientists—on the team's capability to build a great product.

On the other hand, investors are interested in the team's capability to build and scale a business. Hence, the emphasis of the presentation is on the market, competitive landscape and the team's ability to execute and deliver an exit to the investor.

A successful investor pitch can lead to a termsheet for a potential investment and the start-up should have strong negotiation skills to close the funding terms with the investors.

4.3 Negotiation Skills

Fisher and Ury define negotiation as a process by which an agreement that meets the legitimate interests of each party is reached efficiently without damaging the relationship between them. The traditional negotiation process is based on a series of positions taken by each party. Each party tries to persuade the other side of their viewpoint. Counterproposals are then made and evaluated to reach a common agreement based on concessions given and taken. Every negotiation involves information asymmetry, and only aspects that are necessary for a fair process are disclosed. Hence, asking the right questions is an important element of negotiations. It is also important to ensure reciprocity when sharing information. Negotiating effectively, like the other soft skills discussed in this section, is a skill that is acquired by practice.

There are several negotiation methods and tactics in the literature. While some are based on analytics and decision

sciences, others are based on behavioural science and psychology, and the negotiator has to pick the right approach depending on the situation. The technique used for negotiation depends on the power asymmetry between the parties, the number of parties involved and the type of agreement the parties are trying to reach. A good place to start is Fisher and Ury's *Principled Negotiation Framework,* which lays out four key principles, discussed below. It is based on the premise that all negotiators come to the table with common, different or conflicting interests.

- **Separate people from the problem:** Humans are emotional beings, and not everyone communicates in the same manner. These interfere with the objective merits of proposals being made by different parties. Instead of viewing the other party as an opponent and letting egos hijack the negotiation, the participants should work side by side to solve the problem and arrive at a win-win agreement.
- **Focus on interests and not positions:** This requires the participants to go beyond the position taken by the other party to understand the interests that are driving the positioning. During the initial stages of the negotiation, the focus is to uncover and accept the interests of all the stakeholders of the negotiation and design options that will ideally appeal to all of them. This step changes the negotiated agreement from a compromise to one that best meets the interests of all the parties.
- **Invent options for mutual gain:** When dealing with common interests, the parties can work together to identify ways to achieve them, since both sides want

the same thing. Instead of each party trying to generate options separately, the parties can collaborate to expand the range of possible options. During this collaborative phase, care should be taken to not reveal all information to each other but to reveal enough information to define as many options as possible. The parties can also collaborate on a feasible structure of the deal without specific numbers. Where the parties have different interests, they can trade them to increase mutual gain.

- **Insist on using objective criteria:** When parties have conflicting interests and cannot agree on an option, one party might gain the upper hand by using their bargaining power or by simply walking away. Instead of agreeing to an arbitrary decision in such circumstances, the other party can bring the focus back to the negotiation table by insisting on objective, independent criteria to unblock the situation.

Before going into a negotiation, the negotiating team should review the different negotiation methods. They should understand the background of the other parties and actual people involved in the negotiation and try to find out any information about their negotiation tactics. Depending on the composition of the other negotiating parties, the team should ensure that the right members of their team are included. When dealing with an investor, the start-up team should consist of a legal consultant and a trained negotiator, apart from the leadership team. The leadership team should also be careful before committing to the terms, as they may need to seek board approval for such decisions.

In the Indian context, enforcement of contracts is expensive. Similarly, arbitration and international litigation are costly. Hence, contracts should be designed to leave minimum room for subjectivity. The agreements should be drafted to ensure that payments are made upfront, and the cost of compliance is included in the price.

5. Lessons from the Trenches

"The journey of a thousand miles begins with one step"

– Lao Tzu

An entrepreneurial journey starts with the strong conviction of the founders to make this world a better place. As they embark on this long and arduous journey, they encounter several uncertainties. They should also find innovative ways to deal with those and overcome the limitations of their entrepreneurial ecosystems. While the previous sections discussed the various aspects of the journey and the skill required, the best way to learn about the various aspects of building a science-based venture is to learn from the peer group. This section looks at the lessons learned by real-life entrepreneurs and investors as they navigated science-based venture creation and growth in the Indian ecosystem.

5.1 Lessons from Science-Based Entrepreneurs

The lessons discussed in this section are based on a panel discussion conducted as part of the AIM-PRIME programme. The panellists included:

- Dr Renuka Diwan, Founder and CEO, BioPrime Agrisolutions Private Limited

- Dr Nusrat Sanghamitra, Founder and CEO, Cygenica Private Limited
- Mr Sachhin Dubey, Founder and CEO, Module Innovations Private Limited
- Mr Aniruddha Atre, Co-Founder and Director, Jeevtronics Private Limited
- Mainak Chakraborthy, Co-Founder and CEO, GPS Renewables Private Limited

While the first two panellists are scientists themselves, the other three have engineering and business backgrounds. Independent of their experiences, they embarked on their entrepreneurial journey because of a deeply felt drive to solve a real-life problem faced by friends and family, or to give back to society by solving problems using technology. Additional factors that enabled them to take the plunge include exposure to entrepreneurship in college, family background, contact with high profile public figures like Prof CK Prahlad and Mr Sam Pitroda, and disinclination to pursue traditional career paths.

Finding a Co-Founder

Entrepreneurship is a hard and stressful endeavour, and no one person has all the skills necessary to build a successful venture. Co-founders can bring in complementary skills and networks. They also share the various risks of the venture – especially during its early days. Except for Dr Sanghamitra, who did not have a co-founder until much later in her entrepreneurial venture, the others found their co-founders among their friends from college, or people with similar interests in their alumni networks.

Fundraising

'Cash is king' in any business, and this is especially so in early-stage ventures with very few tangible assets. As entrepreneurs explore different sources of cash, they should be sensitive to the 'colour' of the money that comes in. Some sources like grants and various forms of debt do not decrease the entrepreneur's equity share and help them retain their decision-making capability. Early-stage companies prefer these non-dilutive sources of cash. Cash provided by private angel investors or venture capital companies reduces the percentage ownership of the company for entrepreneurs. However, these sources can potentially come with other benefits like the contacts and the business expertise of the investors. All the panellists were recipients of grant funding from Indian government sources, like BIRAC from DBT and IUSSTF from DST. A few of them also secured grants from international agencies like SOSV. Some of them bootstrapped their way by starting with smaller, high throughput products targeted at large customers. They used the resulting corporate relationships to build credibility in the market. Other strategies used include accessing debt against confirmed purchase orders, getting a term loan and increasing working capital limits from the bank. While these kinds of debt funding are hard to come by for start-ups, entrepreneurs should explore them fully before reaching out to private investors. The longer the entrepreneurs can wait before raising dilutive financing from investors, the greater the percentage ownership that the entrepreneurs can retain.

Managing Growth

As different sources of cash start coming in, the start-ups

can execute on their growth plans without worrying about money. To ensure momentum, they need to put in place clear processes to streamline the organisational decision-making and to ensure transparency. The panellists used different strategies to achieve this—especially after receiving external funding. One of these strategies is to ensure strong corporate governance from the beginning by having independent board members with high public profiles. Having debt holders and international grant funding agencies with strict reporting standards will also ensure that start-ups keep good records. Irrespective of external forces that accelerate the adoption of corporate governance practices, keeping clear financial records for the different legal entities of the company across geographies will bring discipline and transparency.

Go-to-Market

Understanding customer needs and developing a product that meets these needs is critical to the success of a start-up. Scientists and engineers are generally uncomfortable with taking a less-than-perfect product to the market. However, all the panellists emphasised the need to work closely with the customer at all stages of product development. Doing thorough market research and identifying customer needs can help the company develop a product that meets the customer's needs. This close interaction with the customer means that sometimes the company may need to switch its product strategy to meet the customer's immediate needs while using cash from those sales to fund new solutions that may not be on the customer's radar. The first product launched by the start-up does not need to be perfect, as long

as it meets the customer's critical needs. These emotional first sales are crucial to build the founder's confidence. To continue its journey, the start-up needs to work closely with customers and fine-tune its offerings by acting on their feedback to deliver upgraded versions as soon as possible. A modular product design, where individual elements can be modified without impacting the overall robustness of the product, will help it provide this agility. A start-up also needs to build trust with customers and overcome their inherent biases to launch a product successfully. It also means working alongside the customer in their native environment to understand how the product is being used and educating the customer while learning from them.

Serendipity

While planning, hard work and cash availability are important elements of the entrepreneurial journey, the role of serendipity in the success of a start-up cannot be underestimated. As french microbiologist and chemist Louis Pasteur said, "In the fields of observation, chance favours only the prepared mind." Similarly, in entrepreneurship, chance favours those entrepreneurs who are out there talking to everyone, noticing industry trends and working to create solutions that will change people's lives for the better.

5.2 Lessons from Early Stage Venture Investors

The lessons discussed in this section are based on a panel discussion conducted as part of the AIM-PRIME programme. The panellists included:

- Ms Radha Kizhanattam (Partner, Unitus Ventures)
- Dr Ramesh Byrapaneini (MD, Endiya Partners)

- Mr Mukesh Sharma (MD, Menterra)
- Mr Amitabh Srivastava (Managing Partner, July Ventures)
- Dr Premnath Venugopalan (Director, Venture Center; BIRAC SEED & LEAP Fund & DST Funds)

All the panellists have engineering, medical or science backgrounds and extensive experience working for multinational companies, funding start-ups at different stages of their growth and nurturing them towards exit.

Early Equity Funding

Early equity financing for start-ups is provided either by business angels or early-stage venture funds. Business angels are individuals who provide the first external equity investment into start-ups. These angels invest directly or through their family offices or as part of angel networks and angel funds. While angel networks comprise loosely connected angels, angel funds operate very similar to early-stage venture funds. These venture funds provide the first institutional investment into start-ups. In angel networks, deal sourcing is done collectively, and due diligence is led by one or two angel investors who share their findings with other members of the network. The angels then make decisions on investments individually. While this provides a broad platform for start-ups, they may only get limited support from the angels after investment. Compared to institutional venture funds, funding from individual angels and angel networks have less rigorous reporting requirements. While this helps experienced teams, young start-ups may gain from the close monitoring and experience of the partners managing the venture capital funds.

Strategic Investments

Strategic investment into start-ups could come from individual angels with relevant experience, or from corporate partners. The panellists felt that while investments by angels with deep expertise in the field add significant credibility to the start-ups, corporate partnerships may not always add value. Strategic corporate partnerships that form early in the life of a start-up can significantly influence the direction of the start-up's growth. These early-stage partnerships typically lead to joint technology or product development and can help the start-up avoid the valley of death. However, if these partnerships are not handled properly, they can consume significant time and resources of the start-up and expose it to various risks that could depress its valuation. These include potential constraints on the start-up's ability to work with competing corporates or compete with the partnering corporate later in its evolution. However, the panellists emphasised that corporate partnerships that come in the form of corporate venture investments and come later in the life of a start-up could increase valuation significantly as it signals the credibility of the start-up in the market.

Deal Sourcing and Evaluation

The panellists emphasised how investing in a company is fraught with many uncertainties, especially in the start-up's early stages. Hence, the evaluation process can take anywhere between three to ten meetings and has a high attrition rate of 1:100. The panellists' source deals primarily from three channels—random emails from entrepreneurs, proactive engagement with incubators and accelerators around the country, and referrals from their network. While

random emails get the least attention, referrals from their network garner the maximum attention from the panellists.

Entrepreneurs are advised to look at the investment firm's websites and partner blogs to understand the investors and their preferences before approaching. The first contact via email or phone call should be a crisp, short message focusing on the problem the team is trying to solve and their key differentiators. Its main purpose is to elicit enough interest to get the first meeting. The accompanying pitch deck can include additional details.

During the various meetings with the start-ups, investors will evaluate all aspects of the business and the compatibility between the start-up and investors. The evaluation criteria used by the investment firms vary depending on their investment preferences, expertise and experience. Criteria used by the panellists include the following:

- **Team:** The panellists emphasised the importance of the team, their ability to build the business and alignment of their vision with that of the investors. As the investors interact with the teams, they evaluate the team's understanding of the technology and domain and the unique insights about the customers and existing solutions they bring to the table. As investors are looking for high returns from their investments, they want to ensure that the team has an aggressive and bold vision that goes beyond the current round of funding to build a high growth sustainable venture. The investors also evaluate how the teams learn and process feedback from various stakeholders in their ecosystem and how they act on them. The panellists also discussed the need for diversity of the team and

how the potential for adding people with the missing skills is an additional criterion they evaluate. They also consider the team's dedication to the start-up and how much 'skin in the game' each has.

- **Value Chain:** Mr Mukesh Sharma spoke about developing their thesis on opportunities for maximum value creation and identifying emerging trends that support or obstruct the realisation of that value. While investing, they specifically look for models that are most likely to benefit from those opportunities and growth drivers that create maximum commercial and social impact.
- **Cap Table:** The panellists emphasised that the team's ability to manage the capitalisation ('cap') table is an important evaluation criterion. Strategic investment from reputable individual investors in earlier rounds adds significant credibility to the venture. However, a fantastic team with a good market and great product may not secure investment if the start-up has given away too much equity in earlier rounds. If the founding team does not retain more than 50 percent of equity when they approach early-stage investors like the panellists, founders may not be able to control the company's direction. They may lose the financial motivation to build the company as founder equity drops further in future investment rounds.
- **Intellectual Property:** The panellists described how early-stage investors invest based more on their strong conviction in the field than on the quality or quantity of the start-up's IP. They expect the company to have IP to create a barrier to entry. However, they do not perform

deep due diligence on the IP, freedom-to-operate or how it will protect the company. They emphasised teams' understanding of the regulatory road map and their ability to commercialise the technology.

- **Other Criteria:** Other criteria the panellists evaluate while performing due diligence are the team's ability to execute and their operational and financial discipline. While financial traction in terms of revenue may not exist at the early stage in which the panellists evaluate the start-ups, they look for other actionable metrics such as customer conversion rate, loyalty and revenue per customer, and how the team uses the information. Investors also expect the team to have realistic expectations of the potential revenue and risks involved in the company. Apart from these, a term sheet from another investment firm adds significant credibility and accelerates the evaluation process.

Pitch Deck

A pitch deck should accompany a short and crisp email focusing on the problem the entrepreneurs are trying to solve and their key differentiators. As discussed above, entrepreneurs should understand the investor to whom they are sending the pitch deck. The panellists advised that the pitch deck should be customised and have just enough information to attract the investor interest, given the stage of interaction between the team and the investor. While accompanying the first email to the investor, it could be a short presentation outlining high-level details such as the problem the team is trying to solve, information about the team, top-level business model and any other key information

that can get the attention of the investor. As the discussion with the investor progresses, more details of the venture can be shared in subsequent decks. Prototype demonstrations and customer testimonials should be used where available to complement the information in the pitch deck.

Negotiating the Deal

When negotiating the deal with investors, the panellists advised the start-ups to have fair valuation expectations. They prefer to own a small piece of a successful business rather than a large piece of a poor or underperforming business. As early-stage investments come with many uncertainties and risks, valuation is based on several assumptions. Hence, both parties should work together towards creating reward structures that constructively bridge the differences in valuation expectations. If the team is talking to the right investor who is going to be a good partner for the start-up, then they should go beyond valuation and identify clear strategies to de-risk the investment for the investor and move towards value creation for all stakeholders.

Mode of Investment

The early-stage investment made by the panellists comes mostly in the form of compulsorily convertible preference shares (CCPS). Unlike ordinary shares owned by founders or friends and family who invest early, CCPS are non-dilutive and have a coupon rate attached to them. The CCPS is structured to give investors voting rights and board seats and provide liquidation preference over ordinary shareholders. It implies that in the event of liquidation of the company assets, CCPS holders get their pay-out before

ordinary shareholders. This instrument can also help postpone the discussions around valuation to a later date, thus enabling the team and investors to rapidly focus on building the company.

Post-Investment Interaction

Early-stage venture funds expect to have monthly review meetings and quarterly board meetings with their investee start-ups. In the initial days, they also interact with the start-ups regularly via WhatsApp groups. Once there is a clear understanding of expectations on both sides—typically after the first three to six months—this frequency of interaction drops. When new investors come in, interaction with the early-stage investors also comes down significantly.

The panellists advised the start-ups to work with the investors to clarify the type and format of the information shared during the review meetings and set up management information systems to track them efficiently. They should also be honest with the investors and identify potential challenges at the earliest opportunity as their interests are more aligned after closing the funding. Investors can also help with various issues ranging from connecting regulatory experts to hiring and product development strategy.

Co-Founder Issues

One of the reasons for the failure of start-ups relates to disputes and unresolved issues among co-founders. Co-founder issues are especially challenging in the Indian ecosystem, where co-founders are friends with no clear expectations of roles and responsibilities and performance assessments. The panellists recommended a strategy

based on a detailed business plan, role clarity, schedule of authority, performance-based culture and robust governance to address co-founder issues. They also recommended vesting equity—an often strongly negotiated clause in the investment term sheet—to protect the founders against co-founder disputes. Having an empowered board is also essential, as it allows for more consistent and structured support to the co-founders.

A related co-founder issue is when the co-founders are family members. While family members performing well can be an active part of the team, non-performing family members should be moved to non-executive roles.

Exit

The preferred exit route for panellists is based on valuation rather than IP or asset sale. While selling assets or licensing IP may be required during the bootstrapping phase of the start-up, the panellists recommend the start-up to focus on value creation and business model after they receive venture funding. Start-ups should also find the best route to provide an exit to their investors, including listing overseas or using a flipped ownership model.

Investor Sentiment Around Science-Based Start-ups

The Indian start-up ecosystem has high liquidity and is becoming more mature. While interest in deeptech or science-based start-ups is increasing because of this liquidity, it is challenging to secure later funding rounds for such start-ups in India. The panellists felt that most investors are not able to support deep-tech start-ups, especially those requiring long gestation periods.

5.3 Nuances of Scaling Technology Start-ups

The lessons discussed in this section are based on a panel discussion conducted as part of the AIM-PRIME programme. The panellists included:

- Dr Shyam Vasudeva Rao (Founder, Director Forus Health, Renalyx and Rx DHP)
- Dr Yogesh Patil (Co-Founder, Biosense Technologies Private Limited)
- Mr Mudit Dandwate (CEO, Co-Founder, Turtle Shell Technologies Private Limited ("Dozee''))
- Dr Aditya Ingalhalikar (Founder & CEO Indius Medical Solutions Inc.)

The panellists come from diverse backgrounds in computer science, mechanical engineering and medical domains. They have extensive experience studying and working internationally and with multinational companies. They have experience raising multiple rounds of funding for their ventures and exiting the companies they founded in the MedTech space. The panel discussed several aspects of scaling up the venture after the initial product development phase.

Definition of Scaling

The discussion started with what scale means to the panellists. The panellists viewed it as a destination or a mile marker. The former group defined it as the founders' vision about where the venture should go in terms of markets, the number of customers and market value in order to build the right team and establish the right supply chain, sales networks and other processes to reach it. Those who viewed

it as a mile marker defined it as a stage in the company when the product gets accepted by multiple customers. It is also a stage when all the supply related issues are fully in control and the company is unable to meet demand, as it outstrips the current capacity and infrastructure. It is the stage of the company when it will need experts, reliable manufacturers, and better technologies. By adding more resources, the company can grow at a predictable rate in proportion to the resources. Others described it as a continuous process of building partnerships, distributors and customers to address growing market demand. It involves constantly anticipating problems and challenges from a sustainability perspective and working on solutions to overcome them.

Achieving Scale

The panel then discussed how a company could achieve this scale. The most important advice to new entrepreneurs is not to be afraid of scale. They also advised teams not to get comfortable with business as usual. The team should be bold and take potentially high-risk decisions such as getting large orders, even when it is not fully prepared. One of the key ingredients for scale is the availability of funding. So the team should anticipate funding needs for the next 24 months and raise funds accordingly. The availability of funding decreases the concerns of the leadership team about taking on bigger orders. While the availability of equity funding might encourage the team to take calculated risks on payment terms that could potentially increase working capital requirements, the panellists advised the start-ups to ensure that they are not using equity to finance working capital, as doing so could lead to dilution of founders stake

too early. The team should be able to finance any such additional working capital needs using debt financing to increase the IRR for the investors.

Being from the MedTech domain, they emphasised focusing on regulatory considerations from early product development phases. Getting a CE certification can help expand the market to most countries outside India, except the US and China. Similarly, getting FDA approval will help the company enter the US market but not the EU market. The company needs to identify these opportunities early in the product development stage and allocate resources accordingly. During the Product-Market-Fit and Business-Model-Fit stage, the product is fine-tuned to meet the customers' needs while creating value for the company. During these stages, instead of focusing on multiple products, it is advisable to focus on one product and stabilise it to a phase where it can be scaled without high human resource requirements. This product establishes the brand and opens the doors for new products and solutions. As the team looks towards expansion, the team has to spend substantial time observing the users, attending conferences, cultivating key opinion leaders and incorporate these learnings into the product portfolio and the messaging around them. One strategy for scaling the business is identifying the customers that incumbents are not focusing on and serving them well. Depending on the markets, this could also mean adding new products to target the existing market. While the company may use distributors to penetrate the market, as the business scales initially, they should recruit their own sales representatives to increase margins. If the business is focusing on the

government sector, then the panel recommends working with a partner. While payments are delayed and unit profits are low in the government sector, the volumes are significant, and the panel members believe that working with the government is worth it.

As the company scales, the team would also have to deal with supply-related issues. The team should have a good estimate on lead time and cost of available options and seek help to fill the gaps. They may also need to build multiple redundancies into the supply chain or go with larger suppliers as orders increase. Larger suppliers can provide a price advantage and can help manage the volumes more easily. The company should also not hesitate to procure parts from outside India to ensure quality. Depending on the complexity of the product, this could also involve licensing the manufacturing to another player who can help expand the access to new segments of the markets.

While vision and people who believe in it are important initially, the company should build a strong culture as it scales. The leadership team should learn to delegate and let go of control by implementing good processes to track performance.

Timing of Investments into Design, Manufacturing and Certifications

The panel then discussed the timing of investment into aspects such as designed-for-manufacturing (DFM), quality management and certifications. Indicators to signal the right timing for investment into DFM and quality management are successful installations with satisfied customers, well established key opinion leaders and enquiries from

complementary players. With new manufacturing techniques, this could be done earlier. As discussed earlier, regulation is an important part of product development. Hence, the panel advised the entrepreneurial teams to get minimum required certifications to avoid penalties in the early stages. Once the product-market fit is established by working with the customers and incorporating their feedback, the company can invest in full-blown compliance requirements to develop and grow the brand. The panel also advised entrepreneurs to get good quality clinical trials and registered studies. India is slowly developing as a hub of contract manufacturing facilities for medical devices. CE/FDA-certified manufacturing facilities in India make it easier for medical devices start-ups to apply for these certifications. Companies can also improve the quality of the product by involving industrial designers from the early stages of the product design.

Board and Investor Relationships

The panel then discussed the role of the board and investors in scaling the business and how the relationship with them changed over the journey. The panellists discussed how the first investors may bring connections, but may not understand scaling, especially to break dilemmas related to social return on investment. If the first investors are angel investors, they may add credibility to the company, but may not actively nurture the company. An institutional stage investor like Menterra, with its structured processes and systems background, helped implement such systems and processes. These institutional investors can also help the company with governance and compliance. A start-up team may also not have the maturity to understand such advice in

the early stages. So start-up teams should seek advice from other entrepreneurs and investors who are involved in start-ups that are slightly ahead of them.

It is also important to get like-minded investors who understand the multiple inflexion points in the journey and invest patient capital. If investors do not understand the industry, it is better to seek strategic investment or investors outside India. Identifying them and pitching to them about the vision, current status and how the funds raised will be utilised effectively, is important. For MedTech companies, it is important to have all compliances in place. The investors can then help the company scale by advising the team on the next steps, ensuring strong governance, and help the company sort through problems. It is the founders' responsibility to keep the board excited. They should discuss any problems related to the business with individual board members well before formal board meetings, even if they decide to share the good news in board meetings.

Investors look for an exit from the company. So the entrepreneurial team should have several potential exit routes during initial rounds as part of their vision for the company. It will help the company capitalise on serendipitous opportunities to scale that may arise during the journey. A start-up can also hire investment consultants on a success fee basis to raise Series A and later rounds of funding. Debt financing is a potential source for financing once the company receives substantial certifications like CE. In India, the IPO market in general and for MedTech companies in particular, is growing. It provides another avenue to raise the funding necessary to scale.

Lessons Learned

The panellists then discussed the lessons they personally learned as part of their scale-up journey. Mr Mudit Dandwate cautioned the entrepreneurs that scaling a business is a moving target and that they should maintain their enthusiasm and avoid running the company on autopilot. As the company grows, the entrepreneurs' role changes and they have to upgrade themselves to keep up with its growing demands. Having faith in one's ability to improve and learn from the mistakes is an important skill for entrepreneurs. Dr Yogesh Patil's advice to entrepreneurs is to disclose everything to the customers. He advised them to find large customers who could help the company scale. It is also important for entrepreneurs to learn to take bigger decisions while delegating smaller decisions. Dr Aditya Ingalhalikar's advice is to have a great team of co-founders and management and to learn to delegate responsibilities. It helps the founder to manage time by focusing on bigger decisions and on scaling the company. He re-emphasised the need to have a clear vision and path to achieving it, even if circumstances force course corrections along the way. Dr Shyam Vasudeva Rao's advice is to manage time efficiently. It is important to set expectations among co-founders, but to be ready to adapt to changing circumstances. He cautioned the entrepreneur that in all cases, the entrepreneur is the last person standing.

6. A Final Word

This playbook is synthesised based on the lectures and panel discussions conducted during the AIM-PRIME programme and additional content contributed by the editor. A discerning reader reviewing the video recordings and the playbook might have noticed diverse and at times contradictory advice on several aspects of the science-based entrepreneurial journey. Just as the blind men feeling around an elephant described it as anything from a fan to a rope to a snake, perspectives on entrepreneurship differ based on the type of start-ups and the stage of the entrepreneurial journey most familiar to the speaker. It also depends on the speaker's technical and domain expertise.

The terminology used by speakers can also contribute to some confusion. For example, the term 'prototype' can mean one developed in the context of POC or POV or an initial model tested in the market during the Product-Market-Fit stage. Similarly, an early-stage investor can be anyone investing from the POC stage to the Product-Market-Fit stage. The stages described in this playbook aimed to cover the commercialisation journey of capital intensive, lab-to-market start-ups with long lead times. While the later stages of the journey from product-market-fit are similar for all

science-based start-ups, as discussed earlier, the early stages vary depending on the type of problem and technology risk associated with the invention.

The reader does not necessarily need to read the playbook sequentially, and can focus on the most relevant parts depending on the type of start-up and stage of the entrepreneurial journey. When faced with diverse opinions related to any topic, the reader is advised to review the context of the advice and use the material appropriately.

Additional Resources

These templates serve as an additional resource and can be accessed on www.playbook.primeprogram.in.

Please refer to the relevant sections for more information and contextual clarity.

Template	Referred in Section
Ideality Function	Section 1.3.2 – Inventive Problem Solving – An Analysis-Driven Approach
Kiplings Questions	
5 Whys	
Innovation Opportunity Map	
9 Windows	
Where2play	Section 2.3 – Proof-of-Concept to Proof-of-Value
Value Proposition Canvas	Section 2.4.2 – Defining and Articulating Value Proposition
Value Proposition Statement	
Mission Statement	Section 2.4.3 – Solution Engineering
FRDPARRC	
Pugh Matrix	
Business Model Canvas	Section 2.5.1 – Business Model Canvas
Cap Table Simulation	Section 3.5.2 – Valuation
Elevator Pitch	Section 4.1 – Typical Elements of an Elevator Pitch
Pitch Storyline	Section 4.2.1 – Investor Pitch Deck

Expert Contributors

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Dr Anurag Mairal is Adjunct Professor of Medicine and Director of Global Outreach Programs at Stanford Byers Center for Biodesign, Stanford University. He is also a Faculty Fellow and Lead for Technology Innovation and Impact at Center for Innovation in Global Health. He serves as the Founding Chair of BME IDEA APAC, a community of medtech innovation programmes in the Asia Pacific. Concurrently, he is a co-founder and Executive Vice President of Orbees Medical, a SF Bay Area-based strategy consulting firm serving the global healthcare industry, with a focus on medtech, pharmaceutical and digital health industries. Recently, he took a sabbatical for two years to take a senior leadership role at PATH, a major global health nonprofit based in Seattle. Previously, he held several positions at Johnson & Johnson, including Business Development Director and Product Director for structural heart, cardiology, and peripheral vascular products at Cordis. An active mentor to entrepreneurs and industry professionals, he serves as the chair of PATH's Bay Area Leadership Council, board member at EPPIC Global Network and IIT Bombay Heritage Foundation and advisory board member at D-Rev and Sewa International. He recently took over as the President Sewa International Bay Area.

Dr Mairal holds a Phd in Chemical Engineering, a MS in Chemical Engineering and a MBA. Dr. Mairal was a post-doctoral fellow at the University of Twente, Netherlands and at University of Michigan, Ann Arbor. His work has been published in more than 30 publications, and he has seven patents to his credit.

Ashley Stevens

Dr Stevens is President of the Focus IP Group and has almost forty years of technology commercialisation experience in the biotechnology industry. He is a former President of AUTM and has lectured and published extensively on valuing technologies, technology transfer, licensing and the commercialisation of early-stage technologies. Deeply embedded in the Boston ecosystem, Dr Stevens spent ten years with entrepreneurial biotechnology companies, co-founding two of them, and then became Director of the Technology Transfer office at Boston University for 17 years, following four years in a similar role at the Dana-Farber Cancer Institute, a teaching affiliate of the Harvard Medical School. He currently advises the Forsyth Institute, an affiliate of the Harvard Dental School. He has helped create over 60 spin-out companies from these institutions, a number of which raised substantial amounts of venture capital.

Chintan Vaishnav

Dr Chintan Vaishnav is a socio-technologist, an engineer trained to design and build large-scale systems that possess both human as well as technological complexities. Presently, he serves as the Mission Director for Atal Innovation Mission (AIM), a flagship initiative of the government of India under the auspices of the NITI Aayog. Dr Vaishnav is on leave from the Massachusetts Institute of Technology (MIT) for his present assignment. As a teacher, innovator, and entrepreneur, he has split his time between teaching and research at MIT and living and working with rural communities in India to build solutions that can overcome constraints fundamental to improving human conditions.

Hasit Seth

Hasit Seth works as a counsel in the Bombay High Court. His key focus is on arbitrations and civil and writ litigation. He has negotiated many deals, most of them involving technology and related services. Over the past 20 years, he has been a partner at a law firm, general counsel for a MNC and a start-up founder, and has worked in the US with two law firms doing patent litigation and prosecution.

Hiran Vedam

Dr Hiran Vedam is a business consultant for investors and start-ups in climate tech. She is also Senior Advisor for Innovation and Entrepreneurship at IIT Tirupati. She has considerable experience in different areas of the lab-to-market journey from research to entrepreneurship, technology transfer and early stage investments in the US, UK, Singapore and India. She has a YouTube channel—WorldofDeeptech—to familiarise young researchers on various aspects of commercialising advanced technologies. She also developed a 'Mentoring Framework' for guiding mentors of science-based start-ups in collaboration with a seasoned angel investor.

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M V Shankar

Dr Shankar is the Vice-President, Technology Innovation at Mahindra and Mahindra Group and has featured in the top 50 Innovative Leaders by World Innovation Congress 2020. He is co-inventor on ten granted US patents and five granted Indian patents and has coached over 2,000 innovators. A technology innovation leader, he is passionate about facilitating technology innovations in India. He excels in mentoring inventors to grow their ideas into innovations.

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Dr Hanumara is a Research Scientist in MIT's Mechanical Engineering department, where he focuses on human-centred design of healthcare technologies, with an approach that is collaborative, translational and entrepreneurial. In parallel with MIT, he works with and mentors multiple healthcare-focused start-ups in Cambridge and worldwide and serves as an advisor to the New England Medical Innovation Center.

Premnath V

Dr Premnath is Head, NCL Innovations at CSIR-NCL and Founder Director, Venture Center (National award winning inventive enterprises and deep tech incubator). He is a technology developer, innovation and incubation manager, start-up mentor and a co-founder of two medtech start-ups. One of his inventions—a breakthrough material for hip and knee joint replacements—has been implanted in more than a million patients worldwide. Another technology for porous maxillo-facial implants has been implanted in thousands of patients in India and abroad. He has provided leadership for teams that have won national awards for technology development, intellectual property management and business incubation. He is a chemical engineer and an alumnus of MIT in the USA, IIT-Bombay (Distinguished Alumnus, 2022) and has been a Chevening Technology Enterprise Scholar in Cambridge, UK.

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Mr Ravi Sarangapani is a medical device consultant with over 25 years in the medical device industry encompassing leadership roles in new product development, quality management and regulatory affairs, marketing, sales and business development. He has a proven track record of managing the new product development process from conceptualisation and market analysis through development, risk management, pre-clinical evaluation, verification and validation, test marketing to commercialisation. He is especially skilled at problem analysis and resolution, strategic planning and budget controls. He also has a strong background of interactions with key opinion leaders, customers and trade channels throughout Asia, Middle East, Africa and some areas of Europe.

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Dr Satya Dash is a national innovation ecosystem designer, technology strategist, policy and implementation expert. He has contributed to the growth of Indian biotech and medtech innovation landscape by designing, implementing and driving 17 national programmes when he was the Founding Head Strategy at DBT-BIRAC and In-Charge Head of IP & TT such as BIG (India's largest biotech/medtech program), social innovation (SPARSH), equity (BIRAC SEED & AcE), incubation (BioNEST) and BIRAC-Nesta Discovery Awards and BIRAC-PATH (for IP). Cumulatively, more than 2,000 start-ups/innovators have been supported by the programmes. He also built 12 partnerships for BIRAC (Nesta, Wish Foundation, TiE, Indian Angel Network). Previously he was COO ABLE (nodal biotech industry body) and former Director Global Innovations at PATH and Consultant to Nesta. Currently he is a board member at Venture Center. He holds a triple Masters from the universities of Cambridge (UK), Leicester (UK) and Sambalpur (India) and a PhD from University of East Anglia, UK.

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Dr Shailendra Vyakarnam is presently Visiting Professor at Cranfield University and also Associate of the Senior Combination Room at Kings College Cambridge. Dr Vyakarnam has mentored hundreds of deep tech entrepreneurs and co-founded several businesses over his career. More recently he has invested as a business angel in seven firms, three of which are led by female entrepreneurs. He has published a dozen books, supervised doctoral students, published in academic journals, advised policy makers and held various board positions.

Soma C

Soma has more than nine years of industrial R&D experience in a MNC in the field of speciality materials for electronics, post her MSc in Chemistry from Calcutta University.

Soma leads the Incubation & Mentoring vertical of Venture Center. At Venture Center she is responsible for managing the overall incubation activities beginning with identification of promising start-ups and innovators, providing mentoring/advice, conceptualising and implementing relevant programmes and contributing to the creation of a conducive innovation ecosystem and tracking its impact.

She serves as the nominee director on the boards of two deep science and technology start-ups in the domain of Med device and energy storage.

Soma is a recipient of the Chevening Gurukul Fellowship for Leadership and Excellence from DPIR, Oxford University. She was also winner of DST & ISBA Star Gazing Award for Incubation Managers 2016.

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Mr Srikant Sastri is the President of the TiE Delhi-NCR Chapter, the chairman of the i3g Network and the co-founder of Crayon Data. As an entrepreneur with two successful exits, he now is a mentor on a mission to help start-ups become successful. Srikant is a Board member of Venture Center and is Advisor and Mentor in Digital Innovation and a social enterprise evangelist.

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Uday Phadke

Dr Phadke is the originator of the Triple Chasm Approach, which challenges many of the commonly held perceptions about how innovations are transformed to create commercial, social and environmental impact.

His work over the last two decades has focused on how science and technology-enabled innovation is commercialised with notable publications which question conventional wisdom about how innovations can deliver impact.

He is currently Chief Executive of Cartezia, Executive Chairman of Accelerator India, and Chief Executive of the Triple Chasm Company. He was an Entrepreneur in Residence at the Judge Business School at Cambridge University from 2011-2016.

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Anmol Jaguste is a biomedical engineer from the University of Minnesota and holds two post graduate diplomas in Business (commercialisation) and BioInnovation from Monash University and the National University of Ireland, Galway, respectively. He has significant early stage medical device R&D experience, along with commercialisation planning experience working with start-ups, incubators and universities across USA, Australia, India and Ireland.

Anurag Wasnik

Anurag has over eight years of consulting, government affairs, social sector and public policy experience. He is currently working as the Innovation Lead with Atal Innovation Mission, NITI Aayog, leading multiple strategic initiatives vital to the Innovation and Entrepreneurship Ecosystem building in India. Anurag holds three masters degrees – MBA, IIM-Ahmedabad, MSc in International Management, Bocconi Universita, Italy and MA in Sociology from IGNOU. Prior to NITI-Aayog, he has worked with multinationals such as

Accenture Strategy, Oil and Natural Gas Corporation, ITC and Tata Motors. He has co-founded two start-ups and has three years of entrepreneurship experience.

Ayesha Chaudhary

Dr Ayesha Chaudhary is working as an Officer on Special Duty (OSD) at the Office of the Principal Scientific Adviser (PSA) to the Government of India. She was one of the founding team members for the Atal Innovation Mission. She started her innovation journey with a doctoral degree in biomedical engineering, later co-founded a medtech start-up and has also explored the corporate world.

Ishita Agrawal

Ishita Agrawal has over 15 years of experience focused on the early stage start-up ecosystem. She has been involved with multi-disciplinary responsibilities including programme design and management, policy planning and implementation, developing collaborations, consulting, operations and monitoring.

Part of the founding team of Atal Innovation Mission, NITI Aayog (AIM), Ishita has been working at the intersection of policy, technology innovation and entrepreneurship. She has been a part of AIM's journey as it progressed, creating impact at scale. She has been directly responsible for design and implementation of institution-building programmes that nurture tech entrepreneurs with a view to democratise innovation and entrepreneurship in the country.

Prior to AIM, she has worked with several business incubators in the public and private sector. She has also worked for a couple of years with EY's Development Advisory Services team, gaining a good understanding of the functioning of the not-for-profit sector and CSR.

Manisha Premnath

Dr Manisha Premnath is the Chief Operating Officer at Venture Center. She provides direction and leadership to the Executive team at Venture Center, besides being responsible for operations, strategy and general management. She is a Biotechnologist by training with a PhD from the University of Pune/CSIR-National Chemical Laboratory, Pune, India. She has carried out postdoctoral research at the University of Cambridge, UK. Manisha was a Chevening Rolls Royce Science, Innovation, Policy and Leadership Programme (CRISP) Fellow at the Said Business School, University of Oxford, UK during 2015.

She serves on the Board of Directors of IPCA Laboratories Private Limited (Indian pharma company listed on BSE/NSE), amongst other companies.

Mudit Narain

Mudit Narain is currently working as the Chief Technical Officer (CTO) at the Office of the Principal Scientific Adviser (PSA) to the Government of India. He was one of the founding team members for the Atal Innovation Mission. He has completed his Master's degree in Engineering and Public Policy from the Massachusetts Institute of Technology (MIT).

Mugdha Lele

Mugdha is currently Head-Social Innovations at Venture Center, Pune. At Venture Center, she is responsible for driving the Social Innovations activities and providing technical mentoring for start-ups. She has a PhD from School of Health Sciences, University of Pune. She has been a Fellow of the Chevening Rolls Royce Science, Innovation, Policy and Leadership Programme (CRISP) at the Said Business School, University of Oxford, UK in 2016. She serves as the nominee director on the boards of three start-ups in the medical domain.

Neha Jacob

Neha has over 15 years of experience in the field of audit, accounts, general management and operations. She is a chartered accountant and a company secretary by qualification.

At Venture Center, she is responsible for providing leadership towards general management, human resources and allied activities. She began her career with Ernst and Young (EY) and worked there for ten years, responsible for assignments related to audit and accounts. Prior to joining Venture Center, she pursued her interests in the development sector and worked with an Uttarakhand based NGO – Aarohi for five years.

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Ramesh Loganathan

Ramesh Loganathan is Professor, Co-Innovation at IIIT Hyderabad. He served as a Chief Innovation Officer (interim) of TS State Innovation Cell. After 25 years in the product R&D space serving various executive positions in few of the world famous product companies, he moved full-time into academics.

Shruti Devasthali

Shruti Devasthali is Head-Funding and Investment vertical at Venture Center. She is a chartered accountant and a certified financial risk manager. She is currently operating seed fund activities for Venture Center and monitoring the investments in the organisation's portfolio companies. She is also responsible for mentoring lab2mkt companies on corporate governance, and management of financial and legal matters relating to grant programmes. During her previous assignments Shruti has worked with CRISIL Limited and Dun and Bradstreet Information Services India Private Limited in the areas of credit and financial analysis.

Smita Kale

Smita is leading bio-incubation activities, Center for Biopharma Analysis (CBA) and BIRAC's Regional Bioinnovation Center (BRBC) projects at Venture Center. Smita, as part of the incubation team, facilitates incubator operations by interacting with incubatees, infrastructure and facilities creation and development of the ecosystem.

She has a PhD in Pharmaceutical Chemistry from Institute of Chemical Technology, Mumbai, and has academic experience of 12 years which includes three plus years of research experience.

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In April 2021, Atal Innovation Mission (AIM), NITI Aayog, in collaboration with the Bill & Melinda Gates Foundation launched AIM-PRIME (Program for Researchers on Innovation, Market-Readiness and Entrepreneurship). Implemented by the Venture Center, the PRIME programme was aimed at promoting science-based, deep technology ideas to market, through training and guidance over a period of 12 months.

The programme included several lectures and hands-on sessions on various topics related to the lab-to-market journey. These lectures provide diverse and at times contradictory advice on several aspects of the journey. Just as the blind men feeling around an elephant described it as anything from a fan to a rope to a snake, perspectives differ based on the type of start-ups and the stage of the entrepreneurial journey most familiar to the speaker.

AIM-PRIME Playbook is synthesised based on the knowledge shared by these experts as well as additional content contributed by the chief editor. It aims to be a comprehensive resource for academic researchers, entrepreneurs and incubators involved in building science-based enterprises from lab-to-market.

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