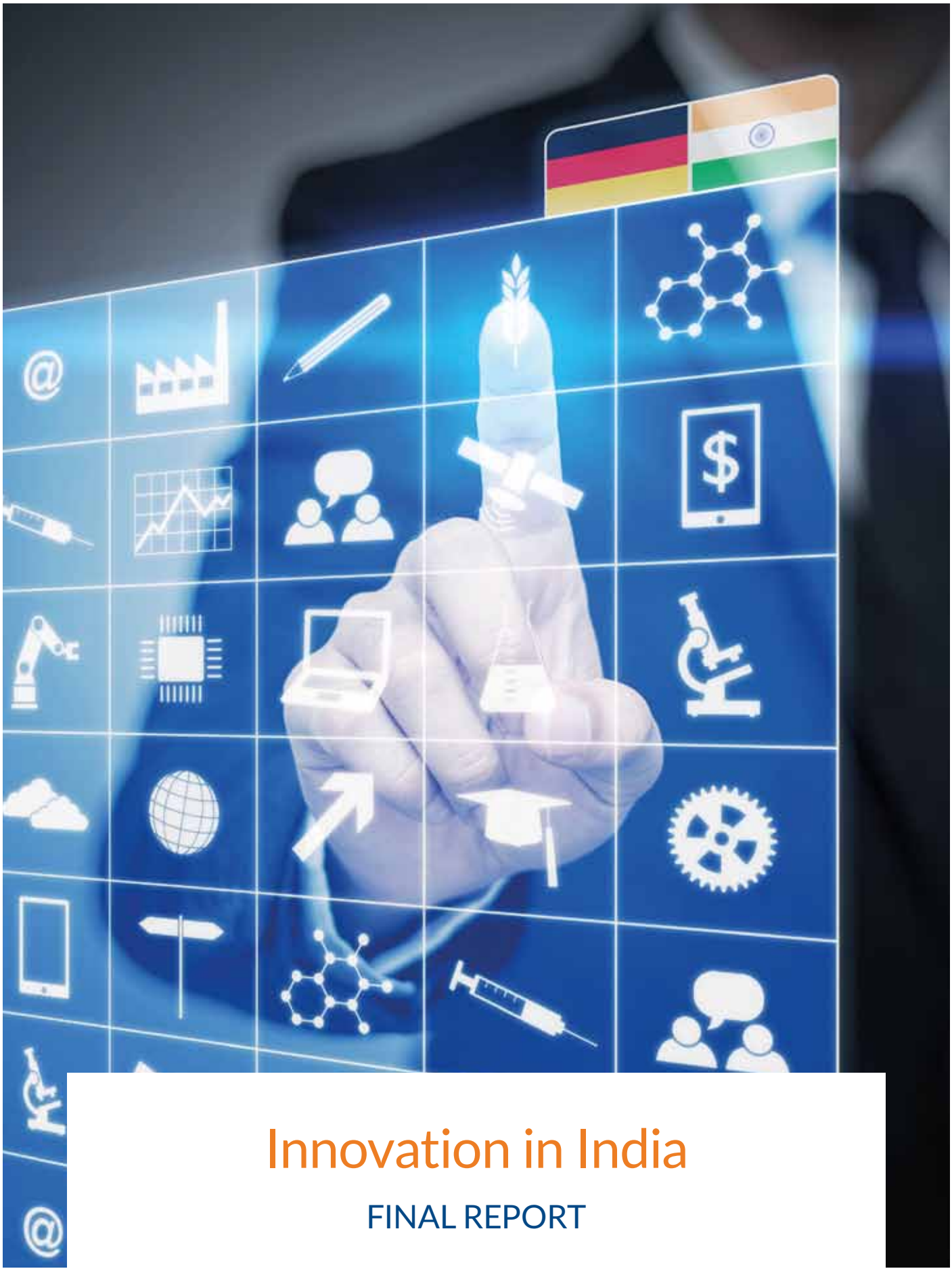

Innovation in India

FINAL REPORT

BertelsmannStiftung

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FINAL REPORT

CONTENTS

FOREWORD BY LIZ MOHN

The dramatic improvements made to our quality of life, from medical care and life expectancy to transport and communication to education and economic welfare have been made possible by the rapid pace of innovation witnessed over the last century. The pace of change has quickened significantly in the last decade as creative ideas from around the globe have fundamentally transformed established industries. Traditional business models in sectors as diverse as agriculture, manufacturing, education and healthcare are being disrupted like never before. For those who aim to remain relevant, they must do more than keep apace with change and take the lead instead.

Globalization is changing the very nature of this increasingly dynamic business world. It has brought about an unprecedented surge in prosperity in industrialized countries that is now lifting millions of people out of poverty, particularly in many formerly weaker economies in Asia, including China and India. The twin phenomena of globalization and ever-accelerating innovation have also transformed our societies. Our world is becoming increasingly integrated as trade, capital and, most importantly, ideas and people cross international borders. As a result, no single country or region can assuredly maintains its hold on technological leadership.

In a context of ever-changing technology and markets, flexibility and the capacity to acquire new skills are demanded of firms and employees alike in industrialized countries. In emerging economies, inclusive innovation serves the needs of the poor who have been bypasssed by the economic growth of recent decades. At the same time, increasingly ubiquitous automation and digitization makes it harder to employ the millions joining the workforce every year. Indeed, the exclusion of the socioeconomically disadvantaged classes is one of the greatest challenges confronting our society. A livable society requires the inclusion of everyone and the capacity to offer everyone a fair chance at upward mobility. In a world of ubiquitous and rapid change in everything from the economy to family bonds, social cohesion becomes even more important as a stable foundation. As technology drives productivity and replaces human labor in an increasing number of sectors, we need to have a global dialogue on how to direct technological growth for the betterment of societies in both industrialized and emerging economies. We also need to have a global dialogue about what kind of future we want to create together for future generations.

Asia is increasingly becoming an important source of ideas not only because of megatrends such as digitization but also because of the shift toward this part of the world in global economic dynamics. Understanding this phenomenon while engaging with stakeholders is crucial for Germany if it is to remain relevant in this innovation-driven future. The Bertelsmann Stiftung's Germany and Asia program aims to build bridges between Europe's largest economy and emerging Asia that foster the creation of mutually beneficial and sustainable partnerships. India is one of the few countries outside the EU with which Germany has a strategic partnership. Whereas Indo-German diplomatic relations – established by India's first prime minister, Jawaharlal Nehru and Germany's first postwar chancellor, Konrad Adenauer – are only sixty years old, intellectual, cultural and economic relations between the two countries are centuries old. The shared values of democracy, secularism and a market economy grounded in principles of social justice form the basis of a partnership defined by mutual respect and benefit that allows both countries to work together in addressing global challenges like sustainable development and inclusive growth.

India has recently attracted considerable attention as one of the world's most dynamic regions for innovation. In order to develop a better grasp of India's innovation potential and deepen the Indo-German innovation partnership, the Bertelsmann Stiftung commissioned the "India Innovation Study." It is the first and most comprehensive study of its kind that illustrates the landscape of innovation in India and the impact this has on the global economy.

I sincerely hope that this study helps deepen relations and foster creative interaction between the governments, companies and, most importantly, citizens of both nations.

SETTING THE CONTEXT

In terms of innovation, Germany ranks high on most global indices. This is a result of German industry's relentless pursuit of better products and solutions coupled with an excellent academic and research network that enjoys the support of a policy environment that has been optimized over decades. However, the German advantage in the high-tech sector cannot be taken for granted and is being challenged not only by traditional competitors such as the United States, but also by emerging economies like India and China, both of which feature a growing market combined with a significant pool of highly qualified engineers and researchers.

As the emerging markets mature and build infrastructures and knowledge capital on par with that present in industrialized countries, they establish themselves as both potential partners and competitors in Asian and global markets alike. Like any other aspect of the global economy, innovation is also subject to globalization. This involves more collaborative forms of corporate and academic research with market and technical inputs from experts around the world.

These developments matter significantly to Germany, where high-tech exports employ almost a third of the country's workforce. Sustaining Germany's technological leadership is unthinkable without robust cooperation among industries and research communities between India and Germany. Fostering this kind of cooperation is at the heart of the Bertelsmann Stiftung's "Asia Innovation" project, which includes studies on innovation in China and other countries. We aim to map the developments in innovation and offer recommendations for establishing meaningful cooperation between Germany and these dynamic economies. The findings that emerge from the various dialogues we hold with stakeholders will help us formulate key policy interventions that are designed to facilitate fruitful cooperation. We are delighted to present the India Innovation Study as the first in our series and look forward to building a constructive dialogue that draws upon on the insights featured here.

Murali Nair
Senior Project Manager
Bertelsmann Stiftung

Stephan Vopel
Program Director
Bertelsmann Stiftung

FROM THE AUTHORS

Indian innovation and its impact on developed nations is a topic of increasing relevance in today's world. The accelerating pace of innovation across Indian-based startups, corporate houses and multinational corporations (MNCs) is bound to have an impact on developed nations such as Germany, where success has been built on technology and innovation.

Industrialized nations need to be aware of the challenges and opportunities these developments create. They need to grasp India's promise as a large and growing market that can be leveraged globally as a lead market for frugal products. They also need to develop an understanding of the fact that collaboration with India's startup ecosystems, provides complementary skills, resources and business models that can drive global success. They also have to appreciate the fact that leading Indian emerging market MNCs have the potential to disrupt their industries.

For Germany, it becomes paramount to leverage India's complementary innovation skills such as those found in the area of frugal engineering. German research organizations should access the Indian market and the German government should develop a clear R&D internationalization strategy that is focused on India.

India needs to drive and invest in innovation at all levels. Companies need to advance innovation in order to safeguard future profit pools. Innovation must cut across industries and not remain limited to a few leading companies in, for example, the pharmaceutical and automotive industries. Academia in India must improve learning outcomes and strive to become relevant in a global R&D setting. At the same time, this will require the Indian government to ensure the consolidation of programs and resources as well as a speedy execution of existing initiatives.

Cooperation between Germany and India is already underway and, as the case studies in the study show, it is largely successful. However, investments overall are dwarfed by the opportunity at hand. It is in the interest of both nations to step up their collaboration and support each other in improving the lives of all citizens.

Dr. Wilfried Aulbur

Nitya Viswanathan

Roland Berger

PROJECT BACKGROUND

"...One of the important lessons of the past two decades has been the pivotal role of innovation in economic development. The build-up of innovation capacities has played a central role in the growth dynamics of successful developing countries"[1]

Germany

Given the volatile, uncertain, complex and ambiguous (VUCA) world we live in, innovation is a critical means by which countries can create and sustain competitive advantage and drive inclusive growth. Innovation has been central to the economic development of countries such as the United States, Germany and Japan. Germany, the fifth-largest[2] economy in the world (ranked by GDP on a purchasing-power parity (PPP) basis), and ranked among the top 15 across a variety of global innovation indexes,[a] has achieved this position in large part due to its innovative high-technology exports. As of 2014, it was ranked as the third-largest exporter in the world, with the machinery and electronics, transportation (i.e., vehicles, aircraft, vessels and associated transport equipment), and chemicals categories accounting for nearly 60% of the country's total exports.[3]

While Germany has been at the forefront of global innovation (see Figurre I.1), this position can no longer be taken for granted, for three main reasons. First, recent demographic shifts and a low birth rate have given rise to an aging population, which is creating a scarcity of highly skilled labor. Germany's population is expected to decline from 82 million people in 2012 to 74.5 million in 2050. Even more worrying is the fact that "the percentage of Germans under 15 is forecast to fall to 13%, among the world's lowest. The share of those over 60 is expected to rise from 27% to 39%."[4] Moreover, while the country is witnessing an increase in migration, Germany would need an influx of 470,000 immigrants each year until 2040 to offset the demographic decline. The German Federal Statistical Office published a report in January 2016 noting that "the demographic difference between the old and the young is so vast that even the current unprecedented level of immigration cannot reverse the trend."[5]

Second, Germany's performance in innovation, while solid, has not earned it a place within the Global Innovation Index's top 10 for the past five years. Moreover, the country has trailed a number of European peers such as Switzerland, Sweden, Netherlands, Finland, Ireland, Luxembourg and Denmark. While Germany has performed well on indicators such as scientific and creative outputs, its rankings on the input side have been weighed down by its performance on subindices such as institutions, market sophistication and business sophistication.

Finally, as seen in the rankings, while innovation is not a zero-sum game, competition between countries to drive innovation and capture larger shares of global markets is intensifying. This competition is no longer restricted to the most advanced countries of the world. Emerging countries such as India and China, with their large young populations and abundance of skilled labor, are also innovating. Given that these countries are at a different stage of economic development than developed economies, the nature and types of innovation involved vary considerably (an analysis of the type of innovation being pursued in India will be explored subsequently in this report). This could have a variety of consequences for Germany's innovation efforts – for example, competition may increase, but new collaboration opportunities may also arise. In light of its demographic challenges, Germany stands to gain from understanding what emerging countries such as China and India have to offer in the context of innovation, and where possible, identifying mutually beneficial areas of cooperation.

India

Much has been said and written on innovation in India. However, while there is increasing buzz regarding India and its role in the global R&D landscape, there is also a significant amount of contradictory information. On the one hand, India is touted as one of the most attractive destinations for R&D – for example, the country is already home to nearly 1,000 R&D centers for leading multi-nationals. Bangalore is globally recognized as the fifth-most-preferred destination for large companies and start-ups with regard to technology and innovation capacities.[6] On the other hand, India spends significantly less on

a Germany is among the top 10 countries across a variety of global innovation rankings, including the Global Innovation Index (2015 rank: 12), Global Competitiveness Index (2015 rank: 5), Innovation Indicator (2015 Rank: 5), Information Technology and Innovation Foundation (2016 rank: 12)

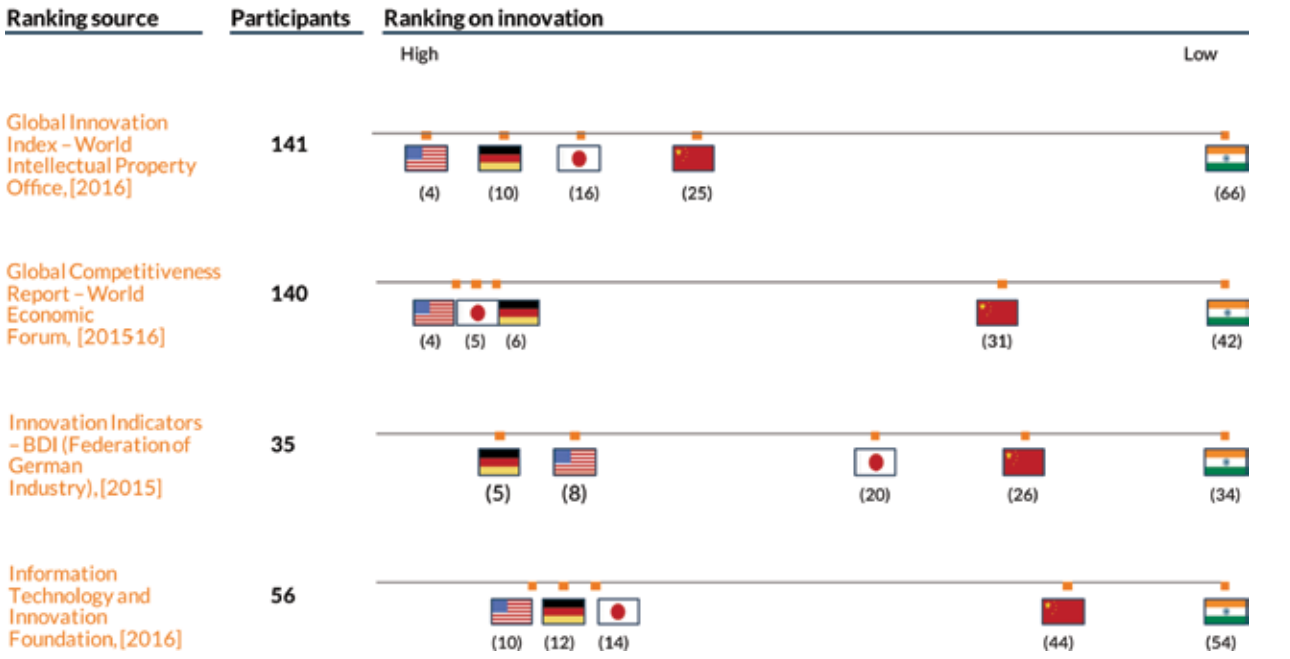
R&D as a percentage of GDP than do global peers (R&D spending amounts to 0.9% of India's GDP, as compared to 1.95% of China's GDP and 3.6% of South Korea's, for example). Moreover, despite a slight improvement in some rankings, India receives relatively poor rankings on a variety of innovation and related indicators (see Figure I.2). Given this contradictory information, what is the real story? Is innovation in India real, or is it just hype? If it is real, what does innovation in India look like? Our study is an effort to shed light on what is genuinely taking place in India. It attempts to provide a realistic depiction of innovation in India, while identifying its key characteristics, the types of organizations involved, the country's strengths and weaknesses, and the areas that need improvement. Moreover, we try to identify the impact that India's rise into an innovative economic power is having on Germany, while outlining how corporate executives, researchers and policymakers in both countries can collaborate so as to develop a synergistic partnership.

FIGURE I.1 **Rankings from Global Innovation Index: Germany (ranking out of 100–150 countries)**

Parameter	2011	2012	2013	2014	2015	2016
Global Innovation Index	12	15	15	13	12	10
Input Sub-Index	21	23	20	19	18	18
Institutions[a]	21	26	21	21	20	18
Human Capital & Research	11	16	19	14	10	10
Infrastructure	21	16	14	17	18	22
Market Sophistication[b]	14	24	21	25	22	16
Business Sophistication[c]	20	24	26	21	20	15
Output Sub-Index	4	7	10	8	8	8
Knowledge & Technology Outputs	14	12	10	11	10	8
Creative Outputs	6	10	14	14	14	7

a Refers to the stability of the government and the quality of public and civic services, the ability of the government to formulate and implement sound policies, and the ease of starting a new business in the country
b Refers to ease of obtaining credit, protecting investors, level of market capitalization in the country, and barriers to trade
c Refers to involvement of citizens in knowledge-intensive jobs, Gross Expenditure on R&D by enterprises, level of collaboration between industry-academia, and absorption of knowledge from outside national borders in the form importing high-tech and ICT services

FIGURE I.2 **Comparison of innovation rankings**



Source: Secondary Research, Roland Berger

I. APPROACH AND METHODOLOGY

1. Approach

Roland Berger India, on behalf of the Bertelsmann Stiftung, has undertaken a study to understand and analyze innovation in India, identify its impact on Germany, and develop a set of actionable recommendations for companies, academia and policymakers which can strengthen the innovation landscape in both countries.

Our study has been a first-of-its-kind comprehensive assessment of corporate innovation in India and its impact on Germany.[a] We believe that innovation is multifaceted and does not always fit within the confines of a particular definition. Therefore, we have been careful not to impose our own definition of the term. Moreover, each organization has its own definition of and modus operandi with regard to innovation. We have therefore adopted respondent companies' definitions of innovation as appropriate. As a consequence, innovation in this report refers to products, process, business models, organizational innovations and combinations thereof.

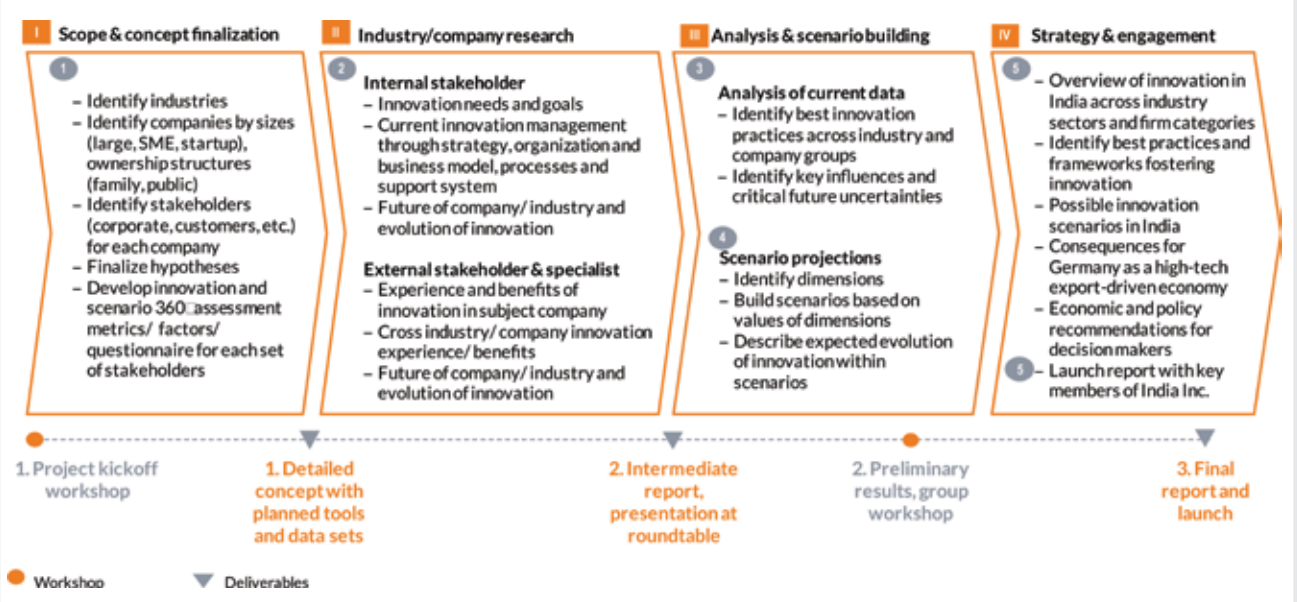
Over the course of nine months with the project, we have followed a four-phased approach (see Figure I.3) through phase I (scope and finalization), phase II (industry and company research), phase III (analysis and scenario building) and phase IV (strategy and engagement). In the first phase, we developed a framework[b] for selecting the industries to cover, identified the industries and selected a list of specific companies.[c] We also developed an initial set

a The focus of our study has largely been on corporate innovation. In addition, we have also analyzed R&D at academic and research organizations. One area that we have not covered in our study is social innovation – this is an extremely vibrant, dynamic and vast space and warrants a dedicated study.

b Framework was based on the size and growth of the various industries and the average R&D spent on each.

c Companies with a broad range of sizes (small, medium, and large), ownership types (government, publicly listed, private – promoter-owned vs. institutional stakeholders-owned), maturity (established and start-ups) and countries (India, European, American, and Asian) were selected.

FIGURE I.3 **Project approach**



Source: Roland Berger

of hypotheses, which we used as a foundation in designing the questionnaire for our later interviews. In phase II, we conducted interviews with a broad range of companies and began our secondary analysis of 10 individual topics related to the Indian market, including the country's performance along key innovation-related indices; innovation policy; the domestic education system; the public and private R&D infrastructure; industry-academia linkages; the investment climate for innovative ideas; intellectual-property rights; the impact of competition and standards; the infrastructure and business climate; organization types and their impact on innovation; and the importance of cultural, socioeconomic and political indicators on innovation. In phase III, we conducted a quantitative and qualitative analysis of stakeholder feedback, examining how these entities approach innovation and what factors (internal and external) influence their innovativeness. The quantitative output was used as an input into our scenario-planning analysis. In the final phase, we developed a detailed overview of innovation in India across sectors and organizational types, identified its impact on Germany, and formulated recommendations for both countries.

2. Methodology

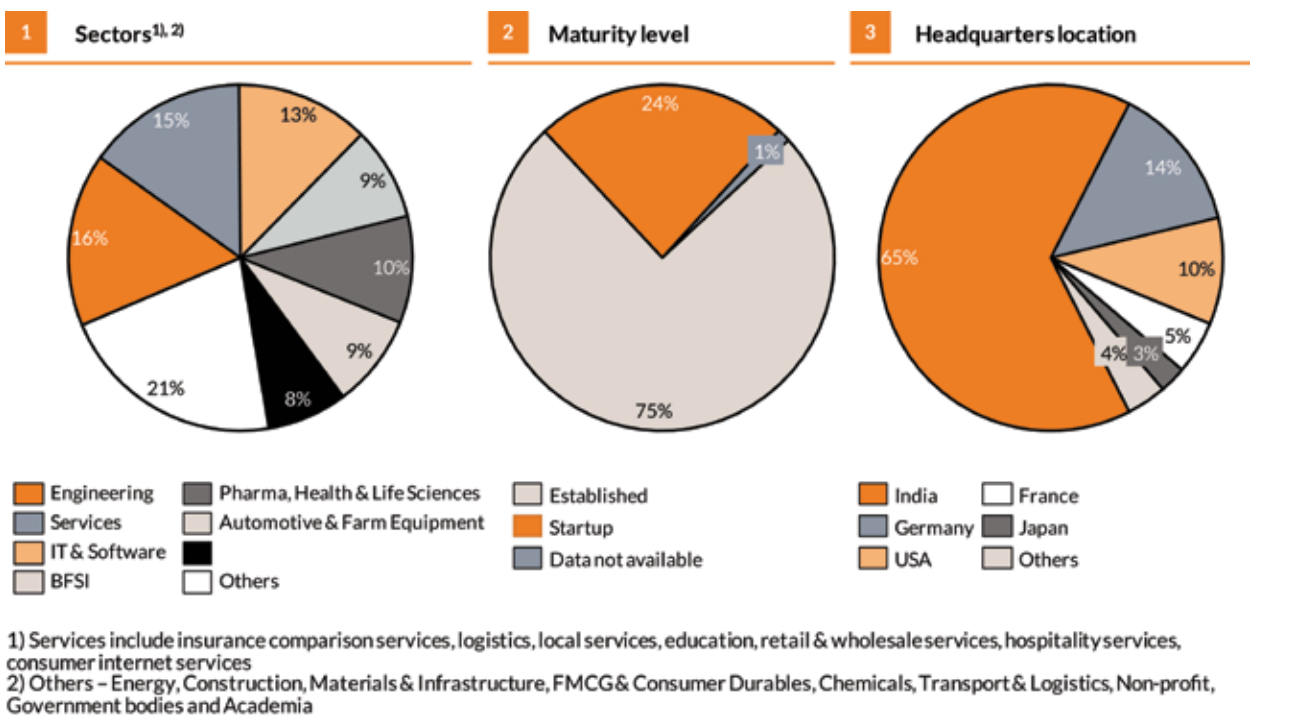
The heart of our study is made up of primary interactions with 80 companies and more than 150 stakeholders.[a] This includes Indian and multinational companies, Indian and German industry associations, universities and research organizations, and government bodies.

Our interview partners represent a broad cross-section of organizations within corporate India (see Figure I.4, Figure I.5)

1. Industry sectors – automotive original equipment manufacturers (OEMs) and suppliers, banking, financial services and insurance, engineering (including capital equipment and machinery, and electrical and electronics manufacturers), construction, materials and infrastructure, information technology (IT) and business process management (BPM), pharmaceuticals, biotechnology and healthcare, energy, and services (includes retail and e-commerce, education, hospitality, travel and tourism, logistics, and media and entertainment).

a Stakeholders include all individuals we have interacted with as a part of this study, either via formal interviews or who have participated in our workshops

FIGURE I.4 **Profile of 80 respondent companies across 11 sectors**



Source: Company interviews; Survey done by Roland Berger (December 2015 – July 2016); Roland Berger

2. Maturity – Established organizations with more than eight years of existence, and start-ups with less than eight years.

3. Country of origin – Indian companies and multinationals from countries including Germany, United States, Japan, Taiwan, and other European countries. Although our study is focused on India and Germany, given the large number of multinational companies in India pursuing R&D, we have cast our net somewhat wider so as to be exposed to and incorporate best practices from companies headquartered elsewhere.

In addition to in-depth interviews, we have held workshops in Germany (Berlin), as well as across major cities in India – Mumbai, Delhi/NCR, Bangalore, Chennai, and Pune to understand multiple perspectives and incorporate regional and industry-wide differences on this topic.

Our primary analysis has been supplemented with secondary research, including a review of leading academic and business literature on this topic.

Finally, our findings have been validated by an expert panel comprising leading members of industry, academia, and Indo-German relations.[a]

a Our expert panel is comprised of a combination of industry leaders in India and academics and experts on the topic of innovation. Members include V. Sumantran (Chairman, Celeris Technologies), R. Gopalakrishnan (Non-Executive Director, Tata Sons), Anup Malani (International Innovation Corps und India Innovation Corps), Bernhard Steinruecke (Director-General, Indo-German Chamber of Commerce), Professor Rishikesha Krishnan (Director, Indian Institute of Management, Indore)and Professor Jaideep Prabhu (Judge Business School, University of Cambridge)

FIGURE I.5 **Respondent companies**

1	Alliance Tire Group (ATG)	21	Lodha	41	Hindustan Computers (HCL)	61	Knowlarity
2	Apollo Tyres	22	Info Edge (India)	42	InteractionOne	62	Bharti Foundation
3	KfW Bank	23	Raina Industries	43	Mindtree	63	DFG [Deutsche Forschungsgemeinschaft]
4	Cummins Engine	24	UrbanClap	44	SAP	64	Achira Labs
5	Mahindra	25	Aarambh Ventures	45	Wipro	65	Abbott Laboratories
6	Michelin	26	Bridge – School of Management	46	Xerox	66	Embassy of India
7	Tata Motors	27	RWE Power	47	Zensar Technologies	67	Indian Institute of Technology Delhi
8	Bajaj Finserv	28	Toppr	48	Ginger Hotels	68	Novozymes
9	BNP Paribas	29	Bharat Electronics	49	HT Media	69	BUGWORKS
10	Catamaran Ventures	30	Foxconn	50	Star India	70	Osteo3d
11	BASF	31	GreyOrange	51	Viacom18	71	Sanofi
12	Oxigen Wallet	32	Altizon Systems	52	Infrastructure Leasing & Financial Services (IL&FS)	72	Fraunhofer Institute
13	Paytm	33	Moserbaer	53	Maker's Asylum	73	Sun Pharma Advanced Research Company
14	PolicyBazaar	34	Environmental Defense Fund (EDF)	54	Humboldt Universität	74	Delhivery
15	Hitachi	35	The German Association for Small and Medium-sized Businesses (BVMW)	55	Essar Steel	75	Interview Mocha
16	Oerlikon	36	Selco Solar India	56	Eros International	76	Embassy of the Federal Republic of Germany
17	Schuler	37	Hector Beverages	57	Arvato	77	BPL Medical Technologies
18	Siemens	38	Marico	58	Taj Hotels Resorts and Palaces	78	Mother Earth
19	Tata Interactive Systems	39	Thomas Cook	59	Compagnie de Saint-Gobain	79	Strand Life Sciences
20	Mitsubishi	40	IdeaForge	60	Shoppers Stop		

ABOUT THIS REPORT

This report is the culmination of nine months of efforts that include quantitative analyses, qualitative feedback, verbatim interviewee quotes, case studies, proposed policy frameworks and descriptions of best practices followed by government bodies, companies and academic institutions that are innovating in India.

We hope that it will provide a useful overview of India's innovation ecosystem, a look into the future of innovation in the country, and an outline of action-oriented recommendations for Indian companies, research institutions and policymakers. Moreover, the report seeks to highlight the implications of Indian innovation for Germany, both positive and negative, while identifying mutually beneficial collaboration opportunities for both countries.

Not including this introductory section, the body of the report is organized into five main sections:

1. **Innovation in India** – This section focuses on our findings regarding innovation at the country, organizational and industry level.

2. **Influencing factors** – Here, we examine the various drivers of organizational innovation, both internal and external, and analyze their importance to innovation in the broader Indian context. Internal influencing factors such as intra-organizational innovation culture (which includes aspects such as innovation mindsets, cross-functional cooperation and organizational structures), organization ownership type, cross-regional cooperation, organizational size and structured innovation processes are considered. External influencing factors such as the quantity and availability of talent, the availability of capital, entrepreneurial cultures (enabling policy environments and innovation infrastructure), industry-academia linkages, intellectual property regimes, the ease of doing business (as rated by the World Bank), multinational spillover effects, intercompany cooperation, stable macroeconomic conditions, and the degree of talent mobility between companies are additionally analyzed, along with their impact on the overall ecosystem.

3. **Future projections** – In this section, we discuss how India's innovation landscape will look in 2030, and present several possible scenarios. Rather than specifically predicting the future, the idea of this section is to identify a number of possible paths that India could take,along with the associated opportunities and threats. The scenarios are based on our interviews with industry experts, secondary research and our own expertise.

4. **Implications for Germany** – Here we outline why and how innovation in India affects Germany. India is a market, a competitor, a collaborator, a talent hub and an ecosystem for Germany. Whether its effect is positive or negative, innovation in India does have an impact within Germany, and we believe policymakers, corporate leaders and scholars in the country should be aware of the associated opportunities and challenges.

5. **Recommendations** – In this section, we identify an action-oriented set of recommendations for Indian companies, research institutions and policymakers aimed at strengthening the country's innovation ecosystem. Moreover, we also provide recommendations for German corporate executives, researchers and policymakers in the context of developments in India, highlighting potential areas of collaboration and competition. Finally, we will outline areas that both countries should explore jointly so as to further develop and strengthen their synergistic partnership.

II. INNOVATION IN INDIA

A. Is India innovating – and if so, is it original?

Nine months of work on this study have led to one main conclusion – that innovation in India is real, and that it is gaining increasing momentum. True to its inherent nature and that of the country itself, innovation in India is complex. Not all innovation in India is truly novel or breakthrough. In fact, some would argue that the country has not yet produced breakthrough or disruptive innovations. Several of India's leading industrialists, politicians and members of the press have observed that no genuinely significant innovation has come out of India (see Figure II.1).

Much criticism has been levelled at Indian companies, with skeptics alleging they are mere "copy-paste" versions of tried-and-tested products and business models from developed economies. This is partially true and also inevitable. It is only partially true because while there has been some level of imitation, the companies engaged in "copying" have not been able to "paste" these products and business models directly. Given India's vast, heterogeneous and underpenetrated markets, Indian companies have had to significantly adapt or tweak the products and services copied from developed market players to the Indian environment, often generating a significantly altered value proposition to the customer. The companies which have succeeded with these offerings have therefore had to master innovative imitation.

Moreover, for an emerging economy, copying or imitation is a natural and inevitable part of economic development. In fact, a number of developed countries have begun their innovation journeys by imitating others. Notable examples include Japan, South Korea, China and even Germany. Innovation typically requires investment, and this can be a challenge for companies in emerging markets. Therefore, until they reach a certain size and level of maturity, industries in these markets often choose to imitate successful global enterprises and focus more on incremental improvements over game-changing innovations. Linsu Kim has outlined three

FIGURE II.1 **Quotes on innovation in India**

"No invention, earth-shaking idea from India in 60 years"
– Mr. Narayana Murthy, Indian IT Industrialist

"India largely lacks innovation skills; Organizations in India have to overcome the systemic mindset of 'branding' themselves as innovative enterprises"
– Active Voice Column, Business Standard and Institute of competitiveness, India

"Innovation remains a distant dream for Indian entities"
– Editorial Team, Business Standard

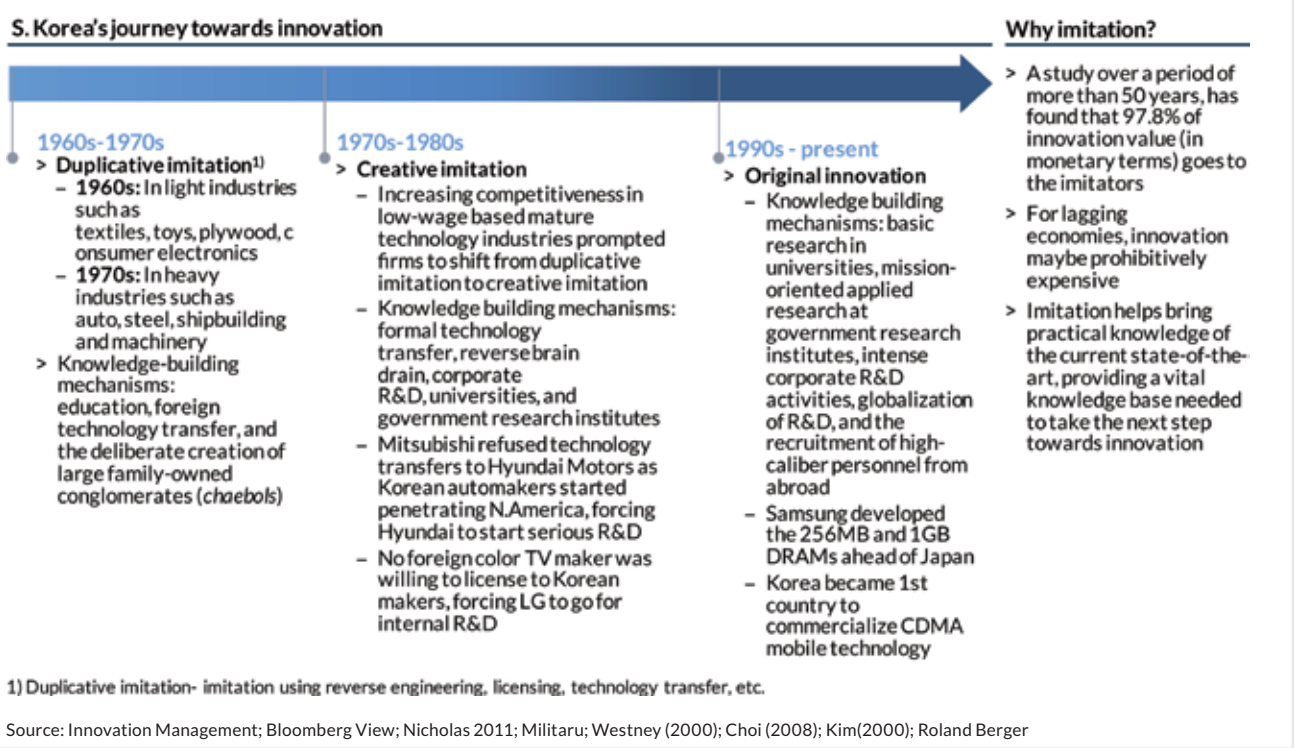
"Shame that so many years after independence, no big innovation in India"
– Mr. Piyush Goyal, Indian Power Minister

"We are IT labor contractors, not IT super power as we lack innovation. We have not come up with any new operating system or real new products"
– Mr. Prakash Javadekar, Indian Environment Minister

"For 'Make in India', first 'Innovate in India'"
– Mr. Lalit Bhasin, President, Society of Indian Law Firms (SILF)

Source: Press Reports; Secondary Research, Roland Berger

FIGURE II.2 **Evolution of innovation in South Korea**



1) Duplicative imitation- imitation using reverse engineering, licensing, technology transfer, etc.

Source: Innovation Management; Bloomberg View; Nicholas 2011; Militaru; Westney (2000); Choi (2008); Kim(2000); Roland Berger

main stages followed by developing countries on their way to industrialization – duplicative imitation, creative imitation and innovation – using South Korea's industrial development as an illustration (see Figure II.2).[7] Another example of this process is offered by German steelmaker Krupps, which became an industry leader in the late 1800s by adopting processes and know-how from the British steel industry, eventually building up a steel empire in Germany.

India's innovation journey

India's innovation journey has taken a slightly different path. A protectionist and inward-looking orientation with regard to trade and foreign investment between the 1950s and 1980s meant a delayed start not only with respect to economic growth, but also regarding innovation. Unable to import key technologies and products, Indian companies were forced to reinvent the wheel, often resulting in substandard and low-quality solutions that suffered from the lack of access to external benchmarks or best practices.[8]

More recently, the country has gone through the first two stages identified by Kim.

Duplicative imitation: 1990s to mid-2000s

The economic reforms of 1991 created an influx of foreign multinationals that brought with them portfolios of high-quality and high-performance products. This captured the attention of Indian industries and consumers alike. However, due to the lack of a strong R&D infrastructure, Indian companies found it difficult to match the design, quality and performance of these foreign products with their own indigenously developed products, and chose instead to duplicate Western ideas and products for the Indian market. The pharmaceutical and agrochemical industries in particular took advantage of an Indian patent law that until 2005 did not recognize product patents; by reverse-engineering drugs from Western manufacturers, they created the foundation for India to become a leading generic – and bulk-drug producer.

Moreover, labor-cost arbitrage opportunities led multinationals to offshore their IT and other back-end activities to India. This gave Indian IT-services companies the opportunity to learn and understand how Fortune 500 companies ran their organizations, and to replicate those processes and systems within their own organizations. While the services provided by these companies were not innovative in themselves, the outsourcing and offshoring wave later gave rise to an important Indian innovation, the global services-delivery model (in the subsequent creative

imitation phase). Moreover, the outsourcing phase trained Indian companies to manage large and complex projects, and prepared them to move up the value chain and excel in the provision of professional R&D services to foreign companies (an issue further discussed in sub-section C, "Innovation as a Service").

Creative imitation: Mid-2000s to present

As the Indian market grew, two things started happening. First, enterprising Indian companies that had grown with the market reinvested their earnings, acquiring technology and talent. Simultaneously, foreign multinationals interested in further exploiting the country's low labor costs started to set up R&D centers in India, focusing initially on product support, but slowly graduating to product design and testing as well. This led to technology and talent spillovers into Indian companies, bot through formal and informal linkages. Domestic companies could now afford to invest in developing their own technologies, and began in-house R&D.

Still nascent, R&D in India remained largely limited to adapting global products and solutions for the Indian customer. However, it gave birth to the next stage in India's growth story: the creative imitation stage. In addition to modifying global products for Indian use, Indian players now began to focus on process and business-model modifications, seeking to improve their operational performance. At this time, CK Prahalad and other academics developed management theories regarding the exploitation of potential at the so-called bottom of the pyramid through the creation of products and services for this low-income population segment. This led companies in India to start thinking about how they could cater to this hitherto underserved market, and gave rise to the frugal engineering approach (discussed in more detail in Section II-B). Multinational companies took heed, and followed suit. Increasing mobile-phone and internet penetration in the late 2000s propelled a new crop of organizations to the fore that leveraged this new technology to create products and services for Indian consumers, giving rise to the start-up boom.

Today, the Indian innovation journey is at a tipping point. While we still observe a significant amount of creative or innovative imitation in the Indian market, we are also beginning to see attempts within the country to develop truly clean-slate innovations. We believe that India is at the cusp of entering the phase of original innovation. However, for India to truly segue into this phase, all stakeholders in the innovation ecosystem will need to make a concerted effort. We discuss this further over the course of this report.

B. Characteristics of innovation in India

Innovation in India has one distinct characteristic. Given the context and environment in which it takes place, innovation in India is typically frugal. Frugal innovation refers to the art of creating sometimes radically new products and services with limited resources. It is a structured-innovation approach or mindset that clearly focuses on delivering customer value at predetermined price points.

India is fast becoming both the lead market and the global hub for frugal innovation. Resource constraints and the desire to open untapped markets to products and services via attractive price points and acceptable value-for-money propositions are at the heart of the frugal-innovation movement.[9] While the concept is not specific to India, there is a reason why India has evolved as the crucible of frugal innovation. Even before its independence in 1947, India has been characterized by an acute scarcity of resources, institutional voids,[a] and a low level of disposable income. This challenging environment gave birth to so-called *Jugaad* or creative improvisation, a crude and rudimentary predecessor to what is today regarded as frugal innovation.

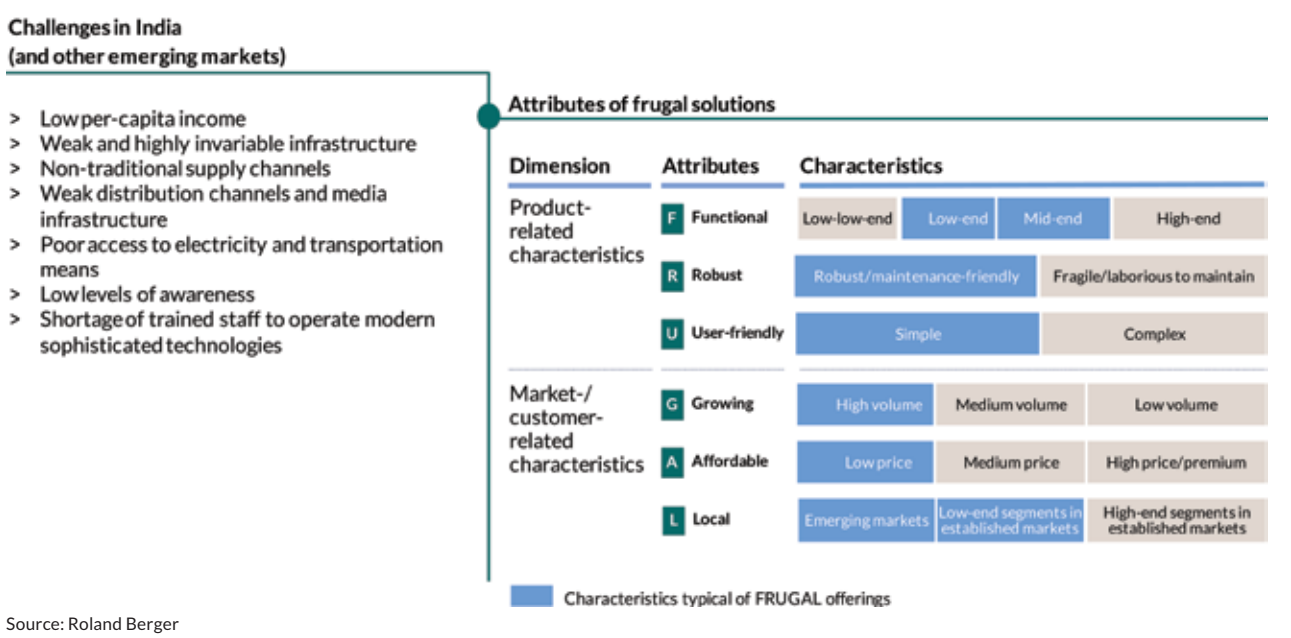
That resourcefulness is today driving a systematic mindset oriented toward innovating with less. The focus is on designing and developing functional, robust, user-friendly, affordable and locally made products (see Figure II.3). While these products, services and business models may be simpler and less costly than their conventional counterparts, frugal innovations by no means compromise on quality. Instead, the focus is on providing the customer the core functionality that he or she desires at the best possible price.

Contrary to conventional associations with the term, frugal innovation does not cater only to bottom-of-the-pyramid (BoP) market segments. Indeed, customers of frugal innovation can be found in developed, middle-income and BoP market segments alike.

We believe that frugal innovation will play a key role in the innovation landscape in emerging markets for decades to come. Fully 95% of global population growth and 70% of global GDP growth through 2030 is expected to come from emerging markets. While these markets will vary, most will be characterized at least to some degree by resource scarcities, institutional voids and low disposable incomes. Companies will need to innovate for these emerging

a Institutional voids are market institutions that are missing in emerging markets, e.g., functioning legal systems, accurate market research capabilities, etc. Source: Tarun Khanna and Krishna G. Palepu, Winning in Emerging Markets. Boston: Harvard Business Press, 2010.

FIGURE II.3 **Challenges in India and the attributes of frugal innovation**



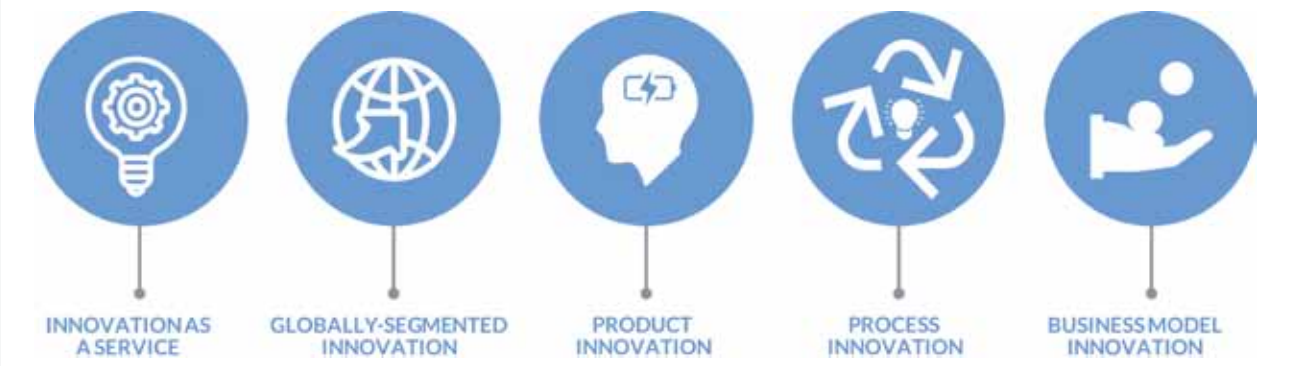
Source: Roland Berger

markets, and India, given its huge customer base, provides an ideal testing ground forthe development of frugal solutions by Indian and foreign multinationals alike.

C. Five archetypes of innovation in India

We identify five main archetypes of innovation taking place in India, catering both to global and Indian customers.

FIGURE II.4 **Five archetypes of innovation in India**



Source: Roland Berger

1. Innovation as a service

Given India's status as an offshoring and outsourcing destination of choice, it comes as no surprise that India is a huge provider of "innovation services" to global and Indian companies. This extends to areas such as engineering services, IT services, and contract research[a] in the areas of pharmaceuticals and biotechnology. The service verticals range from traditional industries, such as aerospace, automotive, telecommunications, semiconductors, consumer electronics and construction/heavy machinery to new and emerging verticals such as computing systems, energy, infrastructure, industrial automation and medical devices. Companies providing innovation as a service include HCL Technologies, Wipro, Infosys, Zensar, Aurigene and Clinigene, among others.

While some of these companies may have started off as so-called body shops (a somewhat derogatory term for providers of basic outsourced services) 25 years ago, they have since moved up the value chain to provide high-end managed services. This has enabled an evolution in India's role, from being a global vendor to being a global partner.

The contribution made by this kind of innovation should not be underestimated. As aptly put by Nirmalya Kumar and Phanish Puranam in their book India Inside, "while this innovative work is delivered in response to somebody else's specifications, it is technically complex, the intellectual property (IP) generated may be co-owned, and sometimes, everything but the final branding and distribution takes place in India."[10] However, given the B2B nature of the R&D services provided, as well as the need for high levels of confidentiality in projects of this nature, much of this innovation is not visible or known to the end consumer. One example of this type of innovation is offered by HCL Technologies and its contribution to Boeing's 787 Dreamliner; HCL was responsible for "two mission critical systems: one to avert airborne collisions and another to enable landing in zero visibility."[11]

The pressure for both Indian and global firms to innovate is percolating down to engineering-services and clinical-research organizations, who must upgrade their knowledge and services constantly in order to provide high-value-added services to their clients. This means these firms are increasingly placing a high premium on innovation as well.

a Contract-research organizations provide contract-research services to the pharmaceutical, biotechnology and medical-devices industries

Case study 1:

Zensar Technologies[12]

Zensar Technologies is a company that has evolved as a result of innovation and high-quality service delivery. It provides technology services to Indian and global organizations across a variety of industries. Innovation is a priority at Zensar, which follows the principle of ambidextrous innovation (a term coined by Michael Tushman). In this model, alongside each business unit working on continuous innovation to improve its own performance is a completely distinct centralized business unit, which is itself dedicated to game-changing disruptive innovation within the company.

In fact, Zensar is one of the few companies we interviewed that systematically measures its innovation output. The firm has developed a framework based on the Capability Maturity Model Integration (CMMI) Level 5,[a] which tracks improvements relative to initial baselines in order to ascertain the impact of innovation. Under this framework, there is a set of defined service baselines that are periodically updated. Metrics are defined at the service level, with project-level metrics additionally defined individually for each project. Following the implementation phase of each project, data regarding the various metrics is collected and compiled, and the change relative to initial baselines is measured in order to assess the impact of innovation.

a Capability Maturity Model Integration (CMMI) level 5 refers to the highest level of maturity in Carnegie Mellon University's process-improvement training and appraisal program.

Zensar: from "body shopper" to the preferred IT partner for Fortune 500 players

The hardware manufacturing days

- In 1922, a tabulating machine manufacturing unit was established in India as the Indian wing of International Computers Limited from Europe
- The company was named International Computers India Manufacture (ICIM)
- Increasing competition in hardware segment, led to ICIM venturing in software

Body shopping phase

- Early 2000 saw ICIM's exit from hardware industry; re-branded as Zensar, it ventured into IT services sector
- In its early years, Zensar recruited and trained engineers in India and sent them abroad to work from client locations where Western companies undertook entire program management

Leveraging the cost arbitrage advantage

- To build a strong home base, Zensar offered its Western clients the opportunity to replicate the clients' entire back office in India at 1/3rd the cost
- It then proceeded from being a cost arbitrage opportunity to an outsourcing option that began with periphery processes and later took on core processes for its clients

Solution selling

- Slowly moving up the value chain, it moved on to create value for the enterprise and the CIO through IT
- Zensar would take over processes at the client office and would assure manpower and cost reductions through IT interventions based on their understanding of the vertical the client operates in

Rowing in the digital wave

- With the onset of digital age, firms wanted to use IT to engage with stakeholders along with keeping records
- Zensar developed its capabilities to become the operating backbone for many companies in Fortune 500 list operating in banking, insurance, retail and manufacturing sectors
- Today Cisco's entire B2B and B2C e-commerce operations run on Zensar platform

Source: Primary Interviews, Roland Berger

2. Globally segmented innovation[13]

More than 900 multinationals currently have R&D centers in India. In many cases, these Indian centers are the largest outside the multinational's home country. These R&D centers tend to be very well integrated into these firms' global innovation agendas. Given that a number of these multinationals operate multi-country (and within countries, multiple-location) innovation projects, innovation activities are often segmented either vertically (in a sequential process) or horizontally (as parallel work packages). This makes it difficult for external observers to ascertain the role played by each country in a given product's development. As a consequence, much of India's innovation activity is not widely recognized.[14] This type of innovation has played a crucial role in India's growth, certainly due to its contribution to the country's foreign direct investment (FDI), but even more so because of the know-how, system and process spillovers it has created.

From our interviews with several large multinationals, it appears that this innovation activity will intensify over time. Bosch's Engineering and Business Solutions team in India offers a good example of this archetype.

Globally segmented innovation is not limited to foreign multinationals in India. Indian multinationals too are segmenting their innovation activities across regions with the aim of leveraging capabilities available indifferent parts of the world. For instance, in 2013, Mahindra set up the Mahindra North American Technical Center in Detroit. This is comprised of a group of engineers with an average of 25 years of experience at companies such as Apple, Mercedes Benz, Ford, Boeing, Tesla, Toyota and Gulfstream. The vision for this center is to provide input at the platform, system and component-engineering levels with the aim of ensuring that Mahindra's vehicles are continuously improving and that the time to market is being optimized.[16] Similarly, Dr. Reddy's Laboratories and the Sun Pharma Advanced Research Company have both established R&D facilities in New Jersey in the United States to supplement their Indian R&D centers, particularly in the area of clinical development.

Case study 2:

Bosch Engineering and Business Solutions (RBEI)[15]

Bosch Engineering and Business Solutions (RBEI) is part of Bosch India. RBEI is the Bosch Group's largest employer in the country, and most likely the largest engineering-services firm in India. RBEI has about 17,000 employees, about 12,000 of whom are engineers. As Bosch's largest R&D center outside of Germany, RBEI employs about a fourth of Bosch's global engineering workforce.

The unit has worked to achieve a high degree of cultural and technical alignment with Bosch organizations around the globe. Significant investments in German-language skills have ensured tight integration with key units in Germany. Consistent management-exchange programs have allowed Indian employees to build networks in Germany or other parts of the international Bosch organization. Expats who have served in various positions in India become advocates for RBEI upon returning to their home organizations. The desire to keep key IP in-house is another powerful motivation to engage in "in-sourcing" while offshoring. Moreover, the center is as qualified as its primary external competitors, and boasts a number of certifications such as CMMI Level 5 and ASPICE Level 3.[a]

Innovation is driven through several separate programs. Innovations pursued bythe new-business team (NBT) are centrally funded projects that are unrelated to any existing business unit or core area including adjacent areas. These projects need to identify and specify a way of addressing a clear market need. Currently, three to four projects from India are running under this framework, one of which is a low-cost eye tester for glaucoma and diabetic retinopathy.[b] The second innovation scheme is the India innovation pipeline (IIP) funded by Bosch India. Here, projects are selected by Bosch India CEO Steffen Berns, and focused along individual business units or core related areas within the Indian market. The third innovation stream is driven by RBEI. Under the organization's pre-investment (PIN) initiative, team members are encouraged to pursue ideas that are technology oriented and require capability exclusively available through RBEI. The goal is to address future local and global needs. In light of RBEI's success, this team has also been asked to set up engineering centers elsewhere in the world. Today, RBEI engineers also work out of Ho Chi Minh City, Vietnam, and Guadalajara, Mexico.

a Capability Maturity Model Integration (CMMI) level five refers to the highest level of maturity in Carnegie Mellon University's process-improvement training and appraisal program. ASPICE is an automotive-specific assessment used to gauge both organizational maturity and process capability. A maturity level of three indicates that the organization has established processes.

b Diabetic retinopathy causes progressive damage to the retina in people with diabetes. http://www.aoa.org/patients-and-public/eye-and-vision-problems/glossary-of-eye-and-vision-conditions/diabetic-retinopathy?sso=y.

3. Product innovation

It is true that Indian examples of "first in the world", globally scalable product innovations are few. For instance, while India is host to one of the most successful generic-drug industries in the world, very few new chemical entities[a] have originated from the country.

However, this is not to say that Indian companies are not innovating with regard to products for the Indian and global markets. Even if they are not always acting disruptively, Indian and multinational companies are engaging in a significant amount of innovation in India, specifically with regard to product development.

India's export-led generics industry may have started through pure imitation of patented developed-world products. However, the industry has steadily grown, and the country is now one of the leading sources of generics in the world. Indeed, for the 2015 fiscal year, India's generics exports comprised 20% of the total volume of the market and its domestic market is expected to grow at approximately CAGR 20% (see Figure II.5). The industry has matured over the past few decades both in terms of size and in terms of systems, processes and quality. Large players are consequently developing the capability and willingness to invest in their businesses. Large Indian pharmaceutical players are today focused on moving up the value chain into areas such as new chemical entities (NCE) and novel drug-delivery systems (NDDS).[b] This has been reflected in the move by leading Indian companies (Sun Pharmaceuticals, Dr. Reddy's, Lupin, Glenmark, etc.) to establish dedicated R&D centers focusing on product innovation.

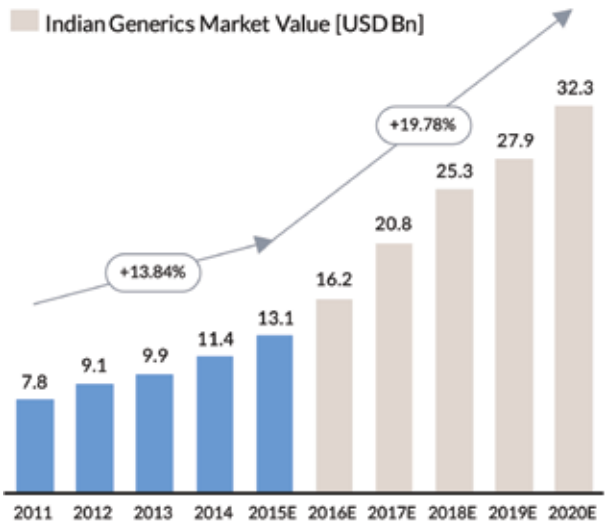
Seeking to increase its focus on R&D and develop new products for international markets, Sun Pharmaceuticals spun out a separate entity under the name of Sun Pharma Advanced Research Company (SPARC). This new research-focused entity is run independently of the generics giant. The reason for this has been twofold. First, the competencies involved in running a generics-manufacturing business are very different from those needed to run a pharmaceutical R&D company. Second, executives sought to shield Sun Pharmaceuticals, a publicly listed company with shareholders seeking relatively quick returns, from the inherently risky business of pharmaceutical R&D. Sun Pharmaceuticals still invests in generics-oriented research, both with regard to process development for active pharmaceutical ingredients

a New chemical entity refers to a drug that contains no active moiety (part of a drug) that has been approved by FDA in any other application submitted under section 505(b) of the Food, Drug, and Cosmetic Act. Source: United States Food & Drug Authority, available at https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?fr=314.108

b Novel drug delivery system is a novel approach to drug delivery that addresses the limitations of the traditional drug delivery systems. The aim of NDDS is to deliver drugs through a method that can have a significant effect on its efficacy. Source: Kaparissides,Costas, Sofia Alexandridou, Katerina Kotti and Sotira Chaitidou, "Recent Advances in Novel Drug Delivery Systems" http://www.azonano.com/article.aspx?ArticleID=1538

FIGURE II.5 **Indian generics industry**

Indian generics industry (growth and forecast)



Indian generics around the globe

- India exported drugs worth USD 11.6 bn in 2014-15. Of this, exports to US alone was USD 3.8 bn. India was the largest contributor to global generics market with 20% of global generic medicines market exports in terms of volume
- Between 2011 and 2015, Indian ranked #2 in the world (after the United States which had 40% share) with market share of 37% of all abbreviated new drug application (ANDA) approvals[1)]
- Two of India's largest generics companies feature in the global top 10 generic companies by market share in 2014
  - Sun Pharma with 6% share of global market ranks at number 5 and Lupin ranked 10th with a 2.7% share of global market
  - Other Indian companies – Aurobindo Pharma, Cipla, Dr. Reddy's Laboratories are also present in the top 20 generic manufacturers around the globe

1) This enables a company to sell generic versions of innovator molecules in the US market

Source: Marketline Research; Statista Database; Press Reports; Secondary Research, Roland Berger

BertelsmannStiftung

(APIs)[a] and formulation development for dosage forms. SPARC, on the other hand, focuses on research into new chemical entities (NCEs) and novel drug-delivery systems (NDDSes) for global markets. While a first right of refusal is provided to the parent company for emerging market products, SPARC also has the freedom to partner with other companies and academic or research institutions.[17]

Product innovation is not only limited to the pharmaceutical industry; indeed, examples also abound in the areas of automotive and engineering. For instance,

a Any substance or combination of substances used in a finished pharmaceutical product (FPP), intended to furnish pharmacological activity or to otherwise have direct effect in the diagnosis, cure, mitigation, treatment or prevention of disease, or to have direct effect in restoring, correcting or modifying physiological functions in human beings. Source: World Health Organization (WHO), July 2011.http://www.who.int/medicines/areas/quality_safety/quality_assurance/DefinitionAPI-QAS11-426Rev1-08082011.pdf

Case study 3:

GreyOrange: Product Innovation

GreyOrange, a Gurgaon-based start-up launched in 2011, provides automated on-demand robotic services for warehouse management and logistics. The company has two main offerings, a butler and a sorter. The butler is a bi-directional robot which can lift up to 500 kilograms, "walk" around the warehouse, and pick up and carry material storage units (MSUs) to the operator, saving time and effort and avoiding human error. The sorter is a high-spewed sortation device that can sort through even non-standard packages that lack accurate dimension and weight data at speeds of 1,500, 3,000or even 6,000 packets per hour.[18]

The firm, which is one of the few robotics start-ups in India, is not limiting its sights to the Indian market alone. Indeed, Wolfgang Hoeltgen, the company's co-founder, seed investor and mentor, believes there is huge global potential for the firm's innovations.[19] Moreover, the firm's institutional investors are very bullish about GreyOrange's potential in the global market. According Blume Ventures Managing Partner Karthik Reddy, "We haven't scratched even the surface of any market – India or otherwise. Different products have appeal in different markets at different times. Like any good market, if there's much demand, there will be investment and there will be competitors. It's not about first-mover advantage. It's about building a culture of innovation at scale in an area like robotics. Tapping into an incredible raw young pool of talent in India gives GreyOrange a vantage position to keep ahead of the curve. This is a multi-decade company that's just getting started."[20] The company's clients include large conglomerates such as Mahindra, large Indian e-commerce players such as Flipkart and Snapdeal, and global logistics players such as Kerry Logistics and DTDC. GreyOrange competes with global players such as U.S.-based Kiva Systems (acquired by Amazon for USD 775 million) and Swisslog (acquired by global robot maker KUKA for USD 357 million).

Combining high-tech software skills with hardware, GreyOrange is busy automating the warehousing industry in India

GreyOrange operations

- GreyOrange is a new age robotics start-up which designs, manufactures and deploys advanced robotics systems for automation at distribution and fulfilment centers
- It offers a unique combination of **hardware and software** and aims to organize one of the most un-organized sector in India – Warehousing

GreyOrange advantage

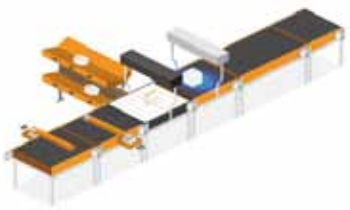
- Highly under-penetrated segment, GreyOrange owns **90% of the market share** in Indian warehouse automation market

GreyOrange product offering

The Sorter

Advanced automated storage and goods-to-man order picking system to handle high volume orders

The Butler



Advanced outbound parcel sortation system capable of handling packages of all sizes

GreyOrange client base

Kerry Logistics, Jabong, Flipkart, Aramex, DTDC, Mahindra, Gojavas

International footprint

- GreyOrange is bullish in its expansion, currently has footprint in India, Singapore and China; is facing tough competition from Swisslog, Kiva Systems and Fetch Robotics

Source: Company website; Secondary Research, Roland Berger

the Tata Ace, a small truck, was a response to the need for a small goods carrier for last-mile distribution. Its release gave birth to a new small-commercial-vehicle segment in India. Indian start-up IdeaForge has developed one of the lightest unmanned aerial vehicles (UAV) in the market, which can be used both for military and civilian applications (see case study in Section II-E). Another start-up, GreyOrange, is innovating in cutting-edge areas such as robotics and automation.

4. Process innovation

Process innovation typically refers to innovations in a business process. This process may be at any part of a company's value chain, from the procurement of raw materials or design process to the manufacturing, sales and even after-sales processes (e.g., customer engagement and retention). While it is often perceived as an unglamorous type of innovation generating incremental value, process innovation is critical, and can be an important precursor to product innovation and a source of competitive advantage.

Driven by the historical need to conserve resources and minimize waste, Indian companies have excelled in process innovation. Examples of Indian prowess in this area have been seen in industries such as pharmaceuticals, engineering, steel, agrochemicals and even IT-enabled services.

While process innovation is not as visible to end consumers as product innovation, it is valued and recognized by global customers, who are increasingly seeking out speed to market, operational efficiencies and production economies.[21] Kumar and Puranam point out that the nature of process innovation in India is unique, since the people working in these ostensibly less glamorous industries in India are typically more qualified than their counterparts in other countries. Therefore, these employees are able to apply their training and intelligence to what are considered "mundane" process innovations, making the companies they work for more competitive and sometimes even generating new products and services.[22]

5. Business-model innovation

Business-model innovation refers to how a company delivers value to its customers and partners. Globally, business-model innovation is becoming more relevant

Case study 4:

IndiGo[23]

IndiGo is a low-cost Indian airline that offers "economy plus" service at economy rates. Through optimizing its processes and implementing apparently small but high-impact innovations, IndiGo has emerged not only as the airline with the largest market share in India (38.4% in fiscal year 2016[24]), but also as one of the few profitable airlines in the intensely competitive Indian civil-aviation industry. The company has focused very tightly on one of the key customer needs for any airline – that of being on time. Its tagline, "Being on time is a wonderful thing," has become justifiably famous.

The firm has developed a robust back-end infrastructure to achieve its promise of always being on time. It has created an "aircraft communication addressing and reporting system" – a digital data link to convey short messages about flight status and other key information between the aircraft and ground stations via satellite.[25] In addition, many other processes have been optimized. To drive on-time performance and fast turnaround times, particular emphasis is placed on recruitment standards and training for all IndiGo personnel. IndiGo employees understand the importance of these factors for the overall success of the airline, and their compensation is tied to turnaround times and fleet utilization. Streamlined service activities in the airport (e.g., check-ins a minimum of 45 minutes prior to departure, a zero-tolerance policy regarding carry-on baggage) are explained by friendly yet firm customer-facing personnel, thus minimizing boarding disruptions.[26] The on-time mantra is facilitated not just by the ground staff, but also by the in-flight crew –the pit-stop approach to aircraft cleaning ensures that aircraft can be reboarded just 20 minutes after arrival for domestic flights.[27] The company also introduced step-less ramps to cut down on boarding time for regular and physically disabled passengers.

These innovations have led to industry-leading flying times as well as airport turnaround times. According to global flight-tracker statistics, IndiGo operated 22,300 flights in April 2016, with 82.94% of them arriving on-time, a cancellation/diversion rate of 0.02% and an average delay of 31 minutes – the best in India.[28] Process innovations and meticulous attention to detail have allowed the airline to position itself as a reliable and business-friendly value airline, rather than a reliance on aggressive discounting.[29] IndiGo's unique and highly efficient operating model is a gold standard in the industry today, and has not been replicated by competitors. Moreover, its efforts are clearly paying off –the company achieved a 50% increase in customers in the last several years, from 22 million in 2014–15 to 33 million in 2015–16.[30]

for two main reasons. First, there is increasing pressure to open up new market segments in new and existing markets. Second, technology and the VUCA world are regularly displacing incumbents, making it vital to reassess business and operating models continually in order to align them to industry and macroeconomic environments. Given that business and operating models are a function of the external environment in which they operate – for example, by reflecting regulatory constraints in a particular market or local consumers' willingness to pay for a product – they are not easily replicated in other parts of the world without requiring some adaptation to the local market.

India, like many other emerging markets, can be a challenging economy in which to do business. Given the institutional gaps (poor supply chains and infrastructure, business and regulatory hurdles), underpenetrated markets, low disposable incomes and poor purchasing power, companies in India have been forced to re-conceptualize their offerings to succeed in the Indian market. This has also driven companies to develop additional service offerings or modify their traditional business models in order to drive greater adoption or market penetration. We find a plethora of examples here among Indian and global companies both large and small, established and in the start-up phase.

Uber is an example of a global player that had to make significant enhancements to its service offerings in India in order to achieve greater market penetration, comply with domestic regulations and create a positive business case for its partners, the vehicle owners and drivers. In order to attract customers, the Silicon Valley company started accepting cash as a mode of payment, discounted fares and introduced a lower-end hatchback offering under a new brand, UberGo. In order to comply with the Reserve Bank of India's two-factor authentication regulation,[a] the firm developed a mobile-wallet innovation in partnership with mobile-wallet provider Paytm. Moreover, to allay fears regarding passenger safety, the firm developed an SOS safety feature that has now been exported to 50 emerging-market cities, and is further offering WiFi in cars in response to the erratic mobile-phone network coverage in some parts of the country.[31] For drivers and aggregators, the company provides a number of incentives such as medical insurance, in addition to providing support in obtaining favorable financing terms. Moreover, press reports indicate that Uber has itself started leasing cars to drivers in an effort to attract and retain them.[32]

a Two-factor authentication is a Reserve Bank of India imposed regulation which stipulates an extra layer of security at the user interface, along with the credit card information and CVV number, the user needs to enter another security code which only the user has access to.This second factor or code can be in the form of a one-time-password or a secure personal identification number (PIN) etc.

Case study 5:

Thomas Cook[33]

Thomas Cook, one of India's largest travel and travel-related financial-services company, has been presented with an opportunity and a challenge – that of the travel-hungry yet increasingly value-conscious Indian consumer. The company also faces stiff competition from online travel aggregators and airline companies. Recognizing the need to enhance its value proposition and stand out in this crowded marketplace, the company engaged in deep consumer research and analytics. Consumer research revealed that Indians tend to be unwilling to take out a loan in order to finance a holiday, forcing the company to think more creatively. In response, the firm developed its innovative Thomas Cook Holiday Savings Plan.

This new offering aims to drive greater penetration among the middle-class segment. Customers seeking to purchase a Thomas Cook packaged-holiday option at a predetermined price can set up a recurring-deposit account at one of four banks. The customer makes a fixed monthly installment for 12 months, earning interest at an annual rate of up to 7.75% (significantly higher than on a typical savings account). Thomas Cook tops up the account with a 13th installment. At the end of this period, the customer will have accumulated the funds required for the selected holiday package. Further savings accrue to the consumer as the holiday is booked at the current price for use the following year, thus making it inflation-proof. The Holiday Savings Plan includes airfare, transfers, accommodation, all meals, sightseeing and taxes for 15 holiday destinations, both in India and abroad. This innovation has a number of benefits: It creates an opportunity for the quintessential late-booker traveler to book as early as 13 months in advance, while allowing travel agencies to pre-book and bulk-buy inventory at discounted or negotiated rates, passing this benefit on to consumers in turn. This mixed product/business-model innovation was the first of its kind in the world, according to Thomas Cook, and in a span of a year, the company has already built a customer base of more than 13,000 travelers.[34]

Case study 6:

Rivigo[35]

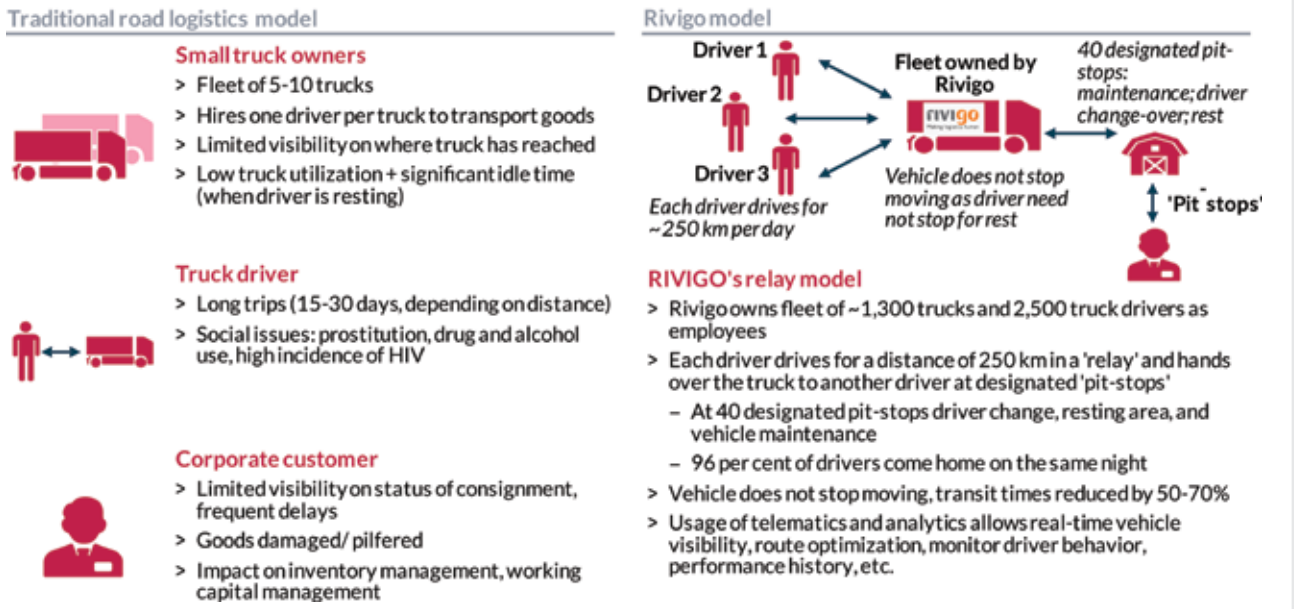
Rivigo, a start-up launched in 2014, is revolutionizing road logistics in India. The company quickly realized that in order to succeed in the logistics business in India, it had to do things very differently. The traditional road-logistics industry creates significant stress on both the truck driver and the B2B customer. The sector is quite fragmented, and small truck owners typically own a fleet of five to 10 trucks and hire drivers externally – one driver per truck to drive from point A to point B. This has a number of consequences. First, the consignment is entirely dependent on one truck driver. There is limited visibility with regard to delivery status, and breakdowns and other interruptions result in frequent delivery delays. This produces additional challenges in areas such as inventory and working-capital manage menton the customer's end. For the driver, who may have to cover distances as long as 2,000 to 3,000 kilometers for a journey spanning the length of the country, this means being on the road for 20 to 30 days at time, living in the truck. This also has a number of social ramifications, including solicitation of prostitutes, drug and alcohol abuse, and a high incidence of sexually transmitted diseases, including HIV.[a] In addition, since the typical compensation for a truck driver is as low as USD 120 per month, pilferage of diesel fuel and/or the transported goods is also fairly common.

Rivigo's unique business and operating model addresses both customer and driver needs. The firm has developed a "relay" model for drivers along with a network of "pit-stops" across the country. Each driver drives an average of 250 kilometers a day to a designated pit stop, where he hands over the vehicle to the next driver, rests, and returns home the same night. This has allowed the company to significantly improve quality of life for its 2,500 truck drivers. At the pit-stop, the vehicle undergoes routine maintenance and then continues on to the next destination. Under this model, the vehicle is on the move for 22 hours out of every day, resulting in significant vehicle-efficiency increases and a reduction in delivery and transit time by 50% to 70% compared to typical fleet operators.[36] Moreover, with a fleet of 1,500 of its own vehicles, leased pit-stops, and the use of telematics and analytics developed in-house, the company is able to offer increased levels of reliability and significant value-add to its B2B customers. For example, Rivigo monitors the temperature of refrigerated shipments; tracks security, location and driver safety; and closely monitors the maintenance requirements and schedule of each vehicle. The feedback from customers, which include e-commerce, fashion, automotive, frozen-food and other businesses, has been highly positive thus far and the firm is planning to expand its fleet size to 2,500 trucks and 5,000 drivers in the coming years.[37]

It is important to note that while some business-model innovations are specific to an emerging-market context, many can be exported to developed markets too. For example, Rivigo's relay model could be applied in many developed markets to make road logistics more efficient and provide truck drivers with a better quality of life.

a According to the National AIDS Control Organization Report 2014–2015, 2.6% of the 2 million truck drivers in India suffer from HIV.

Comparison of traditional road logistics model in India vs. Rivigo "relay" model



Source: Primary Interviews, Roland Berger

6. Key takeaways

- *Innovation in India is real and is increasingly gaining momentum.*

- *Not all innovation is truly novel or breakthrough; some may even appear to be mere "copy-paste" versions of tried-and-tested products and business models from abroad. But this is a natural and inevitable part of an emerging market's economic development path.*

- *Working in a resource-constrained country with price-sensitive consumers, Indians have mastered the art of frugal innovation. Frugalitythus informs the underlying mindset of companies in India as they innovate for Indian or global customers, for mid-market segments as well as for BoP customers.*

- *India's strength lies in its five distinct innovation types: innovation as a service, globally segmented innovation, product innovation, process innovation and business-model innovation. Indian and global multinationals, start-ups and established players across a variety of industries actively pursue each of these innovation types in India.*

  - ***Innovation as a service:*** *India has become one of the world's leading providers of contract R&D services. While some of these companies may have started off as mere "body shops" 25 years ago, they have moved up the value chain, today providing high-end managed services.*

  - ***Globally segmented innovation:*** *Multinational-owned R&D centers in India that form a key element in their parent companies' global innovation agendas are crucial to India's innovation ecosystem, due to their associated know-how, system and process spillovers. Indian firms too segment their innovation work across multiple geographies in order to leverage the infrastructure and skill advantages in each location.*

  - ***Product innovation:*** *There are few Indian examples of "first in the world" globally scalable product innovations. However, even if not always disruptive, a significant amount of product-development innovation is being performed in India by Indian and multinational companies. Examples abound in the automotive, engineering, pharmaceuticals and biotechnology sectors, among others.*

  - ***Process innovation:*** *Driven by the historical need to conserve resources and minimize waste, Indian companies have excelled in process innovation. Examples of Indian prowess in this area have come from industries such as pharmaceuticals, engineering, steel, agrochemicals, and even IT-enabled services.*

  - ***Business-model innovation:*** *As India is a diverse country with a complex business ecosystem marked by institutional gaps (poor supply chains and infrastructure, business and regulatory hurdles), companies have been forced to innovate through new or modified service offerings, and by modifying business models to drive greater adoption and market penetration.*

D. Types of innovators in India

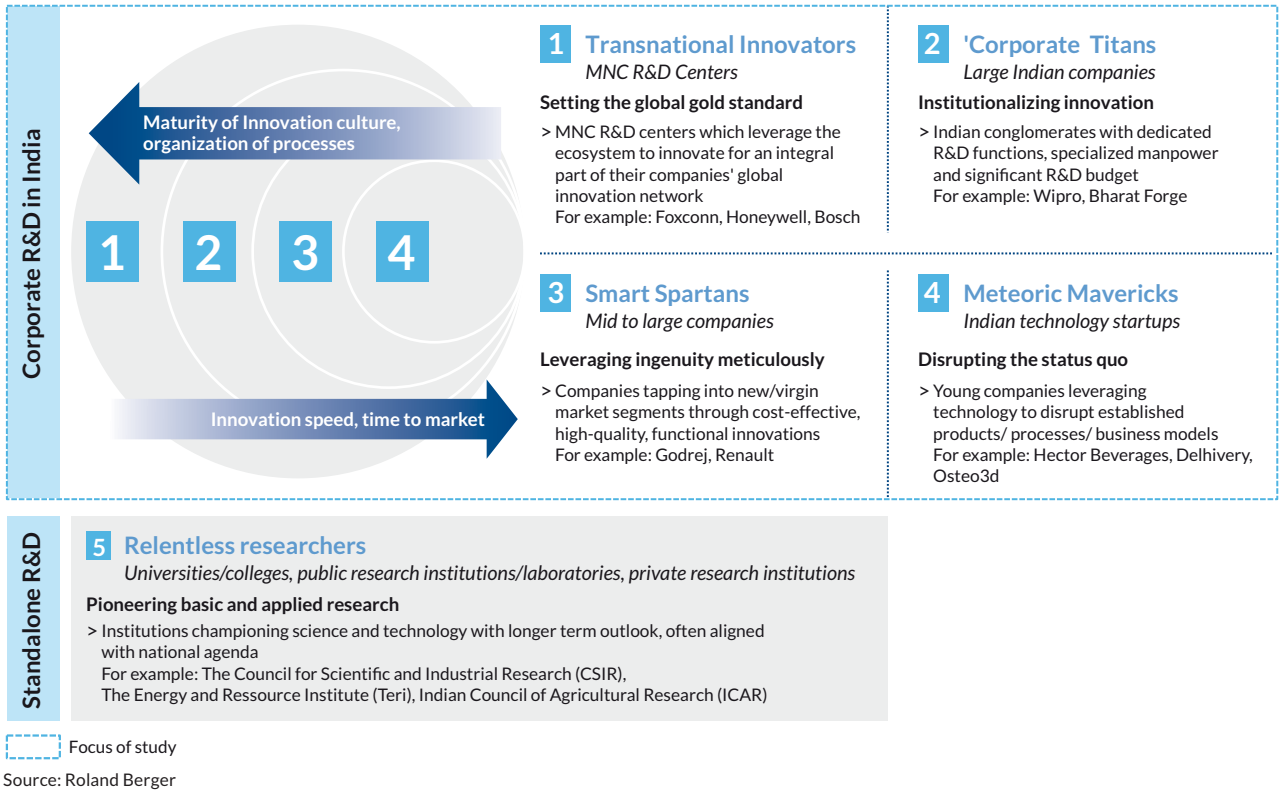
Companies are at the heart of most innovation ecosystems around the world. This is true even to a disproportionate degree in India, given the limited role played in the innovation landscape by research institutions and universities (see Section II-D 5 for more details). Through our interviews and secondary research, we observed that companies of widely varying shapes and sizes are engaged in innovation, each with their own agenda. While no two organizations are identical, we found that companies passionately pursuing innovation tend to fall into four distinct categories in India (see Figure II.6). A fifth category includes innovative public and private academic and research institutions.

1. Transnational innovators

Multinationals innovating in India do so either with the aim of succeeding in the Indian market, driving their global innovation agenda, or both. While reasons for innovating in India vary, the top two reasons for doing so are to improve revenues and to open up new market segments, as reflected in Figure II.7.

India is currently home to more than 1,000 multinational-linked R&D centers, with a total of 928 multinational parent companies. Software and internet companies account for the largest chunk of these (43%), followed by electrical and electronics(9.8%), telecommunications and networking (8.3%), and automotive (6.8%) companies. While most of these R&D centers began as offshore engineering-support centers, the mandate for a number of them has gradually matured toward product stewardship (see Figure II.8 and Figure II.9).

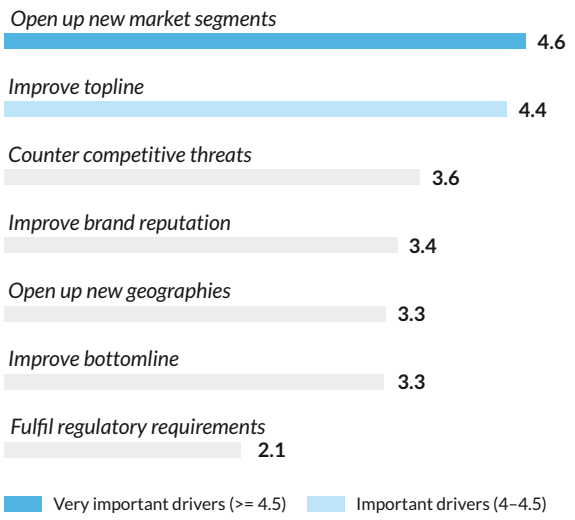
FIGURE II.6 **Five faces of innovation in India**



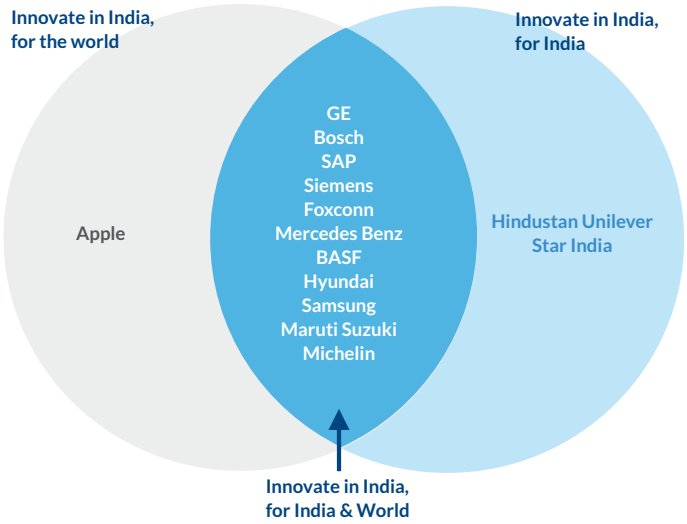
Source: Roland Berger

FIGURE II.7 **Importance of innovation for multinationals' key business drivers**

Avg. importance of innovation for key business drivers [1=no impact, 5=critical for success]

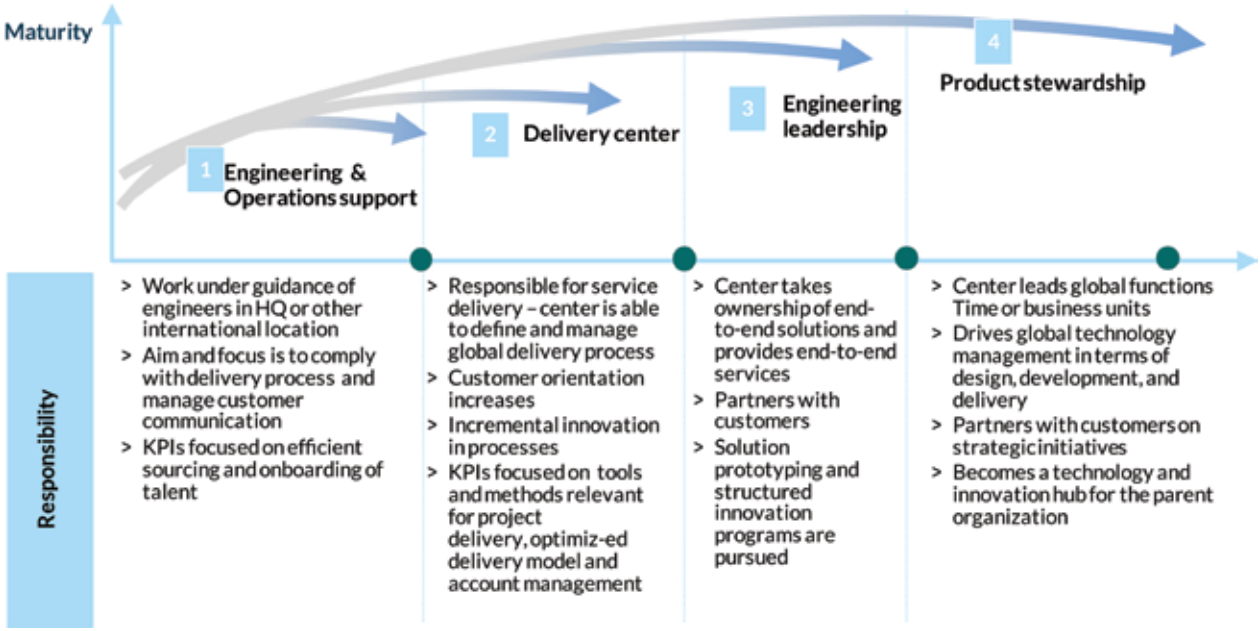


Types of MNCs innovating in India



Source: Survey done by Roland Berger (January 2015–April 2016); Company interviews; Roland Berger

FIGURE II.8 **Maturity model for in-house R&D centers**



Source: Interviews, Secondary research, Roland Berger

Case study 7:

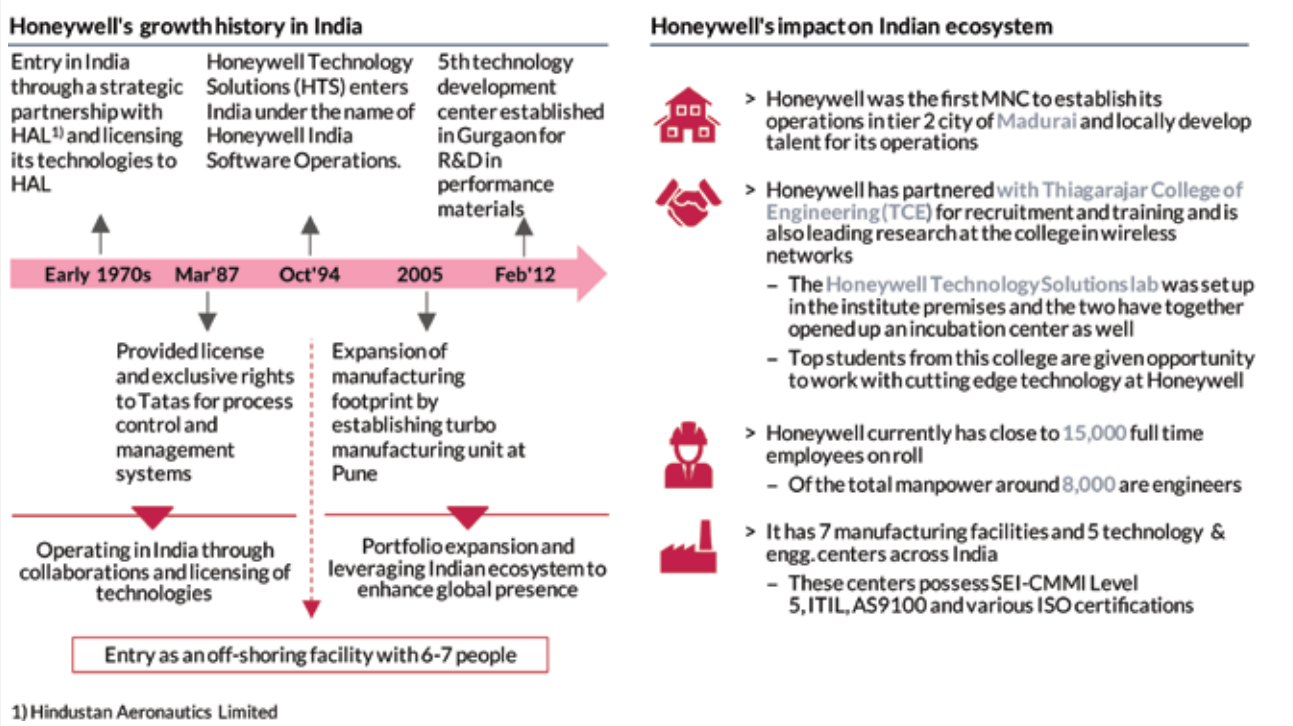
Honeywell

Honeywell India is a subsidiary of Honeywell Inc., an American multinational that manufactures engineered goods for applications in the aerospace, oil and gas, automotive, and heavy-engineering sectors, among others. Its presence in India has evolved from a licensing model to pure offshoring to its present development of technology within the country for use within its global operations. It has established five engineering centers in the country, and currently has a total full-time employee count of 15,000, of which 8,000 are engineers.

Honeywell was the first multinational to set up an R&D center in a tier 2 Indian city such as Madurai. Seeking to leverage the local talent pool and create an innovation-friendly ecosystem, Honeywell partnered with Thiagarajar College of Engineering for recruitment and training, and is also leading research at the college in wireless networks. It has set up a Honeywell Technology Solutions lab on the institute's premises, and has opened an incubation center in partnership with the institution. Top-performing students from this college are thus provided with the opportunity to work on cutting-edge technologies at Honeywell.

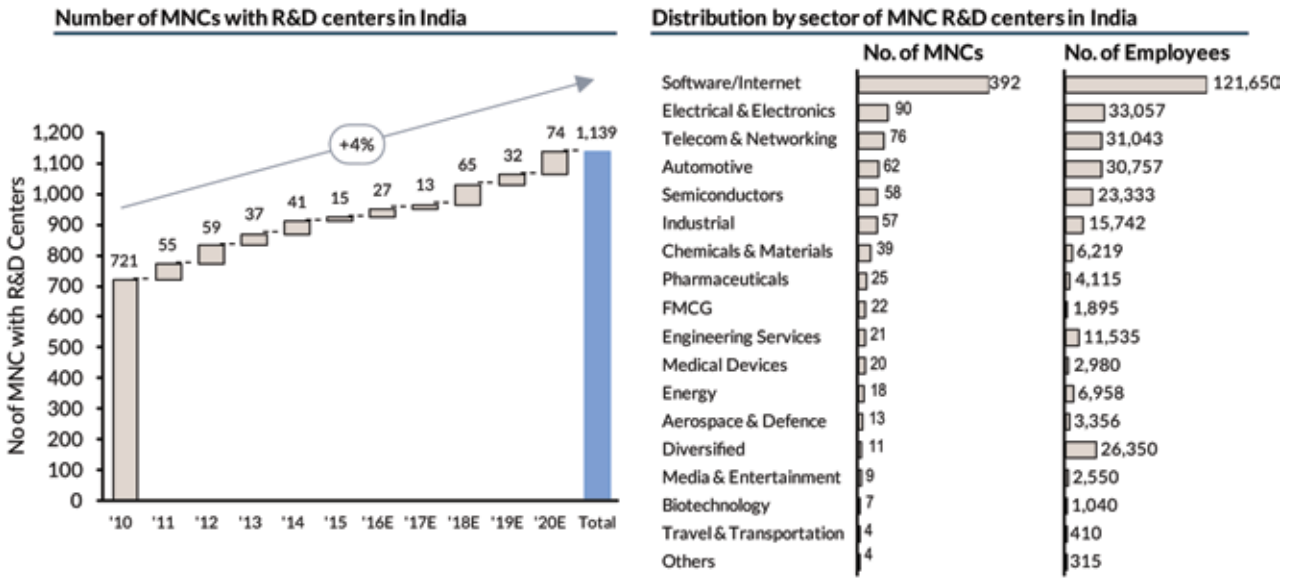
Former Honeywell President Anant Maheshwari explains that "India is a strength for us – we solve some of the toughest problems in the world with the help of more than 8,000 engineers in India. We have engineered more than 3,000 new products, solutions, and applications from this country." The Indian R&D centers have supported product development for India-specific innovations such as the turbocharger for the Honda Amaze, Honda's first compact sedan in India, and the first with a diesel engine.[38]

Honeywell has moved from licensing to offshoring to developing tehnology in India and is the first MNC to leverage tier 2 city talent



Source: Company website; company report; Roland Berger

FIGURE II.9 **Growth and sectoral profile of multinational-linked R&D centers in India**



Source: Zinnov Consulting report, "India MNC R&D Talent Pool Study" available at http://zinnov.com/executive-summary-talent-report/

In addition, scores of multinationals are engaging in innovation in India even without formal R&D centers. Companies like Foxconn, for example, are developing new products and services for Indian customers (see Case study 8).

Case study 8:

Foxconn

Foxconn has pledged to invest USD 5 billion in India, and plans to set up a 1,500-acre manufacturing unit and R&D center in Maharashtra.[39] Foxconn Chairman and CEO Terry Gou has stated, "In India we just don't want to limit ourselves to manufacturing, but want to apply new technology like industry 4.0. You have strength in software, we will merge it with our hardware expertise."[40]

The anchor of Foxconn's India strategy is the Digital India campaign. The firm, which manufactures servers, digital boxes, cloud systems and internet-of-things (IoT) devices, is in discussion with the central government and a few state governments to develop hardware solutions (for example, leveraging fiber optics to provide Wi-Fi connectivity in villages) able to connect the remotest villages in India to the rest of the country. Moreover, the company is also developing affordable biometric-enabled smartphones (with an iris-scanning camera), which would enable people in rural areas to access phone-based banking, e-education and civic services, and government subsidies, while minimizing theft and pilferage. These innovations are not focused on India alone; indeed, they could have a large reverse-innovation potential, particularly in other emerging markets.[41]

2. Corporate titans

These are large established Indian companies, generally among the leaders in their respective industries. Having succeeded in the Indian market, these companies recognize that they will need to be able to succeed within global markets to build global scale. For this, they understand, innovation is critical. They therefore invest significantly in R&D and employee development, and have established innovation processes. Corporate titans can be found in a wide array of industries in India, and include large-scale Indian conglomerates such as the Tata Group, ITC, Mahindra & Mahindra, Reliance, Godrej and the Kalyani Group, as well as large standalone companies such as Pidilite, Ambuja Cements, Sun Pharmaceuticals, Biocon and Wipro.

Corporate titans have a few characteristics in common. Since they often compete with multinational giants and each other, they realize the importance of investing in innovation. This not only means financial investment, but also investment in the establishment of platforms and processes. They also realize the importance of attracting, developing and retaining top talent, as these employees will drive their innovation agendas forward. Many such companies have set up multiple innovation platforms within their organizations, matching and in some cases even outperforming their overseas counterparts. For instance, many of the companies we interviewed, including Tata Motors, Mahindra and Wipro had multi-tiered innovation platforms

3. Smart spartans

The smart spartans are mid-size to large organizations that have championed frugal innovation. These firms are successfully tapping into new or virgin market segments through cost-effective, high-quality and functional innovations.

Smart spartans are driven more by market pull than by technology push. They invest a limited set of resources in the development of product and service offerings that are attuned to customers' needs at a predetermined price. Every aspect of the product is deeply considered, including maintenance requirements, durability and ease of use. Since resources are limited, these companies typically innovate using a structured, stage-gate and time-bound process. Timelines are typically shorter than is the case for conventional products, given that time often results in more resource use, and therefore investment. While frugal innovation is often spoken of in the context of products, smart spartans are not exclusively product companies – they apply frugal principles to service offerings and business models too. Many companies interviewed believe that this frugal approach is one of the competitive advantages of innovating in India, as it allows them to adapt to a wide range of external circumstances.

Not all smart spartans are mid-sized Indian firms with limited resources to invest in R&D and new-product development. In some cases, larger Indian firms with deep pockets have also developed frugal innovations in order to cater to a wider set of customers. Moreover, while large Indian conglomerates such as the Tatas (examples include the Tata Nano and Tata Swach) and Godrej (Godrej Chottukool, Good Knight Fast Card) may have pioneered this concept in parallel with smaller, more specialized Indian companies (Aravind Eye Care, Jaipur Foot), foreign multinationals are beginning to realize the potential of frugal innovation. In fact, a recent Roland Berger survey that included more than 60 global participants from the heavy-industry, automotive, consumer goods, pharmaceuticals, services and other industries clearly showed that in terms of percentage of sales, frugal products are likely to grow from their current level of 12.3% to 22.3% of sales in five years. In terms of percentage of profit, frugal products contribute 10.4% to the bottom line today, but will account for an estimated 18.4% of corporate profit in five years.[42] These results are homogeneous across industries and clearly indicate the growing importance of value-oriented customers in developing as well as emerging markets. Not only are foreign multinationals interested in frugal innovations, they believe that India is the best place to pursue this form of activity. Honeywell President and CEO for Global High Growth Regions Shane Tedjarati says, "As a company, we want to have India as ground zero of innovation and production of the emerging new middle-class products and services, to serve the Indian market and the emerging middle class coming up behind India in the rest of the world."[43]

The story of GE's Mac i electrocardiogram (ECG)[a] machine is comparatively well-known. However, companies such as Siemens, Renault Nissanand Unilever are also developing frugal innovations in India. Even more interestingly, these companies are developing these solutions not just for emerging markets, but are also planning to sell these to specific market segments in developed markets. This practice, referred to as reverse innovation,[44] is gaining traction among a number of multinationals seeking to create differentiated strategies within developed markets.

a ECG is short for electrocardiography, which is the process of recording the electrical activity of the heart over a period of time using electrodes placed on the skin.

Case study 9:

Wipro's corporate innovation strategy

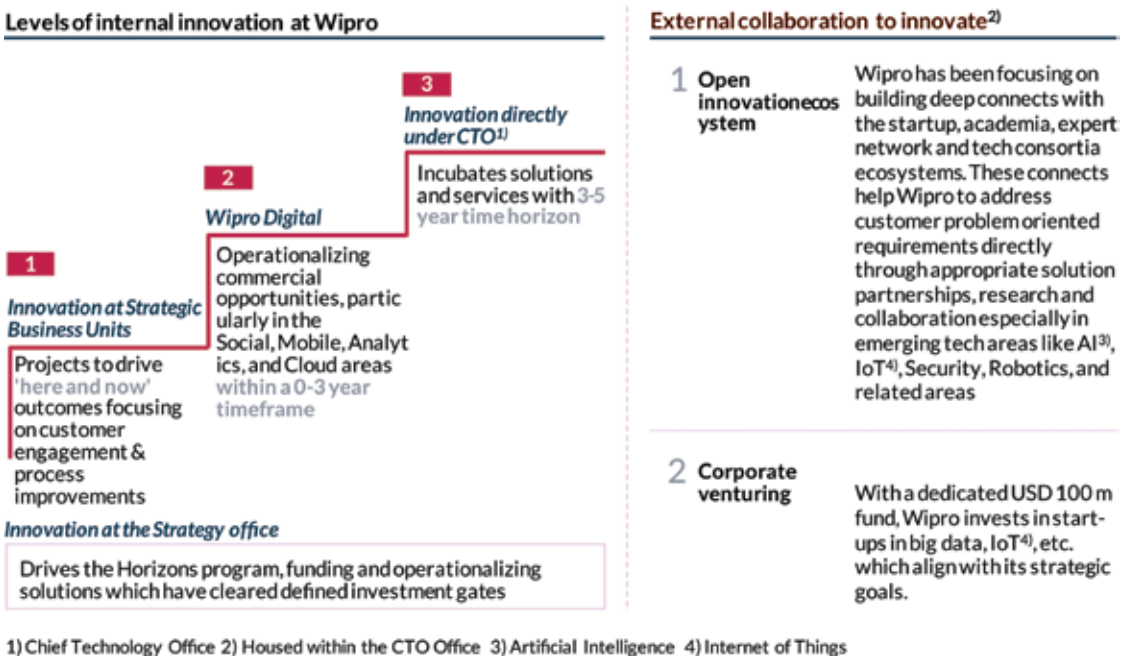
Wipro is a global IT, consulting and outsourcing company headquartered in India. With a workforce of more than 170,000 people, the core of the company's operations is IT services. However, as it has sought to maintain a competitive advantage despite intensifying competition from domestic and international companies, Wipro has realized the importance that innovation and internationalization have for its future. In consequence, the company has utilized a multi-pronged approach in creating its innovation culture, developing a systematic innovation function that looks both at internal and external innovation platforms.

Internally, Wipro has several different vehicles for innovation depending on the level and time horizon for a given initiative. Each strategic business unit (SBU) selects and pursues its own innovation topics – typically focusing on customer engagement and process improvement. The office of the chief technology officeroverseas the incubation of innovation-themed solutions and services, typically over a three- to five-year time horizon. Wipro Digital is focused on operationalizing commercial opportunities over a zero- to three-year time frame, particularly in the social, mobile, analytics and cloud-computing business areas. The company's Strategy Office drives the Horizons program, which funds and operationalizes solutions that have cleared defined investment gates.

By contrast, the company has also established a Wipro External Innovation Group, working from the premise that "not everything needs to be built inside the organization. There is so much cutting-edge work happening outside, and we need to leverage these capabilities." Wipro's Open Innovation initiatives seek to establish connections and deep relationships with start-ups, expert networks, academic institutions and industry technology consortiums, all with the aim of helping Wipro address customers' innovation requirements. By integrating these different capabilities into its own ecosystem, Wipro is able to effectively and rapidly apply emerging and new technologies in order to enhance and differentiate its market offerings. Wipro has also set up an investment arm that focuses on strategic investments in selected enterprise-solution start-ups. These are typically minority investments, with the ultimate goal of building deep strategic partnerships rather than of acquisition.

These efforts seem to be paying off. The company has recently developed cutting-edge technology platforms in areas such as artificial intelligence, IoT and big data. In 2015, the firm won the Aegis Graham Bell award for Innovation in IoT.

Within its two pillars of internal and external innovation, Wipro undertakes projects of varying scope/ impact and with multiple stakeholders



1) Chief Technology Office 2) Housed within the CTO Office 3) Artificial Intelligence 4) Internet of Things

Source: Company interviews; Secondary research, Roland Berger

Case study 10:

Godrej Consumer Products Limited (GCPL)[45]

The Godrej Group, a USD 4 billion Indian conglomerate, has embraced the philosophy of frugal innovation across a variety of its products, from portable refrigerators for rural areas to hair dyes and mosquito repellents. The company has done this using a clean-slate approach, starting by gathering deep insights regarding consumers' needs and desires, and subsequently developing new manufacturing processes, using local suppliers to create packaging and production tools, and increasing productivity overall.

The consumer-products division, GCPL, applied a frugal innovation approach to the development of its runaway hit, the FastCard. Leveraging its Indonesian acquisition, Hit (a line of insect repellents), the company developed a one-rupee (1.5 cents) solution enabling farmers in rural India to get a night of mosquito-free sleep by burning a single sheet of paper. The company collaborated extensively with suppliers to achieve this target price. In the traditional process, the paper was sprayed with a water-soluble reagent to increase the paper's flammability, dried, sprayed a second time with oil containing a mosquito-killing agent, and then dried again. This four-step process was replaced by integrating the whole procedure with the paper-pulp drying process, thus reducing the time needed to manufacture each strip. Moreover, since the active ingredient was known, so were potential chemical barriers, and GCPL worked with the supplier to design a plastic sachet that did not have to undergo a lengthy trial process. The Fast Card was a huge commercial success, generating nearly USD 20 million in revenue within its first 18 months of launch. Moreover, it created a whole new category of repellents in the market. Successes such as this one have made the company a firm believer in the frugal innovation process. As Sunder Mahadevan, the company's head of R&D says, "When you go back to basics and avoid doing anything that does not add value, the sky is the limit."

GCPL has used the frugal-innovation approach to cater to BoP market segments, but its development of strong value propositions at attractive price points has also created new market segments. For instance, the company was successfully able to upgrade its hair-powder customers from the mass-market segment to the so-called masstige (a portmanteau of "mass" and "prestige") segment, driving consumption of its product at a higher but still affordable price. Today, GCPL sees itself as a global company with a strong focus on fast-growing emerging markets. "Our whole strategy here is simple. We look at untapped, newly to-be-created market segments, [seeking] to grow volume and disrupt the market, rather than at taking market share from existing players, "explains Sunil Kataria, GCPL's business head for India and SAARC (South Asia Association for Regional Cooperation).

4. Meteoric mavericks

The meteoric mavericks are India's start-ups. India is home to the world's third-largest start-up ecosystem, with 4,200 start-ups (narrowly trailing the United Kingdom, with its 4,500 start-ups).[46] The country is also home to nine "unicorns," start-ups with a valuation of USD 1 billion or greater within 10 years of being founded.[a] The start-ups are largely concentrated in three hubs across the country – Bangalore, Gurgaon and Mumbai – although cities like Chennai, Hyderabad and Pune are also witnessing some start-up activity.

The most popular start-up domains are e-commerce, enterprise software, aggregators, consumer services and hyper local e-commerce. While the majority are business-to-consumer (B2C) and have a services focus, a small but growing number of Indian start-ups are also working in areas such as augmented reality, IoT and robotics. Moreover, the e-commerce boom has also given rise to a number of e-commerce enablers working on topics such as big data, logistics and supply-chain management. The start-up mavericks typically have lean teams, leverage technology well, have a strong focus on customer needs, understand the importance of speed to market and have a desire to disrupt conventional business models. When asked why they innovate, they overwhelmingly answer that it is crucial to their survival. Unlike the larger and more established Indian firms and multinationals, these start-ups typically lack a separate innovation-focused vertical or function. Instead, they believe that every aspect of their business must constantly be innovating and reinventing itself.

For instance, at Hector Beverages, the Indian beverages start-up behind Paper Boat and Tzinga, "adaptability" and "daily innovation" are among the organization's core values. Whether it's the taste of its top-selling mango juice, or the design and usability of its bottle screw cap, the company spends considerable time and money focusing on

a According to the Wall Street Journal, the United States is home to 88 unicorns, while Europe is home to 16.
Austin, Scott, Chris Canipe and Sara Slobin. "The Billion Dollar Startup Club."The Wall Street Journal and Dow Jones VentureSource, 18 February 2015. http://graphics.wsj.com/billion-dollar-club/

Case study 11:

Osteo3D[47]

The 3-D printing space in India is small but fast-growing. Osteo3D is a Bangalore-based start-up launched in 2014 that manufactures products for customized patient-specific surgeries using 3-D printing technology. Osteo3D has chosen to specialize in 3-D printing specifically for cranial, orthopedic and maxillofacial surgeons. Among other products, the start-up has developed a 3-D-printed helmet for a five-month child suffering from craniosynostosis. [a]

In the course of just nine months, the company has participated in more than 140 cases in which its products have been used by Indian surgeons to increase accuracy and reduce lead times for complex surgical procedures. The start-up aims to significantly lower the cost and enhance the efficiency of complex pre-surgical, surgical and post-surgical procedures by offering custom, high-quality 3-D printed objects and proprietary cloud-based software solutions. Osteo 3D has developed proprietary software and processes that are capable of creating customized designs for implants with complex geometries and shapes that lower fabrication costs while ensuring appropriate functionality. The processes at Osteo 3D are compliant with the Health Insurance Portability and Accountability Act (HIPAA).[b] The company works closely with surgeons and other medical professionals to design products, ensuring high quality and affordability. The firm is expected to obtain ISO13485 certification by the fourth quarter of 2016. Osteo3D is also working toward developing proprietary cloud-based software that can be accessed anytime, anywhere, to generate customized 3-D printable objects. This project is expected to be completed by the end of 2016.

a This is a birth defect in which one or more of the joints between the bones of a baby's skull closes prematurely, before the baby's brain is fully formed

b The U.S. Health Insurance Portability and Accountability Act of 1996 (HIPAA) is concerned with the regulations protecting the privacy and security of certain health information, particularly patient data. Source: http://www.hhs.gov/hipaa/for-professionals/security/laws-regulations/

continuous improvement, thus ensuring that every aspect of its product is attuned to customers' needs. Delhivery, a Gurgaon-based start-up, has evolved from a hyperlocal delivery business to a USD 700 million logistics firm in a span of four years on the strength of four innovation pillars: business-model, process, hardware and data-driven innovation.

5. Relentless researchers

The relentless researchers are a group of public and private educational and research institutions that have been at the forefront of public research in India. Overall, the quality of public research in India is relatively low compared with countries such as the United States, Germany, Japan, South Korea and China. In terms of gross expenditure on R&D, India spends less than 1% of GDP, considerably less than countries such as the United States (2.8%), Germany (2.9%), Japan (3.4%), South Korea (3.6%) or China (2%).Moreover, while other countries spend around 60% of their R&D expenditure on development (80% in the case of China), and split the remainder between applied and basic research, in India, basic research accounts for more than 25% of the overall R&D spend, while the remainder is split nearly equally between applied research and development.[48]

While the number of success stories emerging from Indian academic and research institutions remains limited, pockets of excellence do exist. Academic institutions such as the Indian Institute of Science (IISc), the Indian Institute of Technology (IIT), and the Indian Institute of Science and Educational Research (IISER) are three successful examples. Of the public research institutions, the Indian Space Research Organization (ISRO), the Indian Council for Medical Research and some of the Council for Scientific and Industrial Research (CSIR) laboratories have been quite successful.

Case study 12:

Indian Space Research Organization (ISRO)

Set up in 1969, ISRO breaks the stereotypes associated with being a publicly funded, government-controlled R&D institution. Despite the constraints of limited funding and bureaucratic hurdles, it has consistently delivered breakthrough innovations, and is setting world records with its innovative outputs. The organization has set audacious targets in terms of delivery times and project costs, and repeatedly achieved them. ISRO has developed four key strategies it believes are critical to success. The first is to adopt a modular approach to every project. Every successful launch is based on a previously proven launch technology as a foundation, but this is modified and expanded depending on new targets and prior lessons. As a second strategy, the organization conducts rigorous ground tests. While this is a time-and capital-intensive process, ISRO optimizes the number of ground tests through rigorous testing and extracts the maximum possible in terms of lessons from each test. The third strategy is to maximize the use of software in the development of prototypes, running simulations so as to minimize the need for physical models. Finally, sticking to timelines is sacrosanct at ISRO – scientists and engineers work20-hour shifts if necessary to deliver projects on time.[49]

Over the years, many breakthrough innovations have emerged from the ISRO labs. The most prominent success was the Mars Orbiter Mission (MOM) – Mangalyaan, the cheapest interplanetary mission launched by any country. Moreover, it distinguished India as producing the first successful maiden attempt worldwide. Costing USD 75 million, Mangalyaan's mission was nine times cheaper than NASA's Maven mission, and five times cheaper than the EU's Meteoroid Environment Office (MEO). ISRO employed its philosophy of cost effectiveness, basing the whole project on the previously successful Chandrayaan 1 (India's 2008 – 2009 moon mission).[50] The equipment was manufactured using locally sourced materials, and the team focused on minimizing fuel consumption for Mangalyaan's launch. The orbiter took advantage of the gravity of the Sun, Earth and Mars, and was launched on a slingshot trajectory – using smaller rockets and less fuel than would otherwise be the case, and thus being more cost effective.

Nor does this story end with Mangalyaan. ISRO is also developing reusable satellite-launch vehicles for its portfolio. Once developed, these vehicles will be able to launch spacecraft including satellites into space, reenter the earth's atmosphere under conditions of severe heat and pressure, and land in an preselected spot.[51] Moreover, in April 2016, ISRO completed development of its own satellite-based navigation system, only the fifth country globally to do so. The Indian Regional Navigation Satellite System (IRNSS) is a group of seven satellites with a higher standard accuracy than that offered by the American GPS system.[52] The footprint of this satellite-navigation system will extend 1,500 kilometers (covering all of Asia, and extending to the fringes of Africa and Australia).[53]

Before concluding the section on the types of organizations innovating in India, it is important to point out that the Indian corporate sector is heterogeneous. While many companies are active in the area of innovation, there are also many that are not. Nor is this limited to a particular organization type or industry. In the course of our study, we came across a number of multinationals that have chosen to use India purely as a market or a manufacturing base, and have deliberately decided not to innovate in the country. Many large and small Indian companies are similarly uninterested in R&D. Doing R&D in India is a value proposition that requires careful analysis, and not all companies have the appetite to do so. While some manufacturing companies are active in process innovation as they seek to reduce costs and time to market, a large number do not invest in R&D at all. This is reflected in the fact that of the 0.9% of India's GDP spent on R&D, only 20% to 25% is invested by the corporate sector. In comparison, Chinese firms account for nearly 70% of the R&D spend in that country.

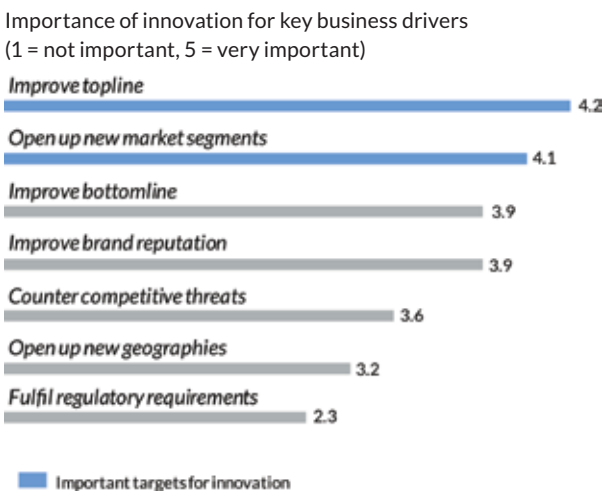
6. Insights from quantitative analysis

Our quantitative-survey results generate some interesting insights. First, we observe that regardless of their sector and stage of development, companies believe that innovation is critical to achieving key business objectives such as improving topline performance and accessing new market segments (see Figure II.10).

As seen in Figure II.11, we find that respondents almost unanimously rate themselves as "more innovative" than Indian peers. However, they have a mixed response when it comes to ranking their innovativeness vis-à-vis global peers. On an industry level, however, most respondents feel that the level of innovations within their own industry is below global industry standards.

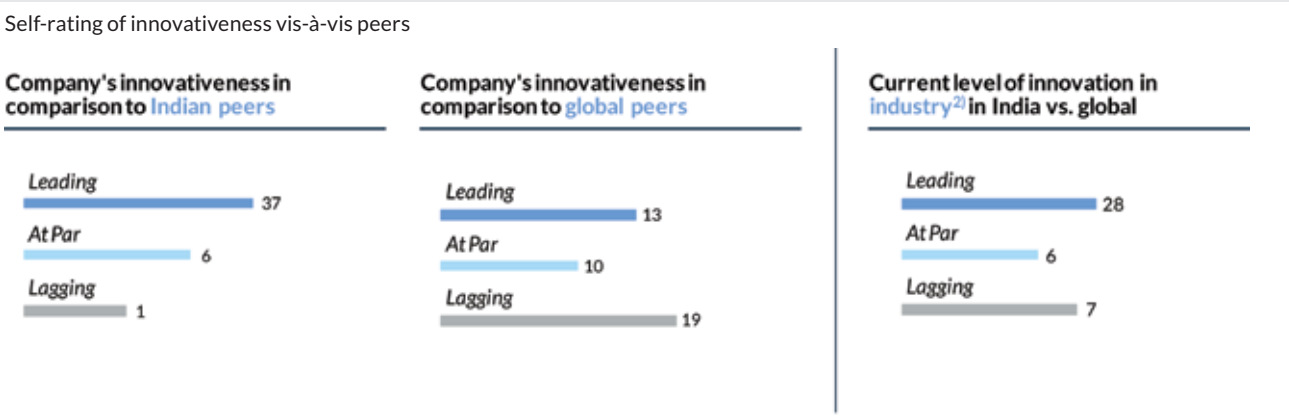
When asked to rank the advantages held by Indian companies vis-à-vis global multinationals with regard to innovation in India, interviewees identified lower cost structures and a superior understanding of the local market as their top choices. When the same question was asked with regard to the advantages held by global multinationals vis-à-vis Indian companies in terms of innovating in India, respondents identified the global companies' brands (or product brands) and technologies as being most important (see Figure II.12).

FIGURE II.10 **Importance of innovation for key business drivers**



Source: Roland Berger survey, January – July 2016

FIGURE II.11 **India Inc.: Innovativeness vs. Indian and global peers**

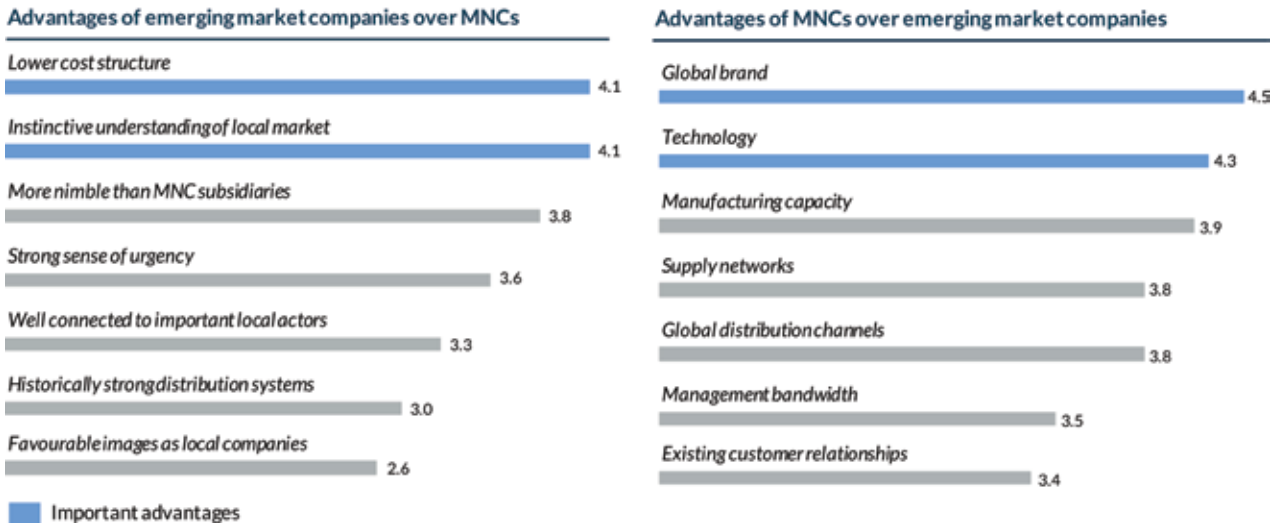


1) Includes Indian, global, start-ups and established companies; 2) Industry to which respondent's organization belongs

Source: Roland Berger survey, January – July 2016

FIGURE II.12 **Advantages held by Indian firms and multinationals innovating in India**

Advantages of Indian firms & MNCs have a global brand & latest tech



Source: Roland Berger survey, January–July 2016

6. Key takeaways

- *Companies form the heart of innovation ecosystem in India.*
- *Within India, we have identified five distinct organization types actively engaged in innovation:*
  - ***Transnational innovators** – Multinational companies innovating in order to succeed in the Indian market, drive their global innovation agenda, or both.*
  - ***Corporate titans** – Large Indian companies that have global aspirations and are innovating to win in global markets.*
  - ***Smart spartans** – Mid-size to large companies that have mastered the art of frugal innovation.*
  - ***Meteoric mavericks** – Indian start-ups that are challenging the status quo with disruptive products, services and business models.*
  - ***Relentless researchers** – Indian academic and publicly funded research institutions that have successfully contributed to Indian innovation with cutting-edge research and technology.*
- *The Indian corporate sector is heterogeneous. While many companies are active in the area of innovation, there are also many that are not. This observation is not limited to a particular organization type or industry, and includes multinationals as well as large and small Indian companies.*
- *Interview insights (includes entire spectrum of interview partners, including Indian and multinational companies, and both established firms and start-ups, across a variety of industries):*
- *Companies in India indicate that innovation is critical to achieving key business objectives such as improving topline performance and tapping into new market segments.*
- *Interview respondents almost unanimously rate themselves as "more innovative" than Indian peers; however, they show a mixed response when it comes to ranking their innovativeness vis-à-vis global peers.*
- *Interview partners believe that Indian companies' primary advantages vis-à-vis global multinationals with regard to innovating in India are lower cost structures and a superior understanding of the local market.*
- *Respondents believe that foreign multinationals' primary advantages vis-à-vis Indian companies with regard to innovating in India include global company or product brands and superior technology.*

E. Innovation at the industry level

In our study, in addition to analyzing innovation at the country and company level, we have tried to understand how innovation is driven at an industry level. In doing so, we have examined a wide variety of sectors. Our analysis in this section focuses on the following sectors:

- Automotive (passenger and commercial vehicles)
- Engineering
- Banking, financial services and insurance (BFSI)
- Pharmaceuticals and biotechnology
- IT and business-process management (IT and BPM)

While we also interviewed players in other industries including construction, materials and infrastructure, steel, energy, consumer goods, and services such as retail, hospitality, education, and media and entertainment, due to a low number of data points, we have not undertaken further analysis of these sectors. Additional sectors such as textiles and apparel and gems and jewelry were not studied, since they did not pass our initial filter of "industries with high level of innovation activity."

Our findings below are based on insights from interviews, and are supplemented by secondary research. Each industry is vast and deep, and to do justice to the topic of sector-level innovation would require standalone studies in each industry covering every step of the value chain. Instead, we have chosen to focus on a few key issues, including the broad structure of these industries, the innovation topics or trends they are currently focused on, and successful examples of their innovation.

When we map this sectoral innovation analysis onto our five innovation archetypes in India, we note that all sectors analyzed are active in "innovation as a service" and "process innovation."

FIGURE II.13 **Selected industries and types of innovation**

Industry	Types of Innovation				
	INNOVATION AS A SERVICE	GLOBALLY-SEGMENTED INNOVATION	PRODUCT INNOVATION	PROCESS INNOVATION	BUSINESS MODEL INNOVATION
Automotive	✓	✓	✓	✓	(✓) (Down-stream)
Engineering	✓ (ESO[1])	✓	✓	✓	(✓)
Information Technology & Business Process Management	✓ (BPO and KPO[2])	✓	(✓)	✓	✓
Pharmaceuticals and Biotechnology	✓ (CROs[3])	✓	✓	✓	(✓)
Banking, Financial Services and Insurance	✓	(✓)	(✓)	✓	✓

✓ – Active (✓) – limited/ nascent

1) Engineering Services Outsourcing 2) Business Process Outsourcing, Knowledge Process Outsourcing, 3) Contract research organization

Source: Roland Berger Survey, January – July 2016

1. Automotive sector

1 a. Current market in India:

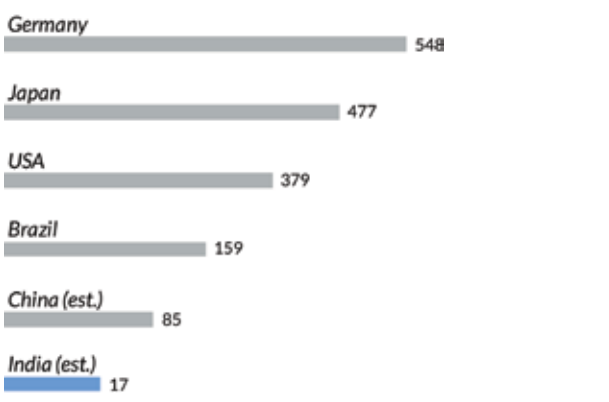
With sales of approximately 2.9 million passenger vehicles and 600,000 commercial vehicles in 2015,[56] India is the sixth-largest passenger-vehicle market and third-largest commercial-vehicle market in the world.

The country is expected to produce annual sales of 4.5million passenger vehicles by 2020, surpassing Japan, the United Kingdom and Germany to become the third-largest market in the world. In terms of Segment A cars (compact cars), India is expected to become the dominant market in the world by 2020, growing from roughly 1.2million sales in 2015 to 1.5 million sales in 2020, surpassing Japan.[57]

With regard to commercial vehicles, India is expected to reach annual sales of 1.1 million units by 2020 to become the third-largest market in the world, trailing the United States and China.

Although India is one of the largest automobile markets in the world, vehicle penetration remains low, indicating significant market potential (see Figure II.14).

FIGURE II.14 **Passenger-car use per 1,000 people for various countries, 2014**[58]



Source: Roland Berger Survey, January – July 2016

Automotive original equipment manufacturers (OEMs), automotive suppliers and downstream companies (such as sales and after-sales distributors, dealers, and online marketplaces) are the key players in the Indian automotive industry. The automotive OEM landscape is fiercely competitive, comprising 11 global multinationals[a], six Indian companies[b] and four joint ventures[c]. The Indian automotive-components industry is a USD 40 billion industry (2015), with exports of USD 11 billion, accounting for 2.2% of India's GDP[59] and employing about 1.5million people directly. The auto-components industry is expected to register turnover of USD 100 billion by 2020, with export revenues reaching USD 35 billion to 40 billion.[60] The downstream segment of the automotive value chain is relatively new and disorganized in India, save for a few large regional dealership groups and parts distributors. The past decade has witnessed the entry of online players such as CarTrade and CarDekho, which are aggregators providing information to consumers regarding new and used cars, and providing lead-generation support to dealers.

a Significant companies include Hyundai, Volkswagen, Renault-Nissan, Honda, Ford and General Motors.
b Significant companies include Tata Motors, Mahindra & Mahindra and Ashok Leyland.
c Significant companies include Maruti Suzuki and Toyota Kirloskar.

1 b. Innovation and the sector:

In terms of innovation in the Indian automotive sector, we observe the following:

A growing number of captive R&D centers

Across India, almost all major OEMs and tier1 companies either currently have a captive R&D presence in the country or are planning to invest in one in the near future (see Figure II.15). Currently, 62 multinationals in the automotive industry have set up R&D centers in India.[61] Moreover, Indian companies such as Mahindra, Tata Motors and Ashok Leyland have separate R&D units both in India and abroad.

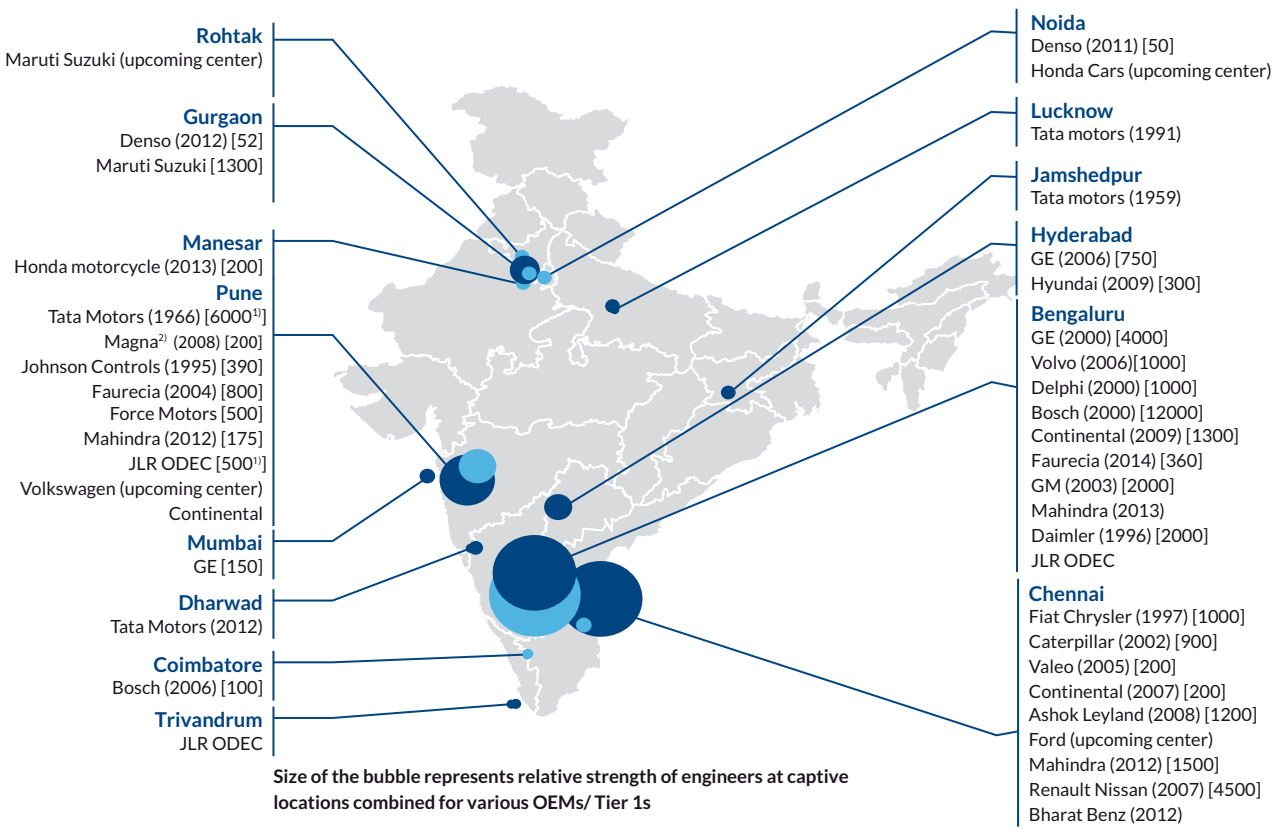
Increasing investment in R&D

Automotive OEMs and component suppliers in India recognize the importance of R&D in their business, and are increasingly investing in it (see Figure II.15 and Figure II.16 for an overview of the leading OEMs and suppliers in India and their R&D expenditure). On average, the level of this investment remains significantly below that of global counterparts. For instance, auto manufacturers in India spent an average of 2.3%[62] of their 2014–2015 revenue on R&D as compared to German manufacturers' 5.65%, while auto suppliers in India spent an average of 1.09% of their 2013–2014 revenue on R&D versus German suppliers' 7.51%.However, the trend appears to be increasing, and companies in India are recognizing both the need to invest in innovation and its impact on creating and sustaining a competitive advantage.

Variety of innovation topics

Auto manufacturers and suppliers in India are working on a wide variety of innovation topics. Representative examples are cited in Figure II.17.

FIGURE II.15 **Auto OEMs' captive R&D presence in India, current and projected**



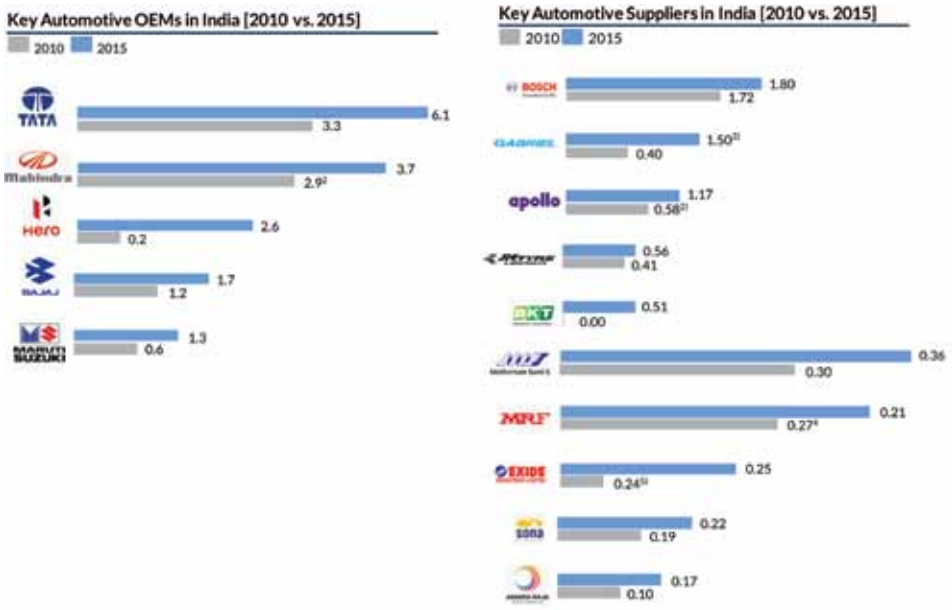
(xxxx): Year of establishment of center [yyy]: No. of employees at the center

1) Total employees in Pune, Jamshedpur, Lucknow and Dharwad ERCs are 6000 2) Magna also has satellite centers at Bengaluru and Chennai

Source: Secondary Research, Roland Berger

FIGURE II.16 **R&D spent as a percentage of turnover for key automobile manufacturers and automotive suppliers in India, FY2010 vs. FY2015**

R&D expenditure as a percentage of total turnover [%]



Source: Company Annual Reports; Secondary Research, Roland Berger

Variety of innovation topics

Auto manufacturers and suppliers in India are working on a wide variety of innovation topics. Representative examples are cited in Figure II.17.

FIGURE II.17 **Innovation topics in the Indian automotive sector**[63]

Auto Suppliers	OEMs	Downstream companies
• Engineering design, simulation and PLM data-managementa support to global units. • Research in advanced design, simulation and materials behavior. • Development of starters and alternators for the small-car segment. • Embedded-software development for engine and powertrain functions, antilock brakes, instrument clusters, air control, multimedia systems, etc. • Technology for powertrains, electrical/ electronics systems, IT, safety equipment, small motors, and thermal products. • Electronics solutions for engine management, power steering, immobilizers, body-control modules and instrument clusters. • Vehicle dynamics, passive safety and sensors, and advanced driver assistance systems (ADAS).	• Testing, including full-vehicle crash tests; sled tests for simulating the crash environment on subsystems; pedestrian-safety tests; pendulum-impact tests; noise, vibration and harshness (NVH) tests. • Lightweight architecture for body and emissions. • Prototype development and styling. • New technologies for engine and alternate propulsion (e.g., CNG, biodiesel, compressed air, electric vehicles). • Lightweight architectures for body and emissions-reduction technologies. • Electronics, including telematics, driver-information systems, navigation and vehicle-tracking systems. • Limited experimentation with Industry 4.0 systems.	• In the downstream segments of the value chain, given the high level of disorganization and informal markets, much of the innovation is focused on disrupting the current informal systems and pursuing business-model innovations. For example: • Used-car portals, spare-parts portals, transportation aggregators, etc., enabled by mobile or internet technologies. • Companies are also learning how to leverage available data and analytics to learn about consumer behavior and enhance loyalty.

[a] PLM data management refers to the use of software and data analytics for product lifecycle management. PLM software allows the user to manage information throughout the entire lifecycle of a product efficiently and cost-effectively, from ideation, design and manufacture through service and disposal.

1 c. Best practices:

Case study 13:

Renault

Renault SA's global chairman and CEO, Carlos Ghosn, set himself a mission five years ago: to build an affordable hatchback that could conquer one of the world's most significant emerging markets. Despite getting a thumbs down on the idea from executives based in Paris and Tokyo, Ghosn brought the man who was behind Renault's successful Logan back from retirement and set him up in India. There, he headed a new team consisting of experienced employees from the company's French and Japanese research centers, along with a number of Indian engineers. This newly formed cross-regional team was given aggressive targets both in terms of product features and costs.

The team's goal was to develop a car that was both affordable for the masses and which also possessed all the features valued by an Indian customer, such as roomy interiors for large families, heavy-duty air conditioning, and fancy navigation and media systems. Early on, the team realized that this would be impossible to achieve based solely on the lessons learned from previous company projects, and that they would thus need to start with a clean slate. Renault subsequently invested more than EUR 260 million to expand its Chennai facility to develop the CMF-A small-car platform for the Kwid.[64] In order to keep the cost of manufacturing to a minimum, the team sought to localize as much as possible, ultimately achieving 98% localization for the Kwid, becoming the second car manufacturer after Maruti Suzuki to reach this benchmark in India. To bring this about, more than 400 local suppliers had to be convinced to expand their capacity, and in a few cases, existing supplier contracts were even terminated. Sumit Sawhney, managing director and CEO of Renault India, explains, "You have to commit certain volumes to suppliers to get a competitive price. From day one, I wanted to sell more than 100,000 units a year. Less than that is not a success."[65]

The Renault Kwid, launched in September 2015, was fully developed in India (from design to manufacturing) and as of July 2016 had already sold more than 75,000 units, coming in third after Maruti Suzuki's bestsellers, the Alto and Wagon-R, in the mini car segment.[66] The success of the Kwid is spurring the company's competition to innovate in the segment. Maruti Suzuki Managing Director Kenichi Ayukawa comments, "We have to congratulate them but we are not happy, so we have to have some countermeasure. We are deciding what kind of product is needed in that segment."[67] Renault is now planning to export the Kwid to other parts of South Asia, Latin America and Africa.

Case study 14:

Ather Energy

While electric and hybrid vehicles are still relatively uncommon in India, a few players are active in this space. In February 2016, Ather Energy, a company created by two IIT-Chennai students in 2013, unveiled its S340, a "smart" electric scooter. Ather Energy founders claim that the scooter addresses the main issues that have prevented use of electric scooters in India – mostly that they typically take more than eight hours to charge, and have a maximum speed of only 25 kilometers per hour. The team resolved these problems by integrating a lithium-ion battery pack instead of a traditional lead-acid battery pack, thus enabling faster charging times and producing higher efficiency.[68] Thus, the S340 battery can be charged within an hour, and a single battery has an average life span of five to six years. The scooter can cover a distance of 60 kilometers on a single charge, and is capable of a maximum speed of 75 kmph. The traditional analog dashboard has been replaced by a 7-inch Linux-based[a] tablet that offers an interactive navigation system. The scooter also comes with an inbuilt vehicular-control unit with GPS, which monitors the rider's behavior and driving style in order to provide predictive analysis regarding the charge remaining and the distance that can be covered. Moreover, the team has replaced the traditional chain drive, which needs significant lubrication and constant re-tensioning, with polycarbonate belts that require less maintenance and no lubrication.[69]

The first scooter is expected to launch in early 2017, with first-year sales target of 10,000 units. The company has raised USD 12 million from Tiger Global.[70] Given that India is the largest two-wheeler market in the world, and the Indian government has set a target of making 25% to 30% of the country's two-wheelers electric by 2020,[71] Ather Energy has potential to create a significant impact in the scooter market.

a Linux is a computer operating system assembled under the open-source model of software development and distribution. It behaves similarly to the UNIX family of operating systems.

2. Engineering

2 a. Current market in India:

India's engineering industry can broadly be subdivided into heavy- and light-engineering sectors. The heavy-engineering sector includes products such as capital goods, transportation equipment and heavy electrical goods, while the light-engineering sector includes forging, castings and fasteners, pumps, and sophisticated microprocessor based equipment.

According to Germany's Mechanical Engineering Industry Association (VDMA), India's heavy-engineering sector was the 10th largest in the world in 2015 (Germany ranked 4th),[72] accounting for approximately 12% of the country's overall manufacturing sector. The sector exported goods worth USD 70 billion in 2014–2015.Exported goods included transportation equipment, capital goods, other machinery/equipment, as well as light engineering products such as castings, forgings and fasteners.[73]

India's electronics industry was worth USD 32.46 billion in 2014–2015, and primarily comprised consumer electronics (28%), electronic components (16%), industrial electronics (17%), computer hardware (5%), communication and broadcast equipment (29%), and strategic electronics (5%).[74]

India's engineering sector includes domestic and international companies. Among the domestic companies are a number of public-sector undertakings such as Bharat Heavy Engineering Ltd. (BHEL) and Bharat Electronics Ltd. (BEL), as well as private companies such as Larsen & Toubro, Crompton Greaves, Kirloskar Oil Engines, Kirloskar Brothers Ltd., and Thermax. The list of international companies includes Siemens India, ABB India, Grundfos, Cummins and Hitachi, among others. In the electronics sector specifically, foreign companies such as Foxconn, Samsung, LG and Whirlpool are present in the country alongside domestic companies such as Godrej, Videocon, Intex and Micromax.

Turnover in the capital-goods and engineering industry is forecast to grow to USD 125 billion by fiscal year 2017,[75] while the value of the electrical-equipment sector is expected to reach USD 100 billion by fiscal year 2022.[76]

2 b. Innovation in the sector

Nascent level of automation and Industry 4.0 adoption

India trails most developed markets with regard to the degree of automation and Industry 4.0 mechanisms. According to a report by the International Federation of Robotics in 2012, India had only one robot per 10,000 employees in the manufacturing sector. And in 2014, only 2,126 industrial robots were sold, accounting for just 0.9% of global robot sales.[77]

Indian companies, especially those with global customers, are slowly realizing the importance of Industry 4.0 mechanisms and the impact this could have on their productivity, quality and competitiveness. As a result, some are laying the foundation for Industry 4.0 within specific parts of their manufacturing operations.

For instance, Altizon, a 2013 Pune-based IoT start-up, is helping numerous engineering companies in India integrate Industry 4.0 mechanisms into their workflows. Using its proprietary platform, Datonis, the firm can connect all machines across its clients' assembly lines. The resulting data can then be processed in real-time, providing insights into overall production efficiency and overall equipment effectiveness (OEE).[a] Moreover, it provides real-time monitoring of equipment condition.

India is a key player in the global engineering-services outsourcing (ESO) market

India is the single largest player in the global ESO market, with a market size of USD 19 billion in 2015 and approximately a 16% global market share, followed closely by China with a 15% share, Eastern Europe at 11%, and other countries and regions accounting for the remainder.[78] Annual turnover in the Indian ESO market is expected to grow to USD 57 billion by 2019,and will be driven primarily by the aerospace, automotive and telecommunications segments.

Limited but growing activity among engineering-related start-ups

Though they remain fewer in number than in the e-commerce or other B2C sectors, engineering-related start-ups are becoming increasingly common in India. For example, as of 2014,[b] India boasted more than 30 augmented-reality start-ups focusing on marketing and advertising, healthcare, and visualization solutions, as well as at least 30 start-ups focused on hardware solutions in areas such as 3-D printing, payments and automation. As funding for hardware start-ups expands, the number

a Overall equipment effectiveness (OEE), according to the Kaizen Institute, "provides a holistic view of asset utilization. It drives an organization to examine all aspects of asset performance in order to ensure that they are obtaining the maximum benefit from a piece of equipment that has been procured."https://www.kaizen.com/knowledge-center/oee.html

b The 2015 NASSCOM report does not provide an updated number of augmented-reality and hardware start-ups.

of firms is expected to increase accordingly. A recent joint initiative by the Department of Science & Technology, U.S. multinational Intel and the Indian Institute of Technology, Bombay (discussed in Section III-B(2)), along with other similar programs, should drive this trend further forward.

Innovation-friendly infrastructure

The Indian government has recognized important influence that incubators, accelerators and laboratories can have in terms of encouraging experimentation. As a consequence, the Atal Innovation Mission has announced a program sponsoring 500 so-called tinkering laboratories in schools across the country, and provided financial support for the development or expansion of 100 incubation centers at academic and non-academic institutions, with a focus on sectors such as manufacturing, transportation, energy, health, education, agriculture, water and sanitation.

Moreover, the Maker Movement[a] is also taking shape in India. While this is currently limited to urban areas, there are approximately 20 maker spaces in the country, which have equipment such as 3-D printers, laser cutters, wood cutters, computer numeric control (CNC) machines and other high-end equipment. This movement is playing a crucial role in encouraging the emergence of more hardware entrepreneurs in the country. It allows people to come to a collaborative space and experiment with tools and equipment to create something from scratch. As Jugaad Innovation co-authors Jaideep Prabhu and Navi Radjou note, the Maker Movement allows the passive consumer to become active "prosumers."[79] The Maker's Asylum in Mumbai does just this. Founded by Vaibhav Chhabra in 2012, this space has spawned creativity in many Mumbai residents who lack the physical space or the equipment to experiment with new technologies and create things on their own. For example, an ophthalmologist used the equipment at Maker's Asylum to develop a new retinal-imaging device that can be attached to his mobile phone. This product is now nearly finalized, and the doctor is developing partnerships with hospitals and medical-devices companies in an effort to commercialize his work.[80]

a A worldwide trend, the Maker Movement is focused on using do-it-yourself (DIY) and do-it-with-others (DIWO) techniques and processes to develop unique technology products without any significant infrastructure requirements.

3. Banking, financial services and insurance (BFSI)

3 a. Current market in India:

The Indian BFSI industry is comprised of banks, non-banking financial institutions, insurance companies and a new breed of "fintech" companies. The country is projected to become the fifth-largest banking market globally by 2020.[87]

Banking

Total outstanding credit by scheduled commercial banks in India currently stands at over USD 1 trillion. Despite this, India's financial-account penetration rate is just 53%, significantly trailing countries such as China (79%), United States (94%), Japan (97%)and Germany (99%).[88] In a move to improve financial inclusion, the central government has launched Prime Minister's Jan Dhan Yojana scheme, which aims to ensure access to various financial services such as basic savings accounts, need-based credit, remittances facilities, insurance and pension plans for the economically weaker sections of the population.

The Indian banking system consists of 26 public-sector banks, 25 private-sector banks, 43 foreign banks, 56 regional rural banks, 1,589 urban cooperative banks and 93,550 rural cooperative banks,[b] in addition to cooperative credit institutions.

The largest public-sector bank is the State Bank of India, while HDFC Bank and ICICI Bank are the largest private-sector banks. Large foreign banks operating in the country include Citibank, Standard Chartered, BNP Paribas, HSBC and Deutsche Bank, among others.

Non-banking financial-services companies (NBFC)

NBFCs play an important role in India's financial system. These are companies that provide a variety of financial services including accepting deposits, making loans and advances, financing leases and installment-plan purchases, and more. As banks are not able to reach all parts of India or provide adequate credit to all population segments, NBFCs have been able to cater to populations living in rural and semi-urban areas, and provide funding in sectors experiencing credit gaps such as housing, consumer durables and transportation. NBFCs typically

b Rural cooperative banks are financial institutions owned and run by village communities, and operate on a one person, one vote principle. They provide village communities with banking services such as loans and deposits. The banksare governed both by banking and cooperative legislation, as they are registered under the Cooperative Society Act, 1965 and regulated by the National Bank for Agriculture and Rural Development (NABARD) and the Reserve Bank of India (RBI).

Case study 15:

Huawei

Huawei, the Chinese telecommunications-equipment provider, set up its first overseas R&D center in Bangalore in 1999. It was a bold move, and remains unique among Chinese companies. In 2015, the company invested an additional USD 170 million to expand its Bangalore center to hold 5,000 employees, making it Huawei's largest R&D center outside China. While the center started off providing software-platform components for Huawei 3G and code-division multiple access (CDMA) handsets in 2005, it has since taken on design responsibility for mobile handsets, mobile-broadband products and set-top boxes.[81] It is today the largest R&D center for Huawei devices.

The R&D center is a CMMI level 5 organization, and has filed a significant number of patents over the past years. Wilson Wang, the chief operating officer of the Huawei India R&D Center says, "The R&D center is aimed at playing a bigger role in the innovation journey of Huawei: creating future-oriented technologies, generating patents from India, contributing to industry standardization, collaborating with peers and academia in R&D, and supporting the digital transformation of the society."[82]

Huawei set up its first R&D center in India in 1999, and it has evolved into one of the major centers for Huawei worldwide

Huawei Technologies India (HTIPL) is Huawei's first overseas software R&D center

- **1999** Set up R&D center in Bangalore
- **2000–01** Started working on first tech project – ring-back tone solutions
- **2002–04** Works on intelligent network projects and network management systems – wireless networks, mobile handset applications and network security
- **2005–06** Starts supporting global clients such as British Telecom, Vodafone and China Mobile from India
- **2007–12** Starts work in domains such as big data, software defined networks and managed services; Pioneers agile and lean development for Huawei globally
- **2015** Opens new R&D campus in Bangalore; seating capacity of 5000

Key facts – Huawei India

2000	USD 2,000 m invested by Huawei in India since 1999
300	USD 300 m invested by Huawei in R&D in India since 1999
800	USD 800 m revenue from India in 2013; plans to generate revenue USD 2 bn by 2017
2700	2700 engineers in India center at Bangalore; out of them ~98% are Indians
170	USD 170 m invested in the new R&D campus
Major Clients	Deutsche Telekom DT, Saudi Telecom (STC), China Mobile Bharat Sanchar Nigam (BSNL), Royal KPN NV, Koninklijke KPN NV, MTN, Bharti Airtel, Orange, Vodafone, Etisalat , COMCAST, BT Group (British Telecommunications), China Unicom

Source: Company website; Press articles; Roland Berger

Case study 16:

IdeaForge[83]

IdeaForge, a start-up created by four IIT Bombay alumni, was founded with the vision of inspiring a surge of unmanned systems in India.[84] It produces unmanned aerial vehicles (UAVs) that can be used both for military and civilian applications. Its flagship product, NETRA, is a UAV small enough to be carried by a person, designed for vertical take-off and landing. It is designed to transmit continuous real-time videos of human movement and/or vehicular movement on the ground, while remaining undetected. NETRA can be flown up to a height of 500 meters, can travel up to five kilometers from the point of take-off, and can fly for more than 50 minutes. The system also comes with multiple fail-safe modes to handle emergencies effectively. According to the company's founders, NETRA has the longest range and best endurance globally for its UAV weight and size class, and is also the only UAV to provide optical zoom with real-time target tracking on its full-endurance payload, making it suitable for security and surveillance applications.

The product can be deployed for counter-insurgency, border-management, hostage-rescue, disaster-management or simply crowd-control applications.[85] In addition to use by the Indian defense forces, it has also been deployed for geographical survey and mapping functions, oil- and gas-pipeline monitoring, crowd management, real-estate photography, and event monitoring. The company has supplied several hundred of the systems to the Indian government.[86]

The passion for engineering led the founders of ideaForge to indigenously design and develop unmanned systems for India

Introduction

> ideaForge was born out of the curiosity and passion that five students from IIT Bombay had for robotics, which they pursued even after graduation

Netra: The UAV

> The flagship product of ideaForge – Netra, is a man-portable UAV[1] which is provides ease of aerial monitoring from a height of up to 500 m
> High quality thermal camera with zoom-in feature enables identifying human activity up to 500 m away from the UAV
> It can fly up to a distance of 5 km from the take-off point and thus, cover an area up to 10 km in diameter
> It can stay up in the air for 50mins+, making it the highest endurance UAV in its class for the wt. & size

Customers and applications

> The commercial applications of Netra include: geographical survey and mapping, oil & gas pipeline monitoring, crowd management, real estate photography and events monitoring
> Government organizations have been the major customer for ideaForge, as their products are suitable for aerial monitoring in both civilian and military applications

1) UAV – Unmanned Aerial Vehicle

Advantage

- The UAVs are capable of providing high quality, stabilized videos during both day and night operations
- Vertical take-off and landing capacity makes it suitable even for constrained area operations
- The autonomous flight mode makes it capable of flying on its own and returning back home after the mission
- The ready to be deployed system takes less than 5 minutes to unpack and provide aerial view of target
- Multiple fail-safe modes to handle emergencies ensure that device comes back after communication breaks

Source: Company website; Press articles; Roland Berger

fall into one of three categories: asset-finance companies, loan-making companies or investment companies. Key players include HDFC, Bajaj Finance, Mahindra Finance and Shriram Transport Finance, among others

Insurance

India is the 15th-largest insurance market in the world in terms of premium volume. The life-insurance industry recorded new-premium income of USD 20.5 billion in 2015/2016, while the general insurance industry's gross direct premium income was USD 1.55 billion. The total market size of the Indian insurance sector is projected to reach USD 350 billion to 400 billion by 2020.[89]

India's life-insurance sector is the largest in the world by volume, with approximately 360 million policies sold. The government-owned Life Insurance Corporation of India holds a 69% market share in this segment. However, insurance expenditures overall represented a mere 3.3% of GDP in 2014/2015, compared to a global average of 6.2%. With regard to per-capita premium payments (known as insurance density), India shows a level of just USD 55, compared to the average global density of USD 662.

The Pradhan Mantri Suraksha Bima Yojana (PMSBY) and the Pradhan Mantri Jeevan Jyoti Bima Yojana (PMJJBY) programs, both launched by the Indian government in early 2015, are attempting to increase insurance coverage across the country. Thus far, the schemes have respectively provided coverage to around 30 million and 100 million additional people.[90]

3 b. Innovation in the sector

Innovation in the Indian BFSI sector is primarily driven by the underlying need to increase financial inclusion and financial-service penetration within the country. This has given rise to a new breed of financial institutions, products and services in the market. Below, we identify four important innovations taking place in the BFSI sector.

Boom in online and mobile banking

Given the country's sparse network of bank branches and ATMs, customers often find it difficult to visit a bank. Banks and NBFCs have thus set their sights on the1 billion mobile-phone users (including approximately 370 million mobile-internet users as of June 2016),[91] aiming to provide a variety of banking and financial services online and via mobile phones. The amount transacted through online banking increased four-fold between December 2014 and December 2015, from USD 1.7 billion (INR 11,323 crore) to USD 7.3 billion (INR 49,029 crore).

Creation of small finance banks

Despite a vast network, the density of India's banking services is sparse in comparison with the country's population. For instance, India has seven bank branches per 100,000 people, significantly below the developed-country average of 40 branches per 100,000 people.[92] In an effort to increase the reach of banking and financial services, which currently do little to serve small businesses, small and marginal farmers, and the unorganized sector, the Reserve Bank of India issued 10 small-finance-bank licenses in August 2015. These banks are now authorized to provide secured and legal loans within the large unorganized economy, bringing these individuals within the ambit of the banking system. The small finance banks will be required to provide 75% of their adjusted net bank credit to high-priority sectors and lend at least 50% of their loans with an average disbursement size of below INR 2.5 million. Moreover, they will have to set up at least 25% of their bank network in currently "unbanked" areas.

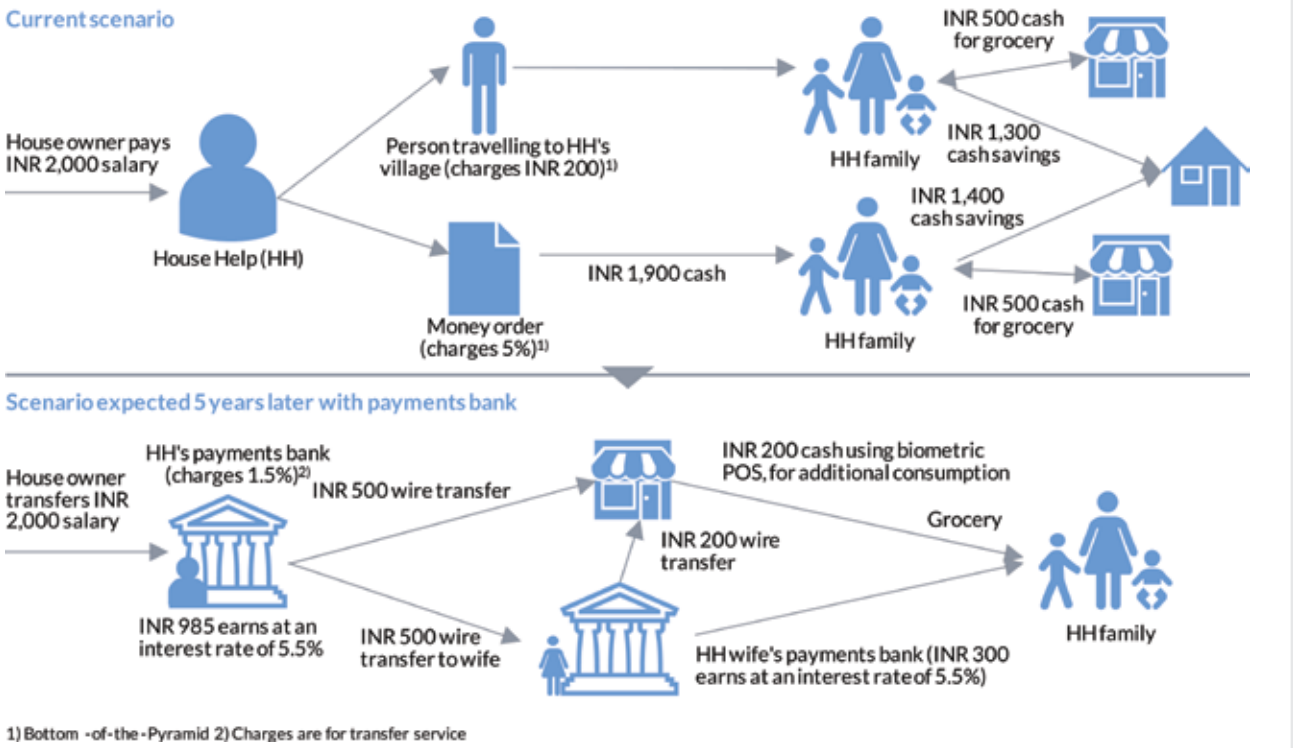
Disruption in the payments industry

Indigenous card-payment scheme

RuPay, a new card-based payment scheme launched by the National Payments Corporation of India (NPCI), has been conceived to fulfill the Reserve Bank of India's vision of offering a domestic, open-loop, multilateral system that will allow all Indian banks and financial institutions (even those of small size) to participate in electronic payments.[93] Thus, RuPay is the Indian equivalent of payment gateways such as Visa and MasterCard. The two main objectives of the RuPay project are to reduce overall transaction costs for banks in India and increase financial inclusion throughout the country. RuPay's transaction charges are lower than is the case for the international gateways, as the transaction processing happens locally. Banks pay a fee of INR 2.5 for an INR 2,000 transaction, compared to INR 3.25 for global gateways. Moreover, there are no entry charges or quarterly fees for banks, as is typical for the international gateway services. The cards are based on a high-end technology chip called the EMV (an acronym standing for Europay, MasterCard and Visa, which created the chip standard) along with an embedded microprocessor circuit, enabling user data to be stored on the card.[94] Debit cards from RuPay are currently in circulation, while credit cards remain in the pipeline. The Pradhan Mantri Jan Dhan Yojana program has driven RuPay debit-card penetration by issuing 172 million cards. As of January 2016, with 247 million cards in circulation, RuPay had a 38% market share with regard to debit cards issued in the country.[95]

FIGURE II.18 **Improving remittance efficiency through use of payments banks[100]**

Payments bank are expected to dramatically improve efficiencies in remittances, leading to more savings and consumption for BoP[1]



Source:

Emergence of mobile-wallet companies

With nearly 370 million mobile-internet users in June 2016, and significant growth of e-commerce in the past five to six years, Indian consumers have shown a strong preference for using mobile-wallet technology for online transactions. There are approximately 200 million wallet accounts in India, which is more than 10 times the number of credit cards.[96] Paytm, one of the largest mobile-wallet players in the country, has 120 million wallet users, which is more than double the penetration of Visa and Maestro in India combined.[97] One of the reasons for the success of these wallets is the easy registration process and their mobile-centric approach to payments, along with their secure, user-friendly interfaces. Unlike the credit-card companies that relied primarily on convenience to foster customer adoption, most mobile-wallet companies in India began by offering discounts on prepaid-phone recharges and utility payments to acquire customers, and today support a broad range of transaction types including taxi fares, cinema tickets and e-commerce. As a next step, mobile-wallet providers are striking partnerships with offline brick-and-mortar clothing and food retailers. "Payments for retail shopping will be disrupted in the coming years…people will use mobile wallets rather than cards or cash to make payments for their day-to-day shopping," says Jitendra Gupta, founder of CitrusPay, the third-largest payments platform in the country.[98] Mobile-wallet companies are expected to play a dominant role as the online-payment ecosystem in India advances, as well as taking a meaningful role even in the offline space.

Mobile wallets are also showing increasing penetration in the peer-to-peer payments space. Annual domestic remittances in India total around USD 20 billion. The breadwinner typically lives and works in an urban area, while his or her family lives in a more remote hometown or village. The breadwinner either passes on the cash he or she earns every month through informal networks, or tries to transfer the money to his or her family via a money-transfer agency or bank. However, given the poor penetration of bank branches in rural areas, both paying and receiving remittances in the traditional way, by visiting a bank branch, are cumbersome, time-consuming and expensive procedures, with costs for both the payer and recipient totaling the equivalent of nearly a day of wages. By contrast, mobile-wallet technology has made this remittance and receipt process comparatively hassle-free, an innovation that is expected to have broad social impact.

Creation of payment banks

Payment banks are new players in the Indian BFSI industry. The Reserve Bank of India issued 11 bank licenses in August 2015, in another move intended to boost financial inclusion within the country. Licensees included telecommunications companies, mobile-wallet providers and other technology firms. The rationale behind providing these licenses to a variety of players was to choose "selected entities with experience in different sectors and with different capabilities so that different models could be tried."[99] These entities are being allowed to provide basic savings, deposit, payment and remittance services to people currently outside the formal banking system. However, they will not be able to offer lending products. Figure II.18 illustrates how payment banks can lower transaction costs and improve efficiency in areas such as remittances.

Development of a unified payments interface (UPI)

The creation of a UPI service is another step for India in its move toward a cashless and digital economy. Created by the National Payment Corporation of India (NPCI) with approval from the Reserve Bank of India, it will allow users to conduct transactions with only a mobile number or email address. For example, a customer visiting a grocery shop might provide the shopkeeper with her virtual identity, which could be no more than her mobile-phone number or Aadhaar number (the Aadhaar Card, which contains a 12-digit unique QR code, is a unique identity card issued to all individuals in India by the government. The card also contains biometric proofs of identity (fingerprint and iris-scan records)). The grocer would then generate an invoice through the UPI system, after which the customer would need to approve the transaction using her mobile phone. The UPI system would then verify the grocer's virtual identity, and transfer money to the shop's account in real-time.[101] Using UPI operation would require only a smartphone app that supports the payment mode. Banks are expected to integrate this into their mobile applications. The system already has the backing of 29 banks in India.

Emergence of innovative players in the financing and insurance space

Credit cards have not taken off in India. Penetration is woefully low, at less than 2% of the population (21 million credit cards had been issued in the country as of 2015). Seeing this as an opportunity, a number of NBFCs and online or mobile intermediaries are developing alternative consumer-and enterprise-finance products.

In conjunction with the adoption of mobile wallets as the electronic-payments infrastructure of the future, third-party intermediaries have emerged with a focus on lending to new or unbanked consumers and small enterprises. Business models in the space are typically focused on reaching customers using mobile apps, assessing creditworthiness using industry-standard metrics, and providing end-to-end digital loan solutions. Consumers are given the ability to select the best loan option for their specific circumstances, with support provided in the form of in-app education and loan documentation. Monetization is secured from lenders, including large banks and NBFCs, who thus avoid the high costs associated with customer acquisition in this segment (e.g., marketing, physical infrastructure) while still benefitting from the increased size of their loan book. Some companies have additionally adopted innovative data-driven measures enabling them to assess creditworthiness, while offering loans from in-house NBFCs.

Addressing similar needs on the insurance side, several innovators have raised significant capital from the venture-capital and private-equity (VCPE) sphere with the aim of bringing greater transparency and digitization to the insurance space. As in the lending business, companies here are focused on acquiring customers using the mobile-phone platform, as well as on providing transparency and support for consumer- and enterprise-insurance solutions. Traditional insurance underwriters have willingly provided IT integration at the back-end to support such services, recognizing the benefits of dealing with large third-party aggregators.

3 c. Best practices:

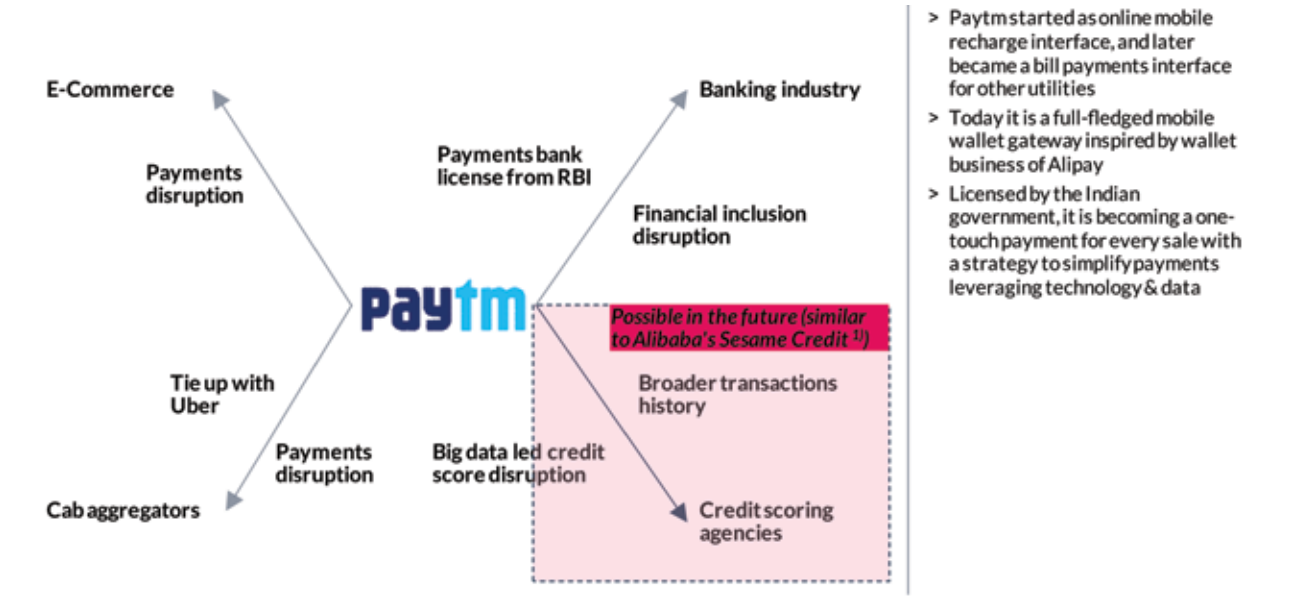
Case study 17:

Paytm

Paytm is a mobile-payments-service company that launched in 2010. The company began purely as a mobile prepaid recharge service. In India, 84% of all smartphone users[102] and 92% of feature-phone users use a prepaid subscription model, where they top up (recharge) their prepaid balance at regular intervals. Paytm subsequently extended this service to utility-bill payments, including electricity, gas and telephone bills. Earning commissions of 2% to 5% per transaction from the mobile-phone and utilities companies, it built a strong user base, ultimately capturing nearly 30% of the market. The company then created its own online marketplace, rivalling Amazon, Flipkart and Snapdeal by offering products such as electronics, apparel, travel and entertainment.

In 2014, Paytm also began a mobile-wallet offering. Based on Alipay's model (a major Chinese payments platform), the company developed a one-touch mobile wallet that could be used to pay for everything from utilities to movie tickets and taxi drivers. A regulatory hurdle that initially caused difficulties for Uber in India (relating to two-factor authentication-system requirements) turned out to be extremely fortuitous for Paytm, as it was able to partner with Uber to use its mobile wallet as an alternative payment channel. This turned out to be a game-changer for Paytm, which in conjunction with cash-back offers built a user base of 120 million wallet accounts.[103] Today, the company is planning to take its business one step further through the creation of a payments bank. Payments banks are allowed to offer current accounts and savings accounts holding up to INR 100,000, but are not allowed to issue credit cards or lend to customers. The firm is hoping to reach 500 million users with its new services, and among other innovations plans to provide non-traditional ATMs at retail outlets and gas stations, and provide debit cards with QR codes. It is also planning to integrate its offering further with that of its investor, Alipay, so that users can use their Paytm accounts at foreign merchant outlets that accept Alipay as a mode of payment.[104]

Paytm began as online mobile recharges interface, and has turned into a full-fledged mobile wallet gateway, disrupting new and existing businesses



1) Sesame credit is a social credit scoring system from Alibaba Group in China, which uses data from Alibaba's services to compile credit score

Case study 18:

Mahindra Rural Housing Finance (MRHF)[105]

The Mahindra Rural Housing Finance (MRHF), a subsidiary of Mahindra Finance, provides cost-effective and flexible home loans to customers in rural and semi-urban areas. Moving into rural housing finance was a bold step for the firm, because – as the company later discovered – in rural communities, building a home is fourth on a typical list of priorities after educating children, finding additional sources of income and financing children's weddings. Moreover, the sizes of such loans were much lower than initially estimated, since it emerged that rural dwellers typically preferred to pay for additions to their existing dwellings rather than construct a new house.

Instead of being deterred by these challenges, MRHF has developed an innovative business model designed specifically for rural home financing. The entire loan process has been redesigned from end-to-end. The first step has been to adjust the business plan to encompass average loan sizes of INR 500,000 to INR 100,000. Mass marketing has been replaced with a personalized relationship-based cluster-selling approach. Collection of loan payments is done via handheld devices that issue payment receipts so as to reduce pilferage. While non-performing assets are still a concern, the company places a stronger emphasis on building customer trust than on dogmatic approaches such as land repossession. Due to the instability of the population's income sources and the frequent lack of proper documentation and information, credit-risk assessment is a challenge. The team has addressed this by developing income models based on crop type, soil or region types, size of landholdings, and other such details. This enables the company to make a reliable estimate of potential earnings. The company is currently in the process of developing proprietary software for estimating the risk associated with rural customers. Moreover, the sales and collection staff has been trained to understand the products, gauge customers' credit worthiness and payment capabilities, and make loan decisions in a decentralized way.

This series of business-model interventions has certainly paid off. The firm is a profitable, and its financials are in line with industry norms. In fiscal year 2015, the firm recorded a profit-after-tax (PAT) to average-assets ratio of 2.52%, and a profits-before-tax to total-income ratio of 20.43%. Most importantly, with loans to 350,000 rural families, about 273 offices and 3,200 employees as of fiscal year 2015,and a compound annual growth rate (CAGR) of more than 60% since fiscal year 2011, the company is set to continue to boost prosperity and empower residents in rural India.

4. Information technology and business-process management (IT-BPM)

4 a. Current market in India:

In fiscal year 2016, India's IT and BPM industry recorded a turnover of USD 143 billion. Of this, exports accounted for USD 108 billion, while domestic sales accounted for the remaining USD 35 billion.[106] Employing nearly 3.7 million people, the sector ranks fourth in terms of total foreign direct investment (FDI) into India, and accounts for nearly 37% of total private-equity and venture-capital investment in the country.

The United States is the top export market, accounting for nearly 62% of export revenue within India's IT-BPM industry, followed by the United Kingdom with 17% and European Union with 11%.

The IT-BPM industry is comprised of four main segments. As of fiscal year 2015, IT services was the largest segment, accounting for around52% of the market, with BPM services accounting for 20%,software products and engineering services accounting for approximately 18%, and hardware products making up the remaining 10%.[107]

Annual turnover in the industry is expected to grow to USD 200 billion to 225 billion by 2020.[108]

Major players in the Indian IT-BPM industry include Indian companies such as Tata Consultancy Services, Infosys, Wipro, HCL Technologies, Tech Mahindra, L&T Infotech, MphasiS Ltd, Genpact, Zensar Technologies, and MindTree Ltd. In addition, a host of global IT-BPM companies also have significant operations in India, including Microsoft, IBM, Cisco, Hewlett Packard, SAP, Cognizant Technology, Oracleand Xerox.

4b. Innovation trends

Indian IT-BPM industry growth rates have slowed from the last decade's 30% to 40% year-over-year levels to current annual rates of 12% to 15%. However, this lower growth rate was expected, as it is relative to a much larger revenue base. As countries like Vietnam and the Philippines increasingly seek to compete with India in this area by

offering lower-priced services, Indian companies are trying to compete by moving up the value chain and focusing on technology. Some of the innovation trends are as follows:

Creation of intellectual property (IP)

In light of changing customer requirements and industry structure (including higher costs), large IT firms are today focusing on creating valuable IP that will make them a preferred partner for their customers.

Internet of Things (IoT)

IoT is expected to be one of the game-changing innovations in the coming decade. The global market for IoT-related products and services is expected to cross USD 1 trillion by 2020. A number of global giants including Microsoft, Google, IBM, Amazon, Oracle, Siemens, Bosch and Qualcomm are making significant investments in developing manufacturing platforms, software systems, mobile applications, twisted-optic-fiber networks, and electronic chips to make their products and services IoT-ready.[109] Given that many of their clients, including leading global engineering companies, are strongly focusing on IoT systems, captive IT R&D centers and IT giants in India are also investing in developing their capabilities to provide software-side support.

Artificial intelligence

Many of the Indian IT companies have invested in artificial-intelligence (AI) technologies, and have developed their own products and platforms. For instance, Tata Consultancy Services, India's largest IT-services exporter, launched its Ignio AI platform in June 2015 both as a standalone product and as a bundled offering with its other services. Infosys, the second-largest player in the country's IT space, unveiled its Aikido offering in August. Wipro launched its Holmes platform around the same time. Several smaller players are planning to follow suit.

Software as a service (SaaS)

The rise of cloud-computing platforms has led to the growth of SaaS, a software-distribution model in which applications are hosted by a service provider.[110] According to Google and Accel Partners, India currently has 500 SaaS companies and is well-poised to capture 8% or USD 10 billion of the global SaaS market by 2025 due to changing customer behavior, market accessibility and growth, talent availability and cost advantage. The report indicates that India's ecosystem is primed for the emergence of product-driven SaaS companies due to a) a good supply of IT and consumer product managers with multinational experience who are now transitioning into entrepreneurship, and b) the necessary developer capacities at a relatively low cost vis-à-vis countries such as the United States and the United Kingdom. Google India CEO Rajan Anandan believes that India has an edge in SaaS given its status as a mobile-first country,[a] and the fact that much SaaS innovation will be focused around mobile applications. Indian SaaS companies are deemed to have particularly great potential in the areas of customer-relationship management, data visualization, human resources, marketing, healthcare and education.[111] Examples of successful Indian SaaS companies include FreshDesk, Appointy, SignEasy, Grabber, WebEngage, Wingify and Helpshift.[112] Ravi Narayan, director of Microsoft Ventures, Microsoft's Bangalore-based accelerator, believes that Indian companies have a unique opportunity to perform well on the global stage owing to their cloud-based offerings, which make it easier to launch products, get feedback from potential customers and iterate quickly. Critical success factors for Indian SaaS companies will include their ability to lower unit costs while improving the quality of customer service, user experience and user interfaces,[b] and creating well-targeted marketing campaigns.

Rise of the start-ups[113]

Start-ups are not restricting themselves to plain-vanilla copies of business models and approaches already pioneered in the West. Indeed, many are actively working in futuristic technology areas. For example, as of 2014,India boasted more than 30 augmented-reality start-ups focusing on marketing and advertising, healthcare or visualization solutions, and at least 30 start-ups were focused on hardware offerings in areas such as 3D printing, payment solutions or automation. As of 2015, more than 75 start-ups were active in the internet-of-things space, providing applications such as wearable tech, home automation or fleet management. Big data and social-media analytics are also hot fields, boasting more than 400 Indian start-ups. Other popular areas include health technology, with more than 120 start-ups, and payments, with more than 70 start-ups. Cloud computing, security, educational technology, advertising technology and gaming are other areas in which young Indian entrepreneurs (nearly 72% of all founders are younger than 35) are redefining the way India looks at innovation and risk.

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a Mobile-first means that a particular software is created first for mobile applications rather than for personal computers or any other device. Given India's large mobile and smartphone subscriber base, the country is considered by many to be a mobile-first and even a mobile-only market.

b User experience refers to a user's subjective experience in terms of satisfaction and convenience of use while interacting with different aspects of a particular software program/service. User interface is the series of screens, pages and visual elements which a user encounters while interacting with a software program or service.

4 c. Best practices:

Case study 19:

CISCO[114]

Cisco Systems, a Fortune 100 American company, designs, manufactures and sells IT and networking equipment worldwide. Cisco set up its R&D center in India in 1996. As company Executive Vice President and Chief Development Officer Pankaj Patel says, "We came to India for the costs, we stayed for the quality, we invested for innovation, and now we are creating a new industry."[115] Today, Cisco's India center is a key player in the firm's global operations.

With a mission to engage in innovation within the Indian R&D center, the center's core team began identifying Indian consumers' points of discontent in the country's networking segment. In light of the unprecedented increase in the number of mobile-phone subscribers in 2008–2009, the company realized an opportunity to develop mobile backhaul routers[a] (also known as cell-site routers), which link cell towers to the core telecom network. While Cisco was previously a leader in core networks and aggregation routers, it had not specialized in mobile backhaul routers – therefore, this was complementary to its existing portfolio. The main challenge associated with networks in emerging markets is the continued heavy reliance on 2G technologies. Thus, this new router, called the ASR 901, was designed to be versatile enough to support existing 2G services as well as to scale rapidly to handle the upcoming 3G and 4G technologies. The Indian team applied a bootstrapping approach,[b] pooling senior engineers from other business units working on advanced technologies in India to develop a working prototype. In addition, the team developed partnerships with engineering service providers to execute the development phase on a revenue-sharing basis. ASR 901 product development required work across the entire stack of technologies – silicon chips, platform hardware, platform software, the network operating system and network management tools – and was predicated on close communication between these elements. The Cisco team thus worked in close proximity with partners to build the product while defining appropriate hardware/software interfaces and engaging in the product test phase. Over time, the ASR 901 prototype gained attention from customer-facing units within the company. The active engagement of the core team with customer-facing groups resulted in a slow but sure realization that the product filled a gap in the company's portfolio. This provided market validation for ASR 901 at the global level. The ASR 901 was successfully launched in 2011, and several variants have subsequently been developed and sold to more than 100 customers in 46 countries.

The success of the ASR 901 project was one of the factors leading to the establishment of the Provider Access Business Unit in India. It has also led to a string of new products from Cisco India. In December 2014, Cisco showcased three new communications products conceptualized, architected and designed in India. To date, Cisco's Indian office has filed more than 800patent applications.[116]

a Backhaul in a telecommunications network comprises the intermediate links between the core network and the small sub-networks at the edge of the entire hierarchical network. Definition from J. Salmelin and E. Metsälä, "Mobile Backhaul" (Chichester, U.K.: John Wiley & Sons, 2012).

b Bootstrapping refers to the creative utilization of limited financial resources to develop a working prototype of a product.

Case study 20:

FreshDesk

FreshDesk is a cloud-based customer-support platform that was launched in 2010 with the mission of enabling companies to provide great customer service no matter what their size. The founder saw the need for a SaaS-based customer-support tool as a result of personal experiences with a broken TV. The company's products allow organizations to support customers by phone or through email, websites, forums and social media. In the crowded and competitive enterprise-software market, the company has not only differentiated itself by price, but has also leveraged its lower cost base to provide superior value to its customers (including human-driven services such as support and training). The company has also built effective marketing tools that enable it to track and optimize every metric along the customer lifecycle, from the cost of acquiring a new customer to churn rates.[117] Today, FreshDesk serves more than 80,000 clients of all sizes across the globe, helping to provide customer services to their customers. The start-up has been widely recognized for its work; indeed, it was the winner of the Microsoft BizSpark Start-up challenge in 2011.[118] In 2016, it won the Economic Times' Start-Up of the Year award, with judges complimenting its technical prowess and track record.[119] The company has also been on an acquisition spree, and has acquired five companies since August 2015.[120]

5. Pharmaceuticals and biotechnology)

5 a. Current market environment in India:

India's pharmaceuticals industry is currently valued at USD 18 billion, and is the world's 13th-largest by value (and 3rd-largest by volume). Branded generics currently account for 70% to 80% of the market and around 20% of global exports, by volume.[121] The Indian pharmaceutical industry is expected to grow between 15% and 20% per year between 2015 and 2020, reaching a market size of USD 55 billion by the end of that period. Key players in the Indian pharmaceutical market include global companies such as Novartis, Glaxo SmithKline, Merck, Sanofi and Abbott, as well as Indian generics companies such as Sun Pharmaceuticals, Lupin, Dr. Reddy's and Glenmark.

The Indian biotechnology industry is currently estimated at USD 11 billion and is growing at a CAGR of 20% year-on-year. India accounts for roughly 2% of the global biotechnology industry, is ranked 12th in the world, and is home to around 800 companies. With a share of approximately 64%, biopharmaceuticals represent the largest sub-sector within the Indian biotechnology industry, followed by bioservices,[a] agricultural-related applications, bioindustry and bioinformatics at 18%, 14%, 3% and 1%, respectively.[122]

Major players in the Indian biotechnology industry include Biocon, Serum Institute of India, Panacea Biotech, and Bharat Biotech. In addition, major pharmaceutical companies such as Cadila Healthcare, Lupin, Dr. Reddy's and Wockhardt are also focusing on biopharmaceuticals.

5 b. Innovation in the sector

New chemical entities (NCE)[b] in the pipeline

Indian pharmaceutical and biopharmaceutical companies, boosted by significant earnings in their generics businesses, are today investing in drug-discovery research. Some have set up in-house NCE-discovery units,[b] while others have chosen to establish biotech-like research units outside the country. Another set of Indian companies have achieved success in the area of "biotherapeutics" through the development of biosimilars.[c]

As of mid-2014, 120 new chemical entities (NCEs) from Indian pharmaceutical and biotechnology companies were at various stages of development.[123] One prominent

a Bioservices refers to the services provided by clinical-research organizations (CROs) and contract-manufacturing organizations (CMOs), often collectively referred to as contract research and manufacturing services (CRAMS)

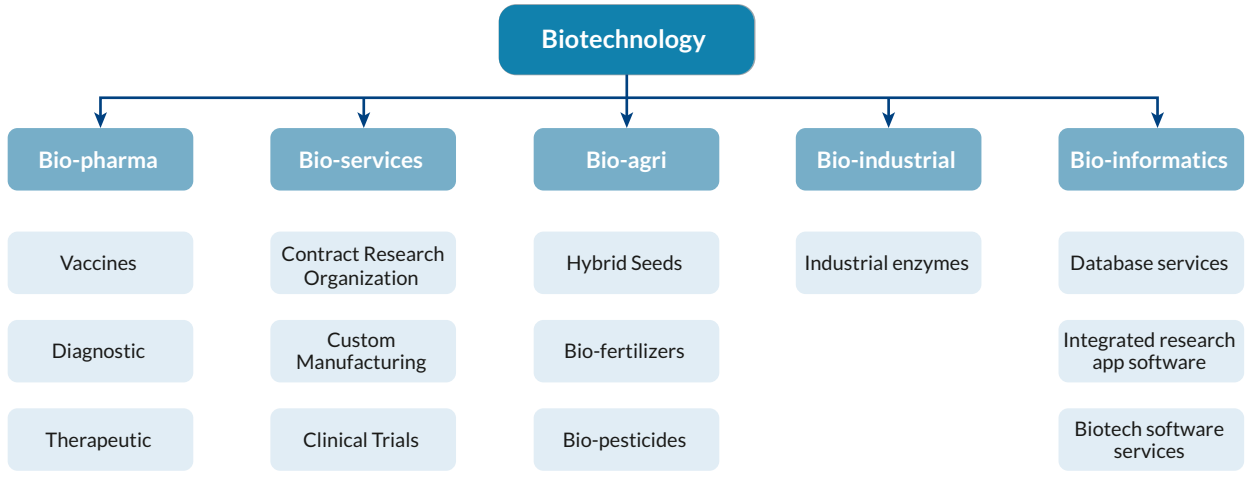
b New chemical entities (NCE) are defined as chemicals that have no precedent among regulated and approved drug products.

c Biosimilars are officially approved versions of innovative biotherapeutic products for which the patent has expired.

FIGURE II.19 **Major products and services of the Indian biotechnology sector**

Ranked 12th in the world, Indian biotechnology industry has around 800 companies working in diverse domains

Major products/services of the Indian biotechnology industry



Source: ABLE – Biospectrum Industry Survey, Ministry of External Affairs, TechSci Research; Roland Berger

example is Zydus Cadila's saroglitazar[a] (Lipaglyn), which as a breakthrough in the treatment of diabetes and cholesterol was India's first NCE to pass all clinical-trial stages.[124] Another example is Ranbaxy's Synriam, the first domestically developed antimalarial drug, which is a simplified three-day once-a-day therapy for the treatment of acute uncomplicated Plasmodium falciparum malaria in adults.[125]

Innovation in vaccines

India is one of the leading vaccine producers in the world. With a market size of USD 1 billion, the Indian vaccine industry has been responsible for several low-cost vaccines, for example the world's cheapest Hepatitis-B vaccine, and the rotavirus vaccine. Moreover, in the past few years, Indian companies have evolved from merely being producers of affordable vaccines to developing complex vaccines for the rest of the world.[126] In early 2016, India's Bharat Biotech was the first company in the world to have two vaccines against the Zika virus ready for testing.[127]

New business models to reduce the cost of innovation

A number of pharmaceutical companies in India are experimenting with different business-model innovations so as to lower the cost of drug discovery, manufacturing and distribution. For instance, Cadila Pharmaceuticals had a public-private partnership with the Indian Institute of Integrative Medicine and the Council of Scientific and Industrial Research (CSIR), and consequently developed Risorine, the world's first boosted-Rifampicin[b] treatment containing a fixed-dose combination for use as an antitubercular drug. When the team launched this drug in 2009, it was about 23% cheaper than other alternatives.[128]

Moreover, Indian pharmaceutical and biopharmaceutical companies are collaborating with global pharmaceutical firms in the area of research and development. For example, Indian biotech giant Biocon, its contract research subsidiary Syngene, and U.S. pharmaceutical giant Bristol Myers Squibb have been collaborating since 2007 to develop integrated capabilities in medicinal and process chemistry, biology, biotechnology, biomarkers, drug metabolism, pharmacokinetics, analytical research and pharmaceutical development. The three parties established a Biocon-Bristol Myers Squibb Research Center (BBRC) in Bangalore. Over the years, this has become the largest Bristol Myers Squibb R&D center outside the United States, and currently houses more than 400 scientists. This collaboration has already produced six drug candidates for further study. In 2014, the three partners extended their partnership for another five years. As Francis Cuss, chief scientific officer of BristolMyersSquibb said, "I am excited about the opportunity to continue our collaboration with Biocon and Syngene. The BBRC has supported the nonclinical development of a large proportion of our small-molecule portfolio assets since its inception, and is a premier example of the high-quality innovative drug hunting that is taking place in India today."[c]

a Saroglitazar is a potential therapeutic option for the management of diabetic dyslipidemia (a condition characterized by abnormal amounts of lipids such as cholesterol in the blood). It is being marketed under the name of Lipaglyn by Zydus Cadila.

b Rifampicin is an antibiotic used to treat several forms of bacterial infections including tuberculosis and leprosy.

c Business Standard, "Biocon expands tie-up with Bristol-Myers," 4 June 2014.

5 c. Best practices:

Case study 21:

Biotechnology Industry Research Assistance Council (BIRAC)

Launched in 2012, the BIRAC is an initiative by the Indian government's Department of Biotechnology (DBT) to generate "bio-innovation capital" in India. Founded as a non-profit enterprise, it acts as an interface agency to strengthen and empower emerging enterprises to undertake research and innovation in the field of biotechnology that addresses nationally relevant product-development needs. BIRAC creates impact by providing access to risk capital through targeted funding, technology transfer, IP management and handholding schemes for individual entrepreneurs, start-ups, small-scale enterprises and academic spin-offs.

As part of its endeavor to nurture novel ideas with commercialization potential, BIRAC operates a grant-based funding scheme called the Biotechnology Ignition Grant (BIG). Under BIG, very early-stage grants are provided to stimulate the commercialization of research discoveries. The scheme is managed through five partners[129] who provide mentoring, monitoring, networking and other business-development-related activities. To date, more than 150 innovators have benefited from the BIG scheme,[130] including a number of the biotechnology start-ups interviewed in the course of this study.

Along with providing financial and mentoring support, BIRAC also provides Indian bio-innovators with an international platform to increase their competency and enhance capacity building. BIRAC has partnered with the Centre of Entrepreneurial Learning (CfEL) at University of Cambridge's Judge Business School to enable five BIRAC-supported applicants to go through an intensive entrepreneurial boot-camp program called Ignite. The program provides one week of intense mentorship and training, and in the second week encourages them to interact and learn from Cambridge's entrepreneurial cluster.

A unique partnership has also been launched between DBT, BIRAC and the Bill & Melinda Gates Foundation to collaborate in scientific and technological research regarding the world's most critical global-health and development issues.[131] To facilitate translational research, BIRAC has partnered with the UK-based Wellcome Trustwith the aim of delivering safe and effective healthcare products at an affordable price.[132] BIRAC has also used the 2+2 method of funding in collaboration with the Indo-French Centre for the Promotion of Advanced Research to fund projects with one academic and one industrial partner from each country. Under the aegis of DBT, BIRAC also invests in ideas and innovations that tackle social problems under its Social Innovation Program for Products Affordable & Relevant to Societal Health (SPARSH) initiative.[133] Through its flagship programs, BIRAC is also making significant investments in the medical-electronics and devices sector. It additionally has several other programs that promote early- and late-stage funding, which have benefited more than 300 organizations.[134] As several interview respondents noted, BIRAC has been successful in creating an ecosystem though which the country's true potential in the biotechnology sector can be realized.

Case study 22:

Strand Life Sciences[135]

Set up in 2000 by a group of four computer-science professors at one of India's top institutions, the Indian Institute of Science (IISc) Bangalore, Strand Genomics (later named Strand Life Sciences) initially started off as a software company catering to the life-sciences sector. The firm began as a bioinformatics company that developed advanced data-processing, annotation and visualization software tools and services for the global bioinformatics industry.[136] Within the first few years, the firm received multiple rounds of seed and series-A funding. During this period, Strand was able to develop high-end contract services and products for a primarily American client base. Over the next 11 years, the firm grew to become a profitable USD 25million company with a client base of more than 1,400 research laboratories worldwide, or roughly one-third of the market.[137] In 2012, the firm's founders sought to take the company to a next step.

One option was to sell the company and make a healthy profit. The second and more exciting option was to do a complete pivot, and move from being a narrow technology provider to a fully vertically integrated molecular-diagnostics company. The founders leveraged their newly acquired next-generation sequencing (NGS) capability as well as their jointly funded genomics laboratory as the foundation for this shift in direction. The founders tapped into their external network to gain insight into the molecular-diagnostics market, find specialized talent in the diagnostics space and form a business plan to take to investors in 2012.

Since early 2013, Strand has been able to raise USD 12 million in capital, build out clinical-diagnostics laboratories in India and the United States, and develop various diagnostic tests for cancer-related genome profiling and familial risk analysis for various inherited disorders. In addition, in partnership with the Mazumdar-Shaw Center for Translational Research, the company has been able to develop affordable diagnostic tests for familial genetic cancer risk for USD 250, versus traditional tests that typically cost three to 10 times as much. It has been able to do this by harnessing its core strength in the bioinformatics field and lowering the cost of chemical reagents by 30% to 40%. Strand co-founder Vijay Chandru believes that two factors have enabled the company to successfully pivot from being a pure bioinformatics company into a personalized-medicine company. The first is a deep understanding of molecular biology and clinical correlates (an information-science challenge and the firm's core competence). The second is its possession of globally accredited CAP[a] /ISO next-generation sequencing capability, a field in which the entry barriers are high.

a CAP accreditation, provided by the College of American Pathologists, ensures the standard and quality of pathology and laboratory services through education and standards setting, and is awarded when the laboratories meet or exceed regulatory requirements.

6. Key takeaways

- *While all five sectors analyzed do show some level of innovation activity across each of the innovation archetypes, they are most active in the innovation-as-a-service and process-innovation fields.*

- *In the Indian automotive industry, the three most significant innovation trends are: 1) a growing number of captive R&D centers; 2) a steady increase in R&D intensity among automotive manufacturers and suppliers; and 3) an emphasis within the downstream segments of the automotive value chain on disrupting semi-formal markets like used-car sales and spare-parts sales through business-model innovation.*

- *In the engineering sector, four main trends are evident: 1) India is the single largest player in engineering-services outsourcing; 2) adoption of automation and Industry 4.0 mechanisms remains at the early stages; 3) the number of engineering-related start-ups is growing; and 4) the quantity of ecosystem enablers, such as tinkering laboratories and maker spaces, is increasing.*

- *Innovation in the Indian BFSI sector is primarily driven by the underlying need to increase financial inclusion and financial-service penetration within the country. The top trends in this sector are: 1) a boom in online/mobile banking; 2) ongoing disruption in the payments sector; and 3) the emergence of innovative players in the financing and insurance space.*

- *In the IT and BPM industry, intensifying competition from countries like Vietnam and the Philippines is pushing Indian companies to move up the value chain and focus on technology. The main innovation trends here include: 1) increasing efforts to create intellectual property (IP) in areas such as the internet of things and augmented and virtual reality; 2) growth in the SaaS model; and 3) growth in the number of start-ups focusing on hardware such as 3-D printing, as well as in the social, mobile, analytics and cloud (SMAC) area.*

- *In the Indian pharmaceutical and biopharmaceutical sector, many companies are seeking to build upon significant earnings in the generics business. As a consequence, companies are: 1) beginning to invest in drug-discovery research; 2) innovating in the area of vaccines; and 3) exploring new business models so as to lower the cost of innovation.*

III. INFLUENCING FACTORS

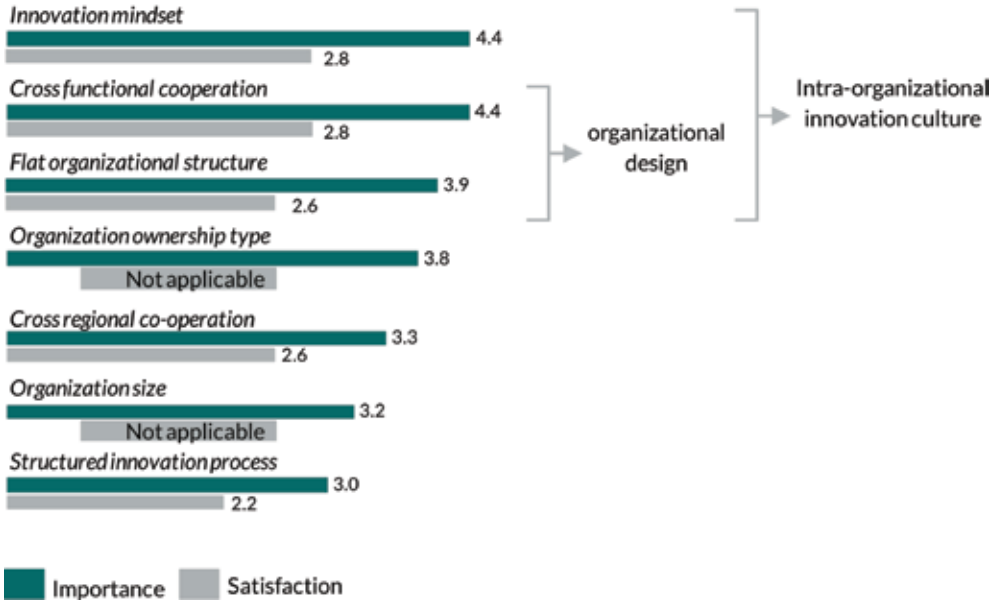
Innovation does not take place in a vacuum. A number of actors both internal and external to an organization affect its ability to innovate. In our study, we have identified what companies ("India Inc.") view as the most important drivers for innovation, and assessed their level of satisfaction with each of those factors in India. Further, we have used secondary research to further explore the strengths and challenges associated with each factor, and here highlight best practices and key success factors for each.

A. Internal influencing factors

We asked interviewees to address specific internal drivers of innovation, and highlight their satisfaction level with each as manifested in India. These internal drivers include the company's innovation mindset (that is, an organization's attitude regarding innovation, including such features as fear of failure or openness to risk), organizational design, (e.g., flat or hierarchical, and whether it encourages cross-functional cooperation), ownership type, size, and internal innovation processes. Our results indicate that companies' internal innovation cultures and the extent of cross-functional cooperation were perceived as being the most significant internal influencing factors affecting innovation. Notably, interviewees also reported less than moderate satisfaction on both these counts (see Figure III.1).

FIGURE III.1 **Internal factors influencing innovation in India: importance and satisfaction**

Importance of and satisfaction with internal influencing factors
[1 = not important/not satisfied, 5 = very important/ very satisfied][a]



Source: Survey conducted during December 2015 – July 2016; Roland Berger
[a] Survey carried out January – August 2016 by Roland Berger

1. Intra-organization innovation culture (innovation mindset and organizational design)

"Corporate culture is, above all, the most important factor in driving innovation."[138]

This refers to the critical uncertainties that are necessary to build innovation-oriented enterprises. On the right side of the axis, we see organizations that have a high level of entrepreneurship. These have the following characteristics:

1 a. Overview

In our survey, we combined innovation mindset and organizational design into one factor – intra-organizational innovation culture – as the two are inextricably linked. Interviewees subsequently identified this as one of the most important innovation drivers. Innovation mindset refers to the attitude of the organization toward innovation; thus, how well it accepts and reacts to failure, and its attitude toward risk, hierarchy and traditional chains of command. In contrast, organizational design refers to structural, formal and informal systems and processes within the organization, and how well they are designed to support innovation. This includes the question of whether:

- Innovation-related projects and initiatives are given importance and priority by the company's leadership.
- There are clear-cut budgets and resources allocated for innovation projects.
- Innovation-related key performance indicators (KPIs) and incentives (formal compensation and/or other types of recognition such as awards) encourage employees to engage in experimentation and go beyond their basic functions to develop new products and services.
- Innovation projects are well designed and efficiently structured, for instance with effective innovation-project team compositions and the use of subject-area experts and external consultants.
- There is a clear governance structure for innovation projects that determines which projects which projects will be undertaken, reviews project progress, modifies strategy and resource allocation if necessary, and determines when a project should be terminated, among other functions.

1 b. India Inc. views

A number of the companies interviewed said that intra-organizational innovation culture was the most important internal factor for innovation, resulting in an average rating of 4.4 out of 5 with regard to the importance of innovation mindset and cross-functional cooperation and an average rating of 3.9 out of 5 for flat organizational structure. In assessing their own degree of satisfaction, most respondents said they did not believe that organizational culture in Indian companies adequately encourages, motivates or rewards innovation, adding that it focuses instead on short-term objectives such as revenue and profit growth. Representatives of several companies said cross-functional collaboration was lacking within their R&D or innovation teams, and that there is a tendency, especially in large organizations, to work in silos. Interviewees also felt that organizations in India tend to be hierarchical, often deferring to authority instead of assessing the true quality of ideas, a characteristic that undermines innovation capability.

Quotes from India Inc.:

- "Indian companies are only now starting to care about innovation" – CEO, engineering company
- "Indian companies are typically complex, siloed and hierarchical," – Strategy head, IT company
- "Traditionally, we do not tolerate failure. I think this is not constructive" – Co-founder of services start-up

1 c. Strengths

Most high-level company executives interviewed expressed an understanding of the importance of a strong intra-organization innovation culture, and cited active steps that they were taking to create this in their companies. Many company representatives felt it was important to promote the idea of "intrapreneurship" within their organizations, as entrepreneurial and high-performing employees are likely to leave for a competitor or their own ventures unless they find avenues to pursue their professional interests internally. Many respondents claimed to have taken formal and informal steps toward creating this culture in their organizations, setting both top-down and bottom-up initiatives into motion.

1 d. Challenges and weaknesses

While companies in India are taking steps to optimize their organizational culture to promote innovation, a few things are holding them back. In particular, many

respondents complained that firms in India are too hierarchical in structure. Innovation is a complex and collaborative process requiring multiple skillsets and perspectives. A "boss is always right" culture can be inimical to this, as it induces employees to repress their creativity. Figure III.2 offers a comparison of how India fares vis-à-vis other countries in terms of power distance within companies (extent of hierarchical organization). Navi Radjou, innovation expert and co-author of Jugaad Innovation, identifies this as one of the key reasons for Indian employees' low level of workplace engagement.[139] Moreover, a number of interviewees expressed the opinion that Indians find it hard to accept failure. Industry leaders such as Adi Godrej (chairman of the Godrej Group) and RC Bhargava (chairman of Maruti Suzuki India) have also discussed this issue in public forums, stressing the need to develop a culture that allows for mistakes.[140] Among the start-up founders interviewed for this study, several cited the difficulty they'd had in convincing their families of the value of following an entrepreneurial path instead of taking a high-paying and steady corporate job at a multinational. While this culture is slowly changing thanks to the success stories experienced by many start-ups in the country, the mindset will remain common for some time to come.

1 e. Best practices and examples

Despite the challenges facing Indian innovators, we also came across a number of companies that clearly recognized and sought to address the cultural shortcomings that hampers India's traditional corporate sector with regard to innovation. Some of these were spotlighted in more detail in Section II. Among the start-up sector specifically, we see that Indian start-ups are actively trying to create a culture that is flat, open and diverse. They encourage a practice of "failing fast" in order to falter, learn and iterate quickly.

1f. Key success factors

- Open discussion of "failures" through top-down initiatives and communications.
- Innovation processes that mandate employees to "leave the designation at the door."
- Support from superiors balanced with provision of sufficient autonomy to employees to experiment.
- Employee's KPIs aligned with innovation objectives of the business unit or department.

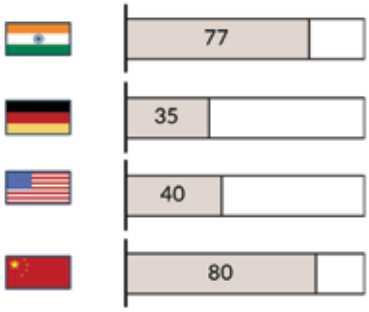
FIGURE III.2 **Hierarchy in India**[141]

Respondents feel that hierarchical organizations in India are hindering innovation

Hierarchy in India is another deterrent for innovation

> Respondents to the RB survey place a high importance to flat organizational structures for innovation
  – But with an average rating of 2.72 out of 5 in terms of satisfaction with it, respondents believed Indians do not work in flat organizations
> Moreover, culturally, power distances are significantly higher in India than in other developed countries

Power distance (extent of hierarchy)[1)]



Hierarchy in India [phrases from the Hofstede Centre][2)]

"Indians, in general are dependent on the boss or the power holder for directions"

"Management directs, gives reason to one's work life & rewards in exchange for loyalty"

"Immediate superiors accessible but one layer above less so"

Industry speak

"Indian companies & the general environment in India is very complex, siloed & hierarchical",
- Director of established Indian Automotive firm

"In many startups, 3-4 founders have all the power. This is too centralized & not conducive to innovation",
- CEO of services startup

1) Calculated by Geert Hofstede et al using a 28 question survey; the index is relative
2) Operated by itim International, with the endorsement of Prof. Geert Hofstede, using data from his study

Source: Company interviews; Hofstede et al (2010); Roland Berger

Case study 23:

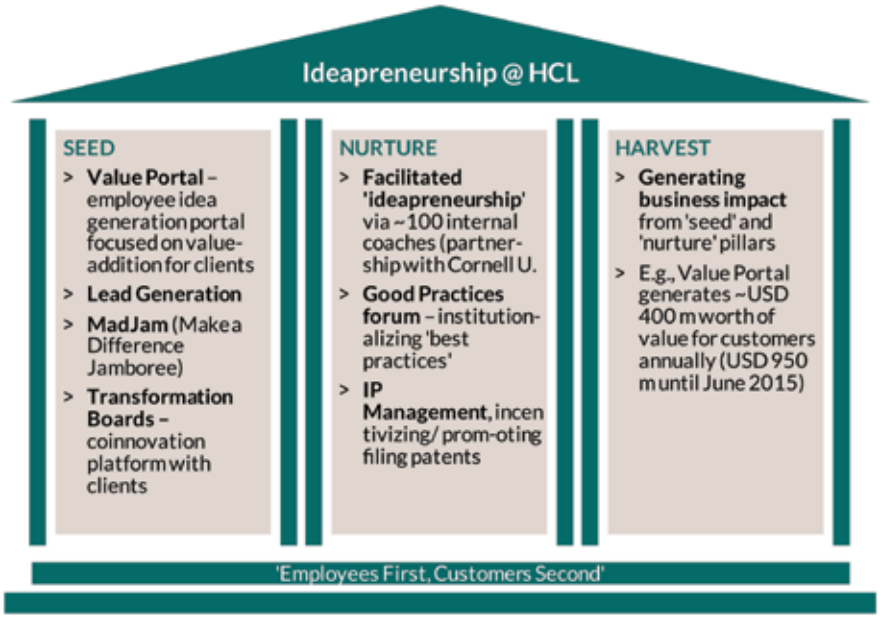
HCL Technologies and "ideapreneurship"[142]

HCL Technologies is one of India's leading offshore IT and software-development outsourcing companies, offering services such as software consulting and application development to clients worldwide. Today, HCL is renowned not only for its IT services, but also for an innovation-driven culture that nurtures employees' entrepreneurial capabilities through its "employee first, customer second" philosophy.

As far back as the mid-2000s, HCL recognized the importance of employees in creating value for its clients. This led to the birth of "ideapreneurship" within the company. Ideapreneurship refers to a client-focused, ideation-oriented, operational and cultural transformation occurring within the organization.[143] The organizational pyramid at HCL was turned upside down, making management accountable to its employees and transferring responsibility for change and value creation to front-line employees.[144] Ideapreneurship is now core operational foundation for HCL's "Relationship beyond the contract" business strategy, which is the company's brand commitment to deliver value that exceeds the stated contractual terms of a customer's service agreement.

The success of ideapreneurship at HCL can be seen in the 40,000-plus ideas generated by the company's more than 22,000employees for more than 400customers between its launch in 2007 and June 2015. Out of this body of ideas, more than 12,600 have been successfully implemented, creating value of more than USD 950 million for clients. In 2011, the company's Value Portal system for collecting employee's ideas received the Forrester Groundswell Award in the Management Innovation System category.[145]

HCL has multiple platforms and initiatives across the organization to build a culture of innovation among its employees



> Innovation is based on the principle of putting 'employees first, customers second'
> The firm emphasizes values such as autonomy, intrapreneurship, accountability, and a sense of purpose
> The objective is to increase the value of every interaction with customers and stakeholders

Impact of Value Portal[1)]

> **No. of employees involved in idea generation:** 22,000+
> **No. of ideas generated:** 40,000+
> **No. of ideas implemented:** 12,600+
> **Value delivered to customers:** USD 950 m
> **No. of active customers on the portal:** 400 +

1) Since 2007, as of June 20th, 2015; this initiative won the company the Forrester Groundswell Award in the management innovation system category in 2011

Source: Company interviews; Company website; Engage for Success; Roland Berger

2. Other internal influencing factors

Our survey revealed that other internal factors such as organization ownership type, organization size, cross-regional cooperation and innovation processes were not considered to be important drivers for innovation in the Indian context. In the following, we address insights from our interviews relating to these subjects.

2a. Organization ownership type

Interviewees indicated a belief that ownership patterns have some impact on corporate innovation in India, but that this is not an important driver (average rating is 3.6 out of 5). While there was a general view that government-owned companies tend to be less innovative than their private-sector counterparts, several respondents cited examples such as the ISRO and CSIR as counterexamples. Moreover, there were mixed responses with regard to the innovativeness of publicly listed companies versus privately held. While some respondents argued that privately held enterprises tend to be less innovative, a number claimed that second-generation family-owned enterprises are increasingly prioritizing the importance of innovation. Moreover, given that they are not answerable to public shareholders, they are more willing to make long-term decisions with regard to investing in R&D. A third point raised by some respondents was that publicly listed companies typically cannot invest in disruptive non-core areas due to shareholder opposition. Others believed this was not the case, and cited the examples of Google, Apple and Facebook continuously innovating in non-core areas of their business, despite being publicly traded enterprises.

2b. Cross regional cooperation

Interviewees believe that cross-regional cooperation is a benefit, but is not an important driver of innovation. This is reflected in respondents' average rating of 3.3 out of 5 for this indicator. Moreover, they indicated that globalization had made innovation across regions a given.

2c. Organization size

Our study reveals that respondents do not consider the size of an organization to be an important driver of innovation, with the indicator receiving an average rating of 3.2 out of 5 in terms of importance. While many indicated that innovation becomes more complex as organizations grow larger, they agreed that this can be overcome by having systematic processes and systems in place allowing for bottom-up and top-down innovation.

2d. Structured innovation process

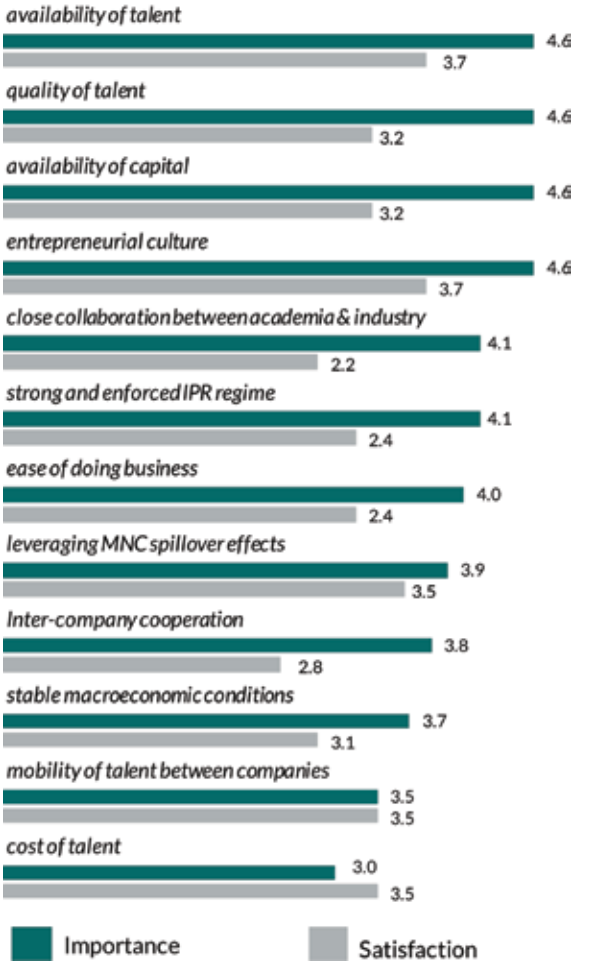
Interviewees gave mixed responses regarding the importance of a structured innovation process for innovation. While representatives from product companies emphasized the need for a structured stage-gate innovation process, given the relatively few number of firms focusing on product innovation in India, many interviewees felt that this was not an important driver of innovation in India. Indeed, some even felt that a structured process can stifle creativity, and that a little "chaos" was necessary to innovate. As a result, the indicator received an average rating of just 3 out of 5.

B. External influencing factors

We also surveyed company representatives regarding the importance of external influencing factors on a company's ability to innovate. Survey results (see Figure III.3) indicate that the availability and quality of talent, availability of capital and an entrepreneurial culture are very important for innovation (average rating of importance > 4.5). Close collaboration between industry and academia, a strong and enforced intellectual-property-rights regime, and the ease of doing business are also considered important external factors influencing innovation (average rating of importance > 4.0).

FIGURE III.3 **External factors influencing innovation in India: importance and satisfaction**

Importance of and satisfaction with external influencing factors [1 = not important/ not satisfied, 5 = very important/ very satisfied]



Source: Survey conducted during December 2015 – July 2016 Roland Berger

1. Quality and availability of talent

"Innovation depends on people who are able to generate and apply knowledge and ideas in the workplace and in society at large." [146]

This refers to the critical uncertainties that are necessary to build innovation-oriented enterprises. On the right side of the axis, we see organizations that have a high level of entrepreneurship. These have the following characteristics:

1 a. Overview

The impact of the quality and availability of talent on innovation is quite clear. Without an adequate supply of high-quality human capital, innovation will not take place no matter how strong a company's innovation culture may be, or how significant the financial resources it devotes to the issue. The availability of high-quality talent is therefore a necessary precondition for innovation to thrive.

India boasts a large workforce of approximately 502 million people.[147] Given the current demographic profile, another 280 million are expected to join the workforce by 2050. Moreover, according to the Ministry of Human Resource Development, around 1 million people enter the workforce in India every month. As a result, the country is expected to see a severe shortage of jobs over the next 35 years.

1 b. India Inc. views

Our interviewees confirmed that both the availability and quality of talent are critical innovation drivers. In terms of satisfaction with the availability and quality of talent in India, respondents were more satisfied with the supply of talent in India (average rating of 3.7) than with the quality (average rating of 3.2). There were some conflicting views with regard to the quality of talent in India – while some believed that the talent is world-class, others felt that the quality of talent, particularly at the entry level, shows severe shortcomings. While there was almost unanimous agreement that Indian employees have the intellectual capacity to innovate, as reflected in the large number of Indian nationals working at and thriving in the world's most prominent innovation centers (e.g., Silicon Valleyor leading world research institutions such as NASA), respondents indicated a belief that the training provided at Indian educational institutions often fails to nurture or inculcate an "innovation spirit." As a result, firms must spend time and resources in training their employees.

Quotes from India Inc.:

- "We are innovating in India primarily due to the availability of some of the best minds in the world" – Vice president, global IT company.
- "India has abundant manpower, but quality is severely lacking – particularly in specialized profiles" – Founder of hardware start-up.

1c. Strengths

India boasts of significant engineering manpower, particularly in the IT and computer-science fields. This talent is not limited to entry-level jobs, but also extends to highly skilled positions, for example within research and development. When asked to name the top competitive advantages of innovating in India, survey respondents unanimously identified high-quality talent as being among the top two advantages.

1d. Weaknesses and challenges

Poor employability of entry-level graduates

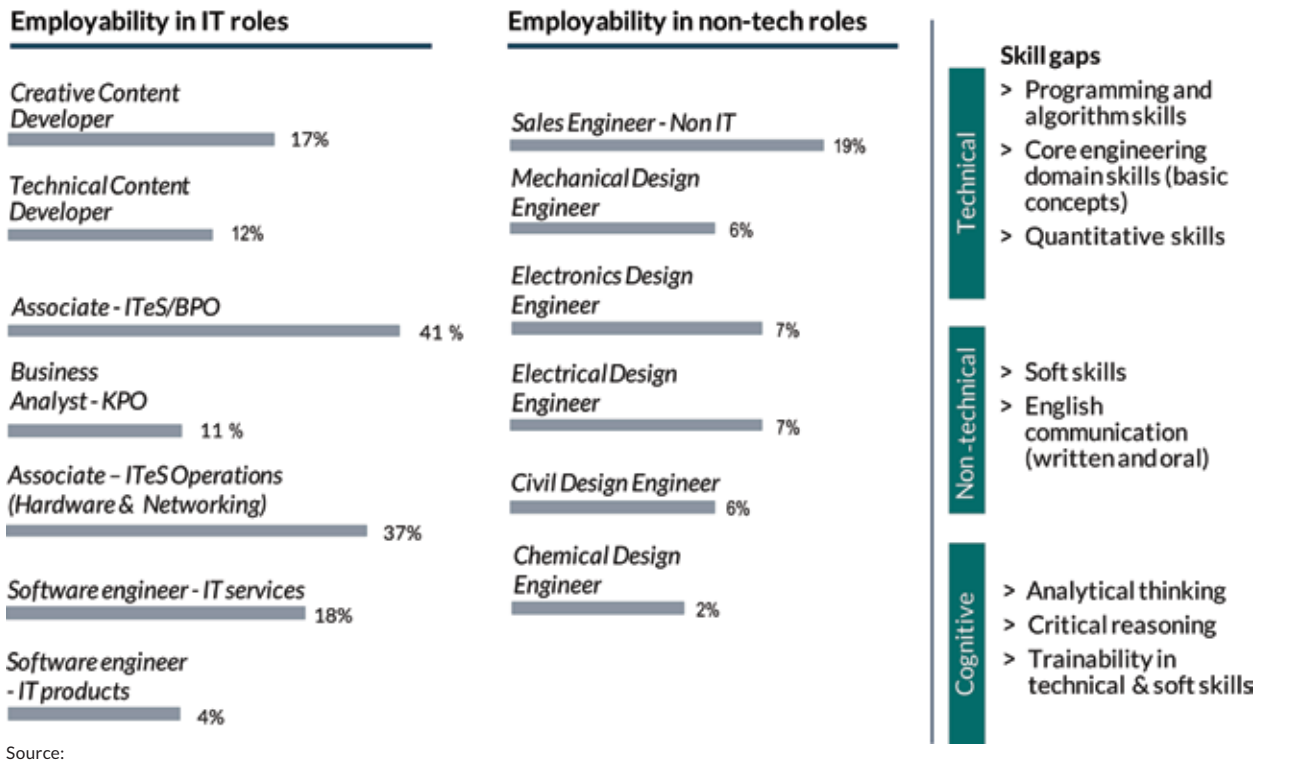
While India may boast of a large workforce, there are significant shortcomings with regard to quality at the level of entry-level graduates. The poor employability of engineering graduates has been widely documented. According to the third edition of the National Employability Report, Engineering Graduates, 2014, only 18% of entry-level engineers are actually employable within the software-services sector (see Figure III.4). In the case of software products, that figure falls to less than 4%. This reflects major skills gaps among entry-level engineers, particularly with regard to programming and algorithm skills, soft and cognitive skills, engineering-domain skills, and English speaking and comprehension skills.[148]

Limited formal training provided by companies

Moreover, only 36% of firms in India provide their employees with formal training, despite widespread complaints that educational institutions do not provide adequate skills. In comparison, in China, 79.2% of firms offer formal training to their employees.[150] It has also been observed that firms providing employee training are 23% to 28% more productive than those that do not.[151]

FIGURE III.4 **Employability of entry-level graduates in India[149]**

Poor level of employability across entry level graduates in several engineering fields is a cause for concern



Source:

Shortage of qualified PhDs

India also fares poorly vis-à-vis other countries with regard to doctorate-program enrollments. The country saw 107,890 enrollments for doctorate-level studies in 2013,[152] compared to 213,000 in Germany, 290,853 in China, and 391,601 in the United States.[153] PhD enrollments represented 0.33% of all tertiary-level education-system enrollments, as compared to China's 0.85%, the United States' 1.96%and Germany's 7.67%. A survey of undergraduates and master's-level students in some premier institutes in India reveals three main factors that may explain the comparatively low levels of doctorate-program enrollment in India. First, many graduates and post-graduates do not believe PhDs provide a significant improvement in job prospects or increase in salary in India, and thus are not worth the low stipends and long period of study required. Second, many students who do decide to pursue a PhD elect to do so abroad, where average doctoral-program quality is higher, funding options are more robust and better post-doctoral career options exist. Some of these students may consider pursuing their PhD in an Indian institute if it is a joint degree with a foreign university or at least entails research exposure to a foreign university. Third, many students simply do not consider pursuing a PhD because of a lack of information regarding this path and the career options associated with it. These students believe that more information on PhD programs and opportunities might make them consider the alternative more seriously.[154] In addition to the number of PhDs, the quality of such degree-holders is also an area of concern. Complaints regarding the "narrowness" of PhD training in India, where students are largely "lab-bound," relate to subsequently poor performance in areas such as communication, ethics, problem-solving and interdisciplinary working.[155] In the past few years, there have been also been numerous media reports on the trend of PhD theses being sold by external agencies (and even from some faculty members).[156] The country's dearth of doctoral researchers, mentors and guides is thus a constraint on the capacity of Indian academic and research institutions to produce high-quality research.[157]

Underdeveloped lifelong-learning culture

Lifelong learning is the ongoing pursuit of knowledge (formally or informally), which is typically done following the completion of formal education, for either personal or professional reasons. In India, it is today used as an umbrella term that includes basic adult literacy or post-literacy education, refresher courses, continuing education

and population education.[a, 158] The University Grants Commission[b] has recently issued guidelines helping to shape this umbrella definition, and has begun providing support for universities aimed at encouraging these programs. The challenges here are manifold, as employees in the formal sector have little time, and informal-sector employees have little disposable income. Moreover, general popular awareness of the programs available is limited, and educational institutions typically have few resources to devote to lifelong-learning programs. As a result, impetus for such programs is low in India, and the country's laws and regulations on the issue have fallen behind those in countries such as South Korea, Taiwan and Thailand, which have been more successful in this endeavor.[159]

1e. Best practices and examples

Bharat Forge[160] offers an excellent example of how an industry can nurture talent in India to create a highly capable and loyal workforce despite comparatively low wages. Bharat Forge is the flagship company of the Kalyani Group, a privately held industrial group in India with interests in engineering, steel, automotive and non-automotive components, renewable energy and infrastructure, specialty chemicals, and defense. The company is led by Baba Kalyani, a Massachusetts Institute of Technology (MIT) graduate from Pune. Bharat Forge aspired to position itself as a high-tech but low-cost vendor across key sectors such as defense, which meant it had to find excellent-quality employees at a low cost. The company faced a complicated recruitment challenge, given that the most highly skilled engineering graduates in India typically pursue careers in non-engineering professions due to starting salary differentials and perceived growth opportunities. Financial services, management-consulting companies and multinational companies have been the employment areas of choice in India since the mid-1990s.

Since Bharat Forge was unable to attract talent on pure salary terms, Kalyani adopted an innovative recruitment strategy, helping analytically exceptional high-school graduates who might otherwise lack the means to attend university pursue engineering studies. The company has established a partnership with BITS Pilani, a high-profile engineering institute in India, and offers top performers the opportunity to complete their undergraduate education in conjunction with work for Bharat Forge. Some of these employees are also given the opportunity for further company-supported education through post-graduate programs at IIT Mumbai and Warwick University (UK).

By providing financial security, educational opportunities and career paths to exceptional high-school graduates, Bharat Forge has engendered an outstanding culture of employee loyalty paired with engineering and technology excellence. At a broader level, Bharat Forge spends 12% of its employee expenses on training, with approximately 10% to 15%of its staff in training at any given point. Attrition rates are at less than 6% at an aggregate level, and less than 1% for higher-level employees. This is one of the core reasons for Bharat Forge's success in maintaining earnings before interest, taxes, depreciation and amortization (EBITDA) margins of around 30% in an industry where many competitors are struggling.[161]

1 f. Key success factors

- Education and training at universities with a focus on:
  - Coursework and examinations that train and test students on conceptual reasoning and problem-solving.
  - Pedagogy that emphasizes discussion, hands-on training and experimentation in place of purely lecture-driven formats.
  - Graduate certification in specific domains such as engineering.
- A formalized system of needs identification and investment in training by firms.
- Continuing-education programs that are designed and administered by a combination of trained faculty members and visiting industry representatives.

a Population education is education related to living within communities, states, nations or even the world as a whole, aimed at instilling basic values to help students develop rational and responsible attitudes and behaviors toward others.

b The University Grants Commission is a statutory body under the Indian government's Ministry of Human Resource Development, responsible for the coordination, determination and maintenance of higher-education standards.

2. Availability of capital

"Financing is extremely important for innovation and growth, in particular at the seed and early stages of business development."[162]

2 a. Overview

Innovation is usually an expensive, time-consuming, and risky proposition for start-ups, as well as for established corporate groups. Having sufficient capital available at all stages is critical in order to build or invest in technology, recruit the right talent, and increase the speed to market. Innovation also tends to be an equity-funded undertaking, as debt capital is typically unavailable to asset-light start-ups, and corporate groups prefer to fund potentially high-risk ventures with their surplus earnings rather than using them to leverage core business assets.

The typical financing path available to innovative start-ups is to raise initial seed capital from informal networks such as friends and family, and then to approach institutional investors such as venture-capital and private-equity funds (VCPEs) for subsequent rounds once the business, market or product has received validation.

The availability of venture funding in India has grown significantly over the past few years, with aggregate VCPE investments in technology companies growing from USD 1 billion in 2010[163] to USD 4.9 billion in 2015.[164] While the majority of this capital has been concentrated in spaces such as e-commerce, and has come in the form of follow-on backing for incumbent leaders, the increasing visibility of the start-up space has created a wider funnel of active high-net-worth individuals and institutional investors willing to be involved at the seed-capital and series-A stages. Notably, between 2014 and 2015, there was a 2.1-fold increase in the number of deals and a 2.3-fold increase in the number of active investors in India.[165]

2 b. India Inc. views

Interview respondents considered "availability of capital" to be one of the most important factors of influence for innovation in India, giving it an average rating of 4.6 out of 5. Respondents appeared to be moderately satisfied with the availability of capital in India, giving this indicator an average rating of 3.2 out of 5.

Quotes from India Inc.:

- "Plenty of capital available as long as it is for tried-and-tested products, services or business models. Institutional capital for more investment-intensive and risky businesses such as biotechnology or other types of hardware product is hard to come by."
  – Founder of an engineering hardware start-up

- "The Department of Biotechnology's Biotechnology Ignition Grant Scheme is truly a great example of how government can seed higher-risk technology areas."
  – Co-founder of a biotech start-up

2 c. Strengths

- Capital availability has been improving, with a number of Indian and international VCPE players now actively funding start-ups.

- A number of Indian and multinational companies are setting up corporate venture funds with the aim of keeping abreast of relevant technological developments and potentially investing in start-ups with complementary offerings.[166]

- Moreover, several privately held or family-owned businesses have established family offices in which private wealth is increasingly being invested in start-ups.

- Newer financing avenues such as crowdfunding and peer-to-peer (P2P) lending are also emerging.P2P lenders in India, including Let's Venture, Termsheet, Equity Crest and Grex, are primarily active at the micro-financing stage, helping individuals invest in start-ups in return for an equity stake.[167] These entities have provided financing to start-ups in sectors such as energy and robotics, and have thus far completed approximately 60 early-stage fundraising deals.

- The government is also playing a strong supporting role. Over the past few years, India's government has undertaken a number of initiatives seeking to ensure that adequate funds are available for start-ups and SMEs. In January 2016, in parallel with the Start-Up India, StandUp India campaign, the country's prime minister announced the launch of an INR 100 billion fund of funds that will invest in venture-capital funds over a period of four years, jointly financed by the national government and the state-owned Life Insurance Company (LIC).[168]

2 d. Weaknesses and challenges

Limited seed capital available for start-ups

VCPE funding is typically limited to start-ups that have met initial product- or market-validation hurdles, and are entering the expansion stage of their lifecycle. Although

the volume of seed- and early-stage capital grew by 2.7 times between 2014 (USD 105 million) and 2015 (USD 285 million), it accounted for only 6% of the overall funding provided by VCPEs in India in 2015.[169] This assertion is further corroborated by feedback from interview respondents, who said that funding is difficult to obtain until companies reach a particular size, and are able to demonstrate a market-proven value proposition. Innovators lacking access to high-net-worth individuals or a supportive informal network may be unable to bring their ideas to market in this environment.

Funding for globally untested ideas or those requiring large up-front investments remains a challenge

According to the founder of a hardware start-up in India, "Seed capital is still hard to get for hardware start-ups. The investment needed is higher and so is risk."[170] This opinion was shared by a number of start-up representatives, who said VCPEs in India are comparatively hesitant to invest in hardware ideas since the initial capital required to build a minimally viable product is typically larger than is the case for internet start-ups, and time to market is longer.

Moreover, because India has had few examples of successful start-ups in areas such as hardware, international investors tend to perceive these undertakings as higher-risk propositions. For their part, some Indian investors may be unable to back these enterprises due to lack of adequate experience or expertise. However, this trend is expected to change. Infosys co-founder Kris Gopalakrishnan, who has created his own venture-capital fund and incubator, Axilor Ventures, says, "We need to make heroes of these companies, whether they succeed or fail. VC funding will come in this area because India is a large consumer market and the numbers are there."[171]

2 e. Best practices and examples

Investing in biotechnology R&D is often a high-risk venture, and it is difficult for small- to medium-scale organizations to dedicate appropriate funds for innovation. The Department of Biotechnology (DBT), a part of India's Ministry of Science and Technology, recognized this problem in 2005 and launched the Small Business Innovation Research Initiative (SBIRI), a public-private partnership to allocate public funds to small private organizations for R&D purposes. These funds are specifically allocated to Indian organizations[a] that qualify as "small business units,"[b] and cover an array of biotechnology projects related to healthcare, agriculture, industry and the environment, as well biomedical devices and instruments. Overall, the SBIRI scheme acknowledges the importance of early-stage funding and provides such funding for pre-proof-of-concept work, high-risk innovative research, late-stage development, validation and commercialization. The scheme operates in two phases: the first phase deals with early-stage pre-proof-of-concept research, and funding is made available in the form of grants and interest-free loans. In the second phase, soft-loan funding[c] is provided for late-stage development and commercialization. These loans and grants do not cover total project cost, but can defray a significant portion. However, a contribution from the recipient company is also mandatory. The Biotech Consortium of India Limited (BCIL) works in close collaboration with DBT and oversees project management for projects funded under SBIRI. A project monitoring committee (PMC) is formed for each project, tasked with monitoring the outputs, milestones, targets and objectives contained in the agreement. The PMC also includes two or three subject-area experts from Indian academic or research institutions, who provide additional support to the project team with regard to execution and IPR-related issues.[172] According to the program's modified April 2013 regulations, the company conducting the research has full rights to the intellectual property generated through the R&D activities.[173] In the period between its launch in 2005 and March 2014, more than 1,100 SBIRI funding applications were received. However, the applications go through a stringent evaluation process, and only 157 projects (105 companies) were allocated funding during this period.[174]

2 f. Key success factors

- Focused, industry-specific public-private-partnership-based funding for high-risk areas such as biotechnology.
- Family offices operated by high-net-worth individuals or successful serial entrepreneurs who are willing to provide seed capital and mentorship in exchange for equity.
- Micro-venture-capital firms with deep domain expertise that are willing to make small to medium-size investments – that is, possibly larger than angel investments, but smaller than full-size VC investments.
- Creative financing models suited for an Indian context, such as crowdsourcing platforms.

a To be considered as an Indian organization under this scheme, the company must be registered in India and at least 51% of the company's shares must be held by the Indian founders, family and friends,or the general public. Definition available at: http://sbiri.nic.in/HTML/who_can_apply.html

b A small business unit is defined as an enterprise with no more than 500 employees, engaged in R&D. Definition available at http://sbiri.nic.in/HTML/who_can_apply.html

c Soft loans up to IND10 million (100 lakhs) carry a simple interest of 1%, while the interest rate is 2% (simple interest) for larger amounts. Definition available at: http://www.birac.nic.in/desc.php?id=21

3. Entrepreneurial culture

3 a. Overview

"Government policies can support innovation by continually reforming and updating the regulatory and institutional framework within which innovative activity takes place."[175]
We define an "entrepreneurial culture" as the combination of an enabling innovation-policy environment with a facilitative "innovation infrastructure" external to an organization. While the former is provided by the government, the latter can be established by the public and/or the private sector.

Enabling innovation-policy environment

An enabling innovation-policy environment is one that has clear and dedicated policies related to the promotion of science, technology, innovation, education, skills development, research, start-ups and intellectual property. Moreover, as some countries have done, the government may also establish a dedicated body that drives innovation at the public-sector level. For example, in March 2016, Israel's government established the Israel Innovation Authority with this kind of mandate.[176]

In the past few years, the Indian government has taken an active interest in creating a policy environment conducive to innovation. Activities have taken place along two primary fronts: first with the goal of creating and empowering institutions to monitor and facilitate innovation in academia and the private sector, and second with the aim of developing policies providing the right level of focus on and resources for innovation (see Figure III.5 for an overview of government innovation policies).

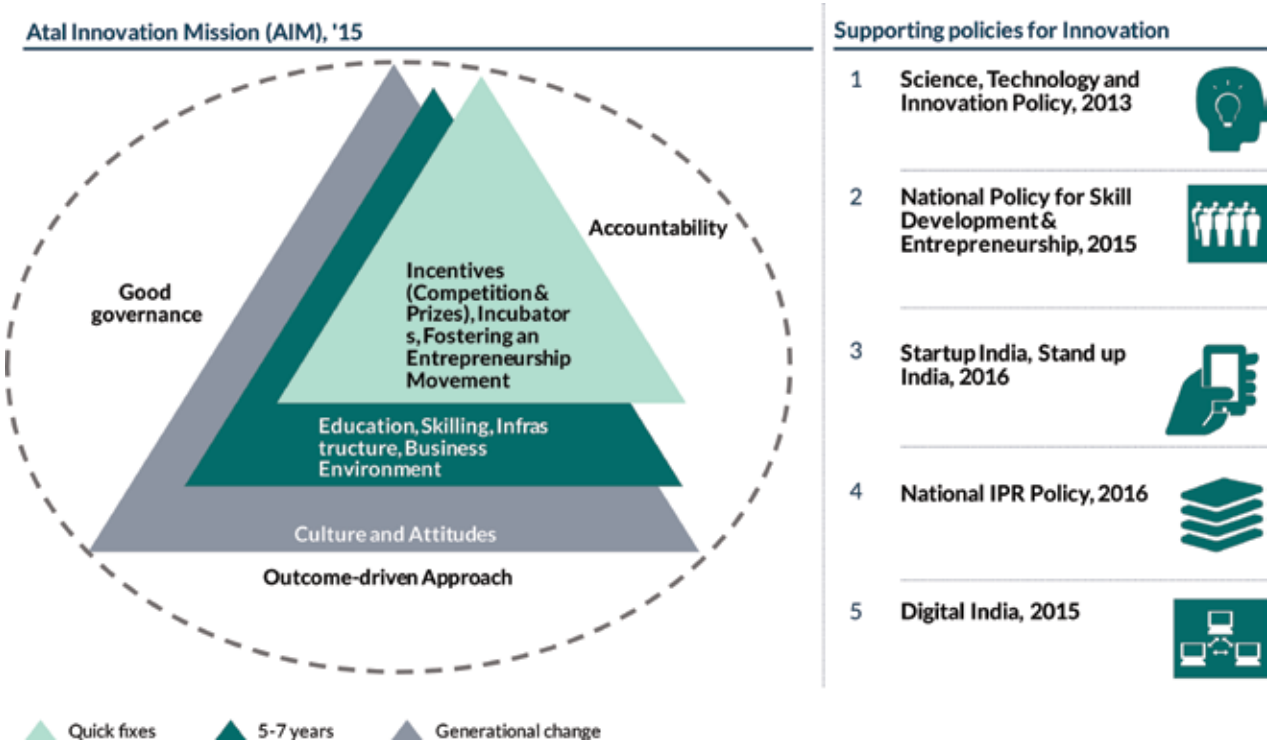
Institution building

Atal Innovation Mission, an initiative of the National Institution for Transforming India (NITI) Aayog,[a] is an innovation-promotion platform that aims to involve academics, entrepreneurs and researchers in fostering a culture of innovation and R&D in India. The platform plans to promote a network of world-class innovation hubs, incubation centers, tinkering labs and grand challenges for India. The platform aims to catalyze innovation by implementing initiatives with short-term effect, passing medium-term reforms and supporting long-term cultural change.[177]

a The National Institution for Transforming India (NITI) Aayog is the central government's planning body. It replaced the Planning Commission of India.

FIGURE III.5 **Indian government initiatives promoting innovation**

Several initiatives have been kick-started by the government to jumpstart innovation in the country – implementation is key



Source: NITI Aayog; National Policy for Skill Development & Entrepreneurship; Secondary sources; Draft IPR Policy; STI Policy 2013; Roland Berger

Policy framework

- **Science, Technology and Innovation Policy, 2013:** This policy is focused on improving scientific capabilities, attracting talented individuals to science through skills-building and career-development opportunities, improving R&D infrastructure, expanding private-sector participation in R&D, and creating a national innovation system able to position India among the top five global scientific powers by 2020. Promoting inclusive economic growth is also a goal.[178]

- **National Policy for Skill Development & Entrepreneurship, 2015:** This is India's first integrated policy addressing skills development and entrepreneurship. Its vision is to empower widespread rapid-action skills-development programs with high standards, and to "promote a culture of innovation-based entrepreneurship" able to generate wealth and employment and contribute to the development of sustainable livelihoods. It seeks to address key obstacles with regards to skills development, align the demand and supply of skills, provide equal opportunities for skills development to all, and educate and equip potential entrepreneurs.[179]

- **Start-Up India, StandUp India, 2016:** This policy aims to foster entrepreneurship and promote innovation by creating an ecosystem conducive to start-up growth. It simplifies and relaxes regulations with the aim of improving the ease of doing business, facilitating greater capital availability, and promoting the establishment of incubators, research parks and innovation centers.[180]

- **National Intellectual Property Rights Policy, 2016:** See section V-3 for details.

- **Digital India, 2015:** This is a flagship central-government program that envisions India's transformation into a digitally empowered knowledge economy. It encompasses a host of programs, projects and policies such as Digital Locker (for storing e-documents safely), MyGov.in (a citizen engagement platform), the Swachh Bharat Mission mobile app (Clean India Mission app), the eSign framework (for digital signatures), the National Scholarship Portal, a large-scale record-digitization campaign, and the Bharat Net project (envisaged as the world's largest rural-broadband connectivity project using optical fiber).[181]

- **R&D incentives to private entities:** India's tax regime for R&D investments is among the world's most generous. Until the 2015–2016 fiscal year, the government provided a 200% tax deduction for any capital or revenue expenditure incurred on in-house R&D by a company. In the future, India is set to reduce this gradually to 150% for the 2017–2020 period, and to 100% from 2020onward. In parallel, the government plans to introduce a patent-tax regime in which income derived from patents developed and registered in India falls under a concessional tax rate of 10% as opposed to the general corporate-tax rate of 30%.[182]

Facilitating innovation infrastructure

We use the term "innovation infrastructure" to refer to all physical and virtual infrastructure that supports innovation. This includes incubators, accelerators and shared industrial infrastructure such as tinkering labs and testing and certification infrastructure.

Incubators and accelerators

Incubators and accelerators are important for start-ups and established companies. Incubation can be defined as intensive support that helps start-ups and established companies grow at an accelerated pace, typically from infancy to a "steady state" condition. Support can come in the form of physical facilities, mentoring, market access, funding and/or administrative services, with the overall objective of increasing incubator members' chances of survival and commercial success.[183] While formal government-funded incubators have existed since 1982[184] (see Figure III.6 for details on the government's public-incubator program), private incubators and accelerators are fairly new to India and have proliferated only in the past six to seven years.

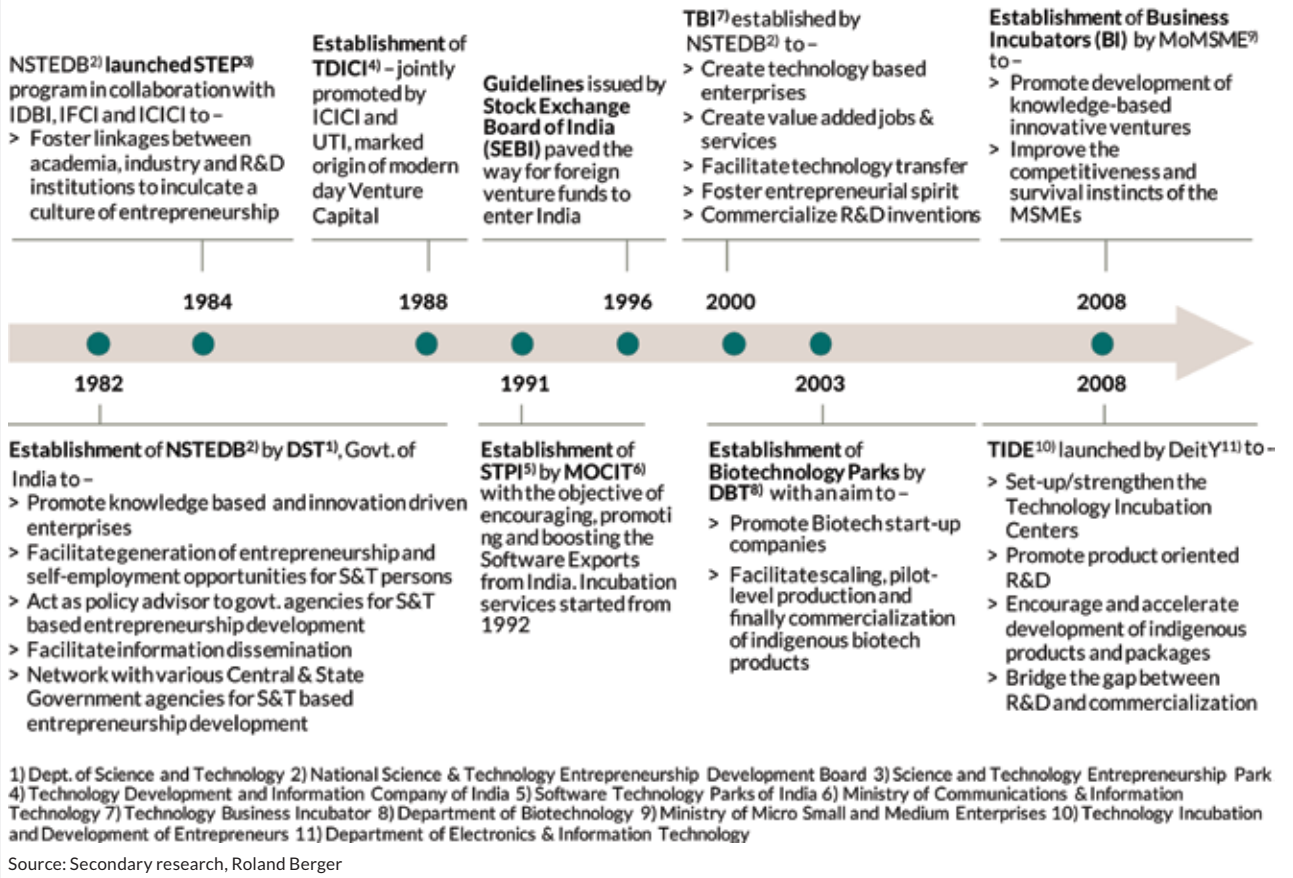
A number of large companies including Microsoft, Google, Target and SAP have set up external corporate incubators as a way to establish links with the start-up community, keep abreast of the latest technology, search for potential licensing or acqui-hiring[a] opportunities, and even increase adoption of their own platforms (e.g., Microsoft Azure, Android)

Tinkering laboratories and public testing and certification laboratories

Tinkering laboratories and public testing and certification laboratories provide start-ups and smaller established companies with access to state-of-the-art equipment that they would not otherwise be able to afford, and allow them to experiment, test, and certify new products. Tinkering

a The act of buying out a company primarily to gain access to the skills and expertise of its staff or start-up team.

FIGURE III.6 **Evolution of India's government-funded public incubators**



1) Dept. of Science and Technology 2) National Science & Technology Entrepreneurship Development Board 3) Science and Technology Entrepreneurship Park 4) Technology Development and Information Company of India 5) Software Technology Parks of India 6) Ministry of Communications & Information Technology 7) Technology Business Incubator 8) Department of Biotechnology 9) Ministry of Micro Small and Medium Enterprises 10) Technology Incubation and Development of Entrepreneurs 11) Department of Electronics & Information Technology

Source: Secondary research, Roland Berger

labs are a fairly new phenomenon in India. A few maker spaces have been established in large cities, and the Atal Innovation Mission has announced a program to fund the establishment of 500 tinkering laboratories across the country.[185] Testing and certification laboratories, by contrast, have been set up both by the government and by public-private partnerships, and are typically concentrated in industry clusters.[a]

3 b. India Inc. views

Interviewees believe that a vibrant entrepreneurial culture is very important for innovation, giving it an average rating of 4.6 out of 5. While there is some variation among respondent opinions with regard to the appropriate nature and extent of government involvement needed for innovation, most agreed that government should be a key facilitator in the innovation ecosystem. The vast majority of respondents acknowledged that India's government is taking active steps to strengthen the innovation-policy environment, and that progress is being made in developing the country's innovation infrastructure. Respondents' satisfaction level with regard to the country's entrepreneurial culture (as defined in this study) was relatively high vis-à-vis other influencing factors, with an average rating of 3.7 out of 5.

Quotes from India Inc.:

- "The government has announced many initiatives to drive innovation and start-ups in India. While this is a positive step, implementation of these schemes is key."
  – Founder of a logistics start-up.

- "Tinkering laboratories and maker spaces are important for innovation and have the ability to turn consumers into prosumers"
  – Founder of a maker lab space.

- "Incubators and accelerators provide critical mentorship and market access to incubate start-ups and act as a filtering criteria for angel investors and venture capitalists"
  – Chief strategy officer of an IT firm.

a Testing and certification facilities are being created under the Cluster Development Program, and are usually categorized as common facility centers. Source: Economic Times article (http://articles.economictimes.indiatimes.com/2013-08-11/news/41295796_1_cfcs-spv-bahadurgarh

3 c. Strengths

- India's government has taken a number of steps to facilitate an entrepreneurial culture.
  - The Atal Innovation Mission has already launched programs to fund the establishment of 100 incubators and 500 tinkering labs across the country.
  - Testing and certification laboratories in some industries are considered to be state of the art by interviewees, with the latest testing equipment being made available. However, use remains a challenge, as the level of awareness of the laboratories is low, and the knowledge regarding how to use such equipment is not widespread.
  - Most existing publicly funded technology incubators in India are supported by top academic and/or R&D institutions. Though there has been no study on the overall impact of all these incubators, the National Science and Technology Entrepreneurship Development Board's (NSTEDB) 53 technology-business incubators (2009), which cost INR 1 billion to establish, have incubated enterprises that have generated revenues of approximately INR 6 billion, indicating a high level of impact.[186]
  - Scores of private and corporate incubators are incubating new ventures and technologies across a variety of domains. Examples include Kyron, biotechnology incubator Escape Velocity Accelerator, the Rural Technology Business Incubator at IIT-M, Villlgro and many more.

3 d. Weaknesses and challenges

- In the past few years, there has been a string of policy initiatives, reforms and new campaigns aimed at improving entrepreneurial culture in India. This indicates a positive intent and direction. However, effective implementation by the bureaucracy and other stakeholders will be critical with regard to ensuring these programs' longevity and success. For example, one government directive ordered central-government ministries and public-sector undertakings (PSUs) to procure at least 20% of their required products and services from micro, small or medium-sized enterprises (MSMEs), a category that also includes start-ups. However, a recent review revealed that less than half of the country's PSUs were complying with the directive.[187]

- Interviews indicate that the government's procurement policy is not innovation-friendly. Though eligibility norms have recently been relaxed for start-ups, cost is still the main criteria for qualification rather than outcome-based metrics such as product efficiency or total cost of ownership.

- Private incubators remain at an early developmental stage, and need to establish operating models that will sustainable over the long term. Several incubators have been launched and shut down (e.g., The Morpheus or Hatch)[188] largely because of infeasible operating models. Our interviewees pointed out that many private incubators try to replicate globally successful models such as that of Y Combinator, (a prominent Silicon Valley incubator) that may in fact not fit the Indian environment without modification.

3 e. Best practices and examples

- Kyron is a Bangalore-based global accelerator and a sister company of ANSR Consulting, a company that sets up offshore captive centers or globalin-house centers (GICs; both terms refer to overseas subsidiaries of global corporations) in India. ANSR customers include Wells Fargo, Target, Victoria's Secret, Time, SuperValu and Lowe's. Typically, ANSR establishes a joint venture, with the client companies taking a stake of about 20% to 30% in the GIC.[189] Kyron helps these GICs set up their corporate-accelerator program and matches them with high-quality start-ups for a period of six months. During this time, the start-up provides customized solutions for these larger corporations, in exchange for mentorship and potential licensing agreements for its technology. In this way, Kyron acts as a very effective bridge between Indian start-ups and large multinational corporations.

- Recognizing the dearth of hardware start-ups in India, Intel is collaborating with the country's government and academic institutions to strengthen support for this sector. In August 2016, for example, Intel announced an incubation program in collaboration with Department of Science and Technology (DST), the Society for Innovation and Entrepreneurship (SINE) and the Indian Institute of Technology, Bombay. This unique collaboration between academia, industry and government is specifically targeting the gaps faced by entrepreneurs in the hardware start-up ecosystem, particularly with regard to product design, development, commercialization and scaling. With a target of 20 start-ups incubated per year, the program consists of two phases. In the first phase, start-ups will be supported on-site at SINE, IIT Bombay or Intel's Bengaluru center. Intel will provide one-on-one mentoring and technology-related support from experts, while SINE will provide business-services support and assist with prototyping and manufacturing.

After six months in the program, the start-ups will present their solutions to investors and other external companies, after which time the program will provide virtual support for another six months. While it is too soon to ascertain its success, this collaborative incubation program represents a positive change for hardware based start-ups which have been lamenting the lack of financial and non-financial support in India's ecosystem.[190]

3 f. Key success factors

- A proactive and supportive government with clear, consistent and entrepreneur-friendly policies and regulations. This can go a long way in developing a strong entrepreneurial culture.
- Incubators and/or accelerators that provide mentorship and market access for start-ups.
- Strong networking platforms that allow entrepreneurs, academics and industry representatives to meet and share knowledge and ideas.

4. Industry-academia linkages

4 a. Overview

"Collaboration between universities and industries is critical for skills development (education and training); the generation, acquisition and adoption of knowledge (innovation and technology transfer); and the promotion of entrepreneurship (start-ups and spin-offs)." [191]

It is a widely accepted fact that close interactions between industry and academia is necessary for innovation. However, the two sets of institutions by nature have different goals and expectations regarding research and innovation. The goal of academic research is to expand the frontiers of knowledge and understanding, at least in the case of fundamental research. By contrast, the primary research-and-development objective of for-profit enterprises is to develop new products and services that can be commercialized. These distinct sets of objectives make most industry-academia collaborations complex and challenging.

Despite the challenges, both parties typically see value in collaborating with one another. Academic research institutions can make significant contributions to a company's progress, by taking blue-sky approaches (that is, not immediately focused on real-world applications) to fundamental research questions, or by providing access to new technologies, patents, tacit knowledge, the validation and testing of industry ideas, and a pool of highly skilled researchers. Industrial R&D also creates value for academia by providing insight into which of the latest technology trends have commercial value, creating curriculum inputs, identifying promising areas of research focus and providing access to funding.

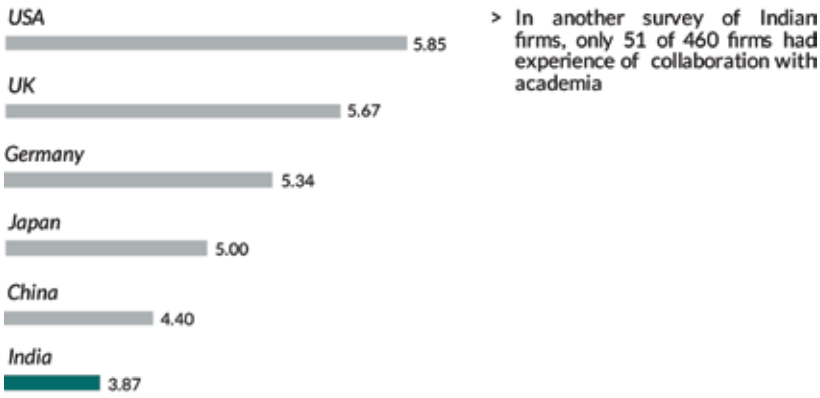
Industry representatives cite the lack of collaboration between universities and industry as the second-most significant barrier to innovation in India, according to a survey conducted by the National Knowledge Commission.[192] Moreover, India scores lower than China, Japan, Germany, the United Kingdom and the United States with regard to the "average rating of extent of collaborative R&D with universities" (see Figure III.7).

4b. India Inc. views

Our interviewees confirm the secondary research results mentioned above. Respondents believe that close collaboration between industry and academia is a significant driver of innovation, giving it an overall rating of 4.1 out of 5 in terms of importance. This factor also ranks the lowest in terms of satisfaction with the current state

FIGURE III.7 **Extent of collaborative R&D between industry and universities**[193]

Avg. rating of extent of collaborative R&D with universities [Scale: 1–7; Executives[1]]



1) Different weights were assigned to data points from differentyears; India – [43.6% weight, 211 executive responses, '14] & [56.4% weight, 236 executive responses, '15]; Similarly, Germany – [39.96%, 99, '14; 60.04%, 149, '15], USA – [42.31%, 369, '14; 57.69%, 458, '15], Japan – [40.65%, 64, '14; 59.35%, 91, '15], China – [44.93%, 362, '14; 55.07%, 364, '15]

Source: World Economic Forum; Global Innovation Index 2015; Joseph et all (2009); Roland Berger

of affairs, receiving an average rating of 2.2 out of 5. While a few respondents said they were increasingly positive regarding the level of interaction between the two types of organizations, the vast majority of respondents identified this as a major area of weakness within the innovation ecosystem.

Quotes from India Inc.:

- "Indian academia has traditionally not worked closely with industry, as having a commercial agenda is usually frowned upon. This dearth of commercial experience has also led to a capability deficiency among Indian academics in terms of [the] timely execution of joint research projects."
  – Vice President of an engineering company.

- "Our experience with partners from academia has been extremely positive, and we are surprised by how well things have gone."
  – Senior R&D manager for an automotive OEM.

- "Mobility options from academia to industry are virtually non-existent in India"
  – Business head at a services start-up.

4 c. Strengths

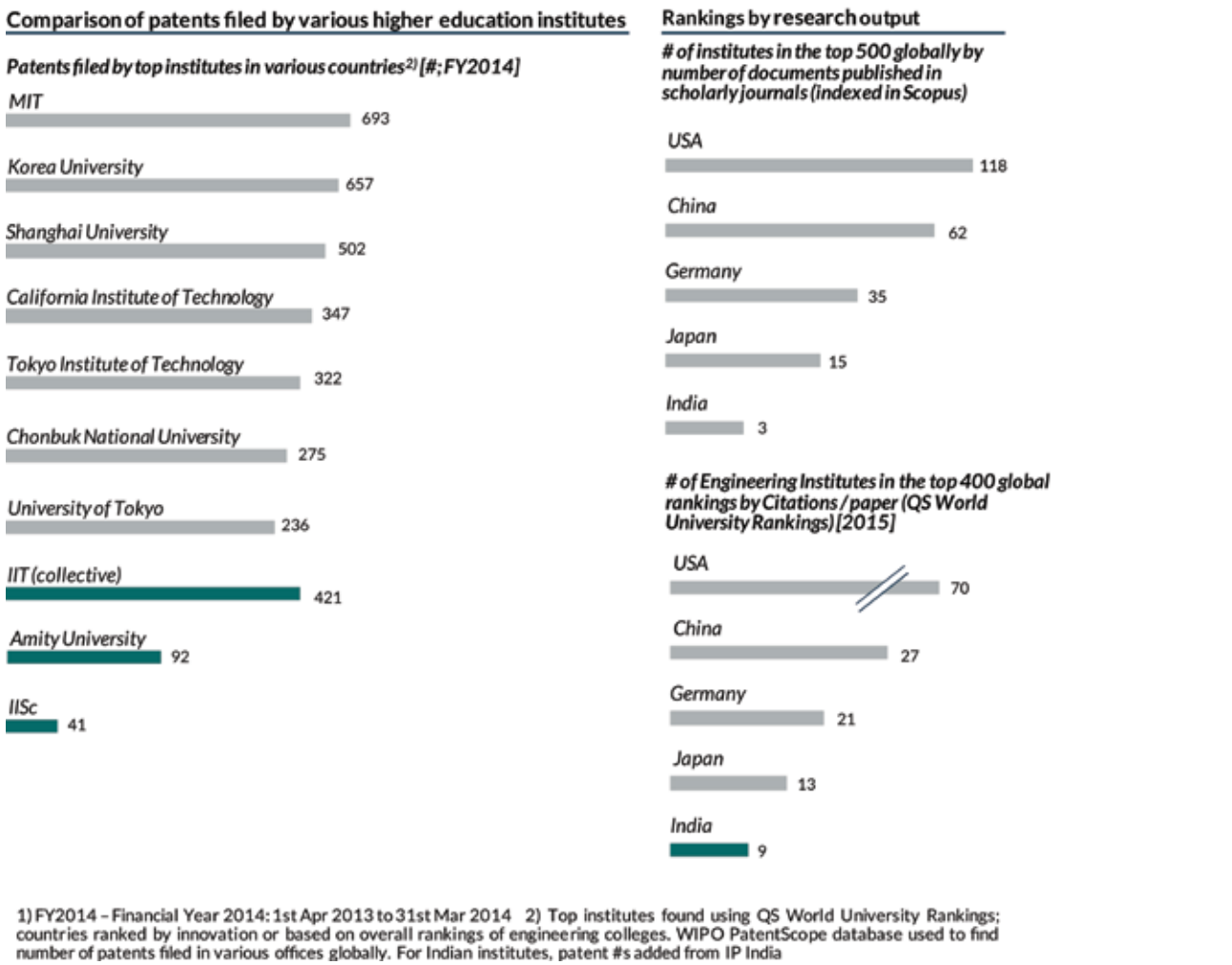
- Pockets of excellence exist. While company representatives lamented the quality of industry-academia collaborations overall, a number of survey respondents reported that they were satisfied with the quality of collaboration with their academic counterparts. These collaborations were largely with top-tier Indian institutions such as the Indian Institutes of Technology (IIT), the Indian Institute of Science (IISc), BITS Pilani, the National Center for Biological Sciences (NCBS), and the Indian Institutes of Science Education and Research (IISER). However, respondents also said that successful partnerships tended to be highly dependent on the individuals involved, particularly on the university or research-institution side. Thus, if key individuals retire or leave one of the participating organizations, collaborations often stagnate or come to a halt.

- Academic institutions are realizing the importance of industry collaborations, and are taking active steps to take this kind of work more seriously. Many institutions are setting up technology-transfer offices, and have formally developed IPR policies and guidelines for collaborations with other institutions and companies. As a result, the number of ongoing industry-academia collaborations is growing, with both domestic and international partners.

4 d. Weaknesses and challenges

Apart from these pockets of excellence, however, our survey revealed that the vast majority of industry-academia collaborations exist purely on paper, and fail to deliver on their original objectives.[194] The interviews further showed that no one party is to blame; challenges exist at the academic/research-institution level, the industry level and in the interaction between the two.

FIGURE III.8 **Global comparison of research outputs**



1) FY2014 – Financial Year 2014: 1st Apr 2013 to 31st Mar 2014 2) Top institutes found using QS World University Rankings; countries ranked by innovation or based on overall rankings of engineering colleges. WIPO PatentScope database used to find number of patents filed in various offices globally. For Indian institutes, patent #s added from IP India

Source: WIPO PatentScope Database; QS World University Rankings; IP India Annual Report 2013–14; Scimago; Roland Berger

At the academic-institution level

Limited incentive to commercialize research

Indian institutions are typically either publicly or privately funded. Respondents from academia and industry alike assert that since their funding is not tied to research output, there is little or no incentive for academic institutions to be self-sustaining or publish research that is of value to industry. Even at the individual level, salary and incentive structures are fixed and do little to push researchers to specialize with the aim of creating and commercializing IP.[195] While respondents from academia and the corporate sector acknowledged that the past decade has seen some improvement, this appears to be limited to a few institutions in the country.[196]

Poor quality of research

Indian institutions lag behind their international counterparts both with regard to the quantity and the quality of their research outputs. The emphasis in such institutions is on teaching rather than on developing deep specialization.[197] This deters many companies from investing time and resources in collaborating with these institutions (see Figure III.8).

At the industry level

Low capacity to absorb research or technology

Respondents from academia mentioned that in many cases, particularly among micro, small or MSMEs, there is little capacity to absorb the research or technology coming out of universities. As a result, there is a low level of "productization" with regard to academic research. While this is slowly changing, our survey respondents identified this as one reason why much of the high-quality research from academia is not commercialized.[198]

Unrealistic timelines
Interviewees from academia also commented that the timelines set by industry are often too aggressive and unrealistic.

4 e. Best practices and case examples

Case study 23:

Collaboration between IIT Delhi Phoenix Medical Systems and Saksham Trust [199]

Independent navigation on the streets is a difficult task for the visually impaired. It is even more difficult in countries like India, where obstacles like window-installed air conditioners and non-standard objects on sidewalks and corridors are common but undetectable by using the traditional white canes. M. Balakrishnan, a professor of computer science at IIT Delhi, was approached by a visually impaired person at the National Association for the Blind and asked to develop a cane that could do a better job detecting a wider range of obstacles. He worked closely with his students to develop a "Smart Cane."

This cane leverages ultrasonic ranging technology,[a] which is commonly used in medical and robotic-vision applications, to detect obstacles above knee level. The development of this device required embedded-system and mechanical-design capabilities. The project team thus enlisted the support of the Rapid Prototyping Lab at the IIT Delhi mechanical-engineering department, where it developed the mechanical design. Once the prototype was developed, the team began to search for private companies that might be interested in commercialization. They came across Phoenix Medical Systems, a small Chennai-based firm, which proved eager to partner with them. However, this firm lacked the funding to carry out the commercial production and marketing.

Given the absence of promising funding avenues, the project stalled until the team participated in a competition organized by the UK-based Wellcome Trust[b] on the issue of affordable healthcare in India. After several rounds of review, the Smart Cane team was selected by the Wellcome Trust for funding. Wellcome, unlike other funding agencies, proved willing to fund the entire phase of translational research, and pushed the team to ensure that the product had the Conformité Européene or European Confomity (CE) mark[c] and other key certifications in order to help with market acceptance. The team engaged in market testing with the aim of getting user feedback. To this end, Saksham Trust, a non-profit organization working to improve quality of life for the disabled, tapped into its member base to conduct 150 trials across multiple cities.[d] Consumer feedback on the first prototype indicated that the cane needed to be gripped in an unnatural manner in order to detect obstacles. The team subsequently asked users to demonstrate their grips on a plaster-of-paris mold, and then made a reverse 3-D model enabling design of a handle that was convenient for different gripping styles. After three prototyping stages the Smart Cane product was finally ready for market. The product was launched in 2014[200] at the affordable price of INR 3,000.[e] It was made available through the Indian government's Assistance to Disabled Persons (ADIP) program, which is free for the visually disabled,[201] and was also recently launched online through Indian e-commerce player Snapdeal. The product has been well-received in the market, with around 10,000 people already using it in India today. While product awareness is currently low, the Smart Cane has significant potential not only in India, but in numerous emerging countries.

a Ultrasonic ranging makes use of ultrasonic sound waves to detect object distances and sizes, thus using a non-contact technology. This is commonly used in medical operations to detect the size of cancer tissues or obstacles in blood vessels, as well as in the robotic-vision field.
b Wellcome Trust is a global charitable foundation focused on biomedical research. It is the largest non-governmental funder of medical research after the Bill and Melinda Gates Foundation.
c CE Mark is a European certification indicating that a product's manufacturer has complied with the essential requirements of European health, safety and environmental-protection regulations.
d Professor Balakrishnan asserted that this was the largest human trial for a disability product in the world to date.
e The only other similar competitor, the UltraCane, is priced at GBP 680 (about INR 60,000 at September 2016 rates).

Assistech laboratory at IIT Delhi has successfully developed a low-cost smart can device to facilitate navigation for the visually impaired

Smart Cane: Navigating the visually impaired

- In countries like India where obstacles like window air conditioners and non-standard boards on sidewalks and corridors are common but undetectable by the traditional white canes[1] which makes independent navigation is difficult for the visually impaired
- At Assistech laboratory in IIT Delhi, under guidance of Prof. M Balakrishnan, researchers have developed a smart cane for efficient detection of obstacles
  - The cane is able to detect obstacles above the knee height
  - It can detect objects located 3 m away from the sensor when moving outdoors and can be adjusted to 1.8 m when indoors

Success of Smart Cane

- The production and scaling phase of the smart cane project was funded by the 'Wellcome Trust' from UK through a competition conducted on "affordable healthcare solutions in emerging markets", Smart Cane was the winner of this competition
- The cane has been displayed in a museum in UK and the designers have also won multiple awards

Key success factors of the Smart Cane

User trials and feedback

- The device went through multiple stages of prototyping and around 150 trials were conducted across India with the help from Saksham Trust

Funding

- Funding from an international organization – The Wellcome Trust which understood that a lot of funds are needed for translational research. The high interest from the investor to increase the global acceptance led to smart cane getting the C-mark

High technology yet easy to use

- Simple yet high technology product which was easy for the user to understand was key to getting the smart cane accepted among the visually impaired

Multi-stakeholder collaboration

- The collaboration between academia (IIT Delhi), industry (Phoenix Medical Systems), end-users (Saksham Trust) and investor (Wellcome Trust) led to a successful product ready for market

1) Traditional white canes used globally are effective in detecting obstacles which fall between the ground and knee height, but often fail to detect obstacles that fall above the purview of the white cane

Source: Primary Interviews, Secondary Research, Roland Berger

4 f. Key success factors

- Industry-academia platforms through which stakeholders can meet, network, share and market ideas, and showcase each other's capabilities and challenges.
- Educational institutes that have a separate unit tasked with managing intellectual-property-related and commercialization topics for the institution, its faculty members and its students.
- A mutual understanding and appreciation for each side's culture, orientation and objectives.
- Liaisons with experience on both sides of the industry/academia fence who can help align interests and expectations and facilitate communication. For example, an academic institution might create the position of Professor of Practice, a dedicated faculty member with industry experience.
- A set of well-defined key performance indicators (KPIs) that are aligned across the institution-industry divide, along with well-defined timelines and other clearly specified contractual features.

5. Intellectual-property-rights (IPR) regime

5 a. Overview

"Intellectual property works to stimulate innovation by transforming intangible discoveries and creations into an asset class for businesses and entrepreneurs at every level, from the start-up to the small business to the multinational company."[203]

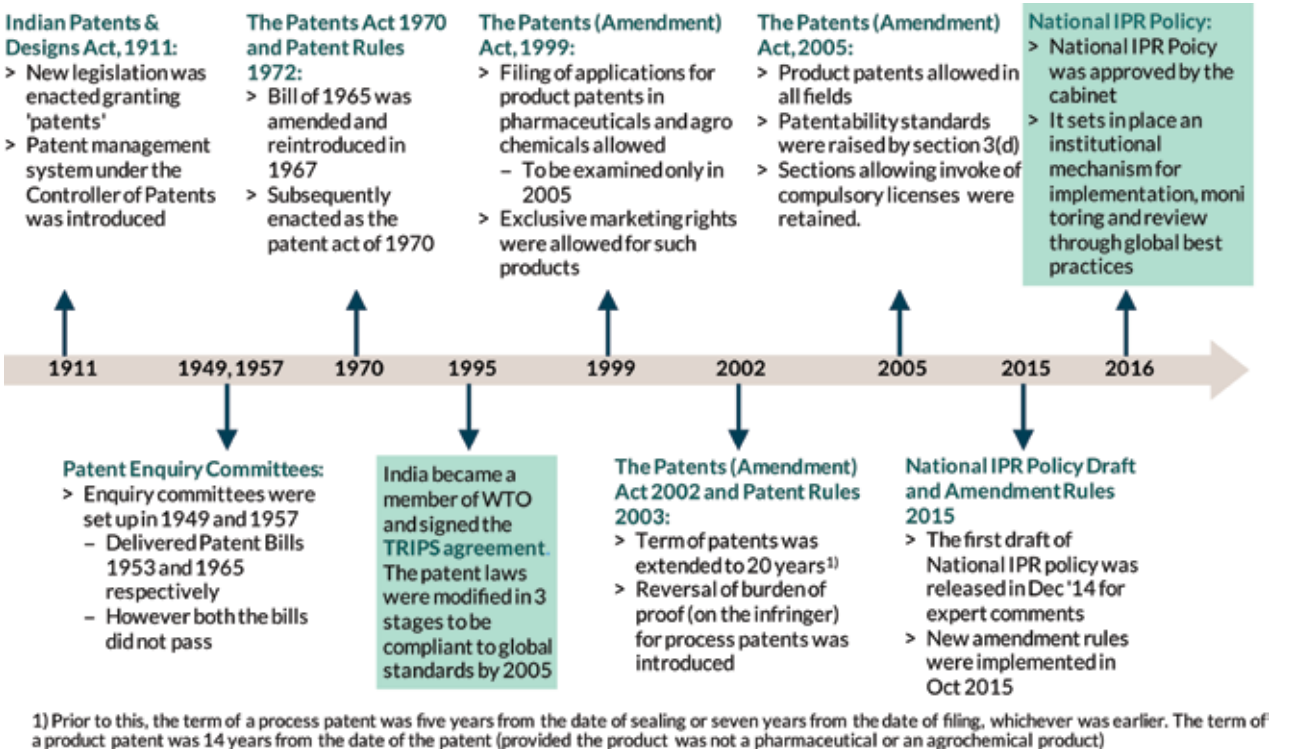
The impact of intellectual property rights on innovation has been hotly debated at a global level. Institutions such as the World Trade Organization (WTO), the World Intellectual Property Office (WIPO), the Global Intellectual Property Center (GIPC), and many corporations and academics believe that a well-functioning IPR regime is critical for an innovation ecosystem to flourish. On the other hand, a growing group of companies in Silicon Valley, as well as academics and politicians, are emerging as advocates of the open-source innovation movement. According to Professor Jeff deGraff, open source refers to "unrestricted access to designs, products and ideas to be used by an unlimited number of people in a variety of sectors for diverse purposes... The proliferation of open-access platforms has redefined the notion of intellectual property."[204] The focus here is less on singular ownership and more on the "distribution of creativity."[205]

Prior to 1995, products could not be protected under patent law. Numerous Indian pharmaceutical and agrochemical companies took advantage of this to reverse engineer existing products and develop generic versions of chemicals. India signed the Trade Related Aspects of Intellectual Property Rights (TRIPS) agreement in 1995, and became fully compliant in 2005. However, although India has been a TRIPS signatory for several decades, Indian patent law remains only loosely enforced. In May 2016, the Indian parliament approved a National IPR Policy. For a brief history of India's IP laws, please see Figure III.9.

5 b. India Inc. views

Interviewees largely agree that a strong and enforced IPR regime is important for innovation, assigning it an average rating of 4.1 out of 5 in terms of importance. Around 10% of respondents (primarily from start-ups, but also a few from large established multinationals) asserted that strict intellectual-property-rights regimes adversely impact innovation, and that an open-source innovation model should be adopted across their industry. Interview respondents were relatively dissatisfied with India's IPR regime, giving this an average rating of 2.4 out of 5. More than half of the respondents expressed dissatisfaction with the enforcement of IPR in the country rather than with the regulations themselves.

FIGURE III.9 **A brief history of India's IP laws**



1) Prior to this, the term of a process patent was five years from the date of sealing or seven years from the date of filing, whichever was earlier. The term of a product patent was 14 years from the date of the patent (provided the product was not a pharmaceutical or an agrochemical product)

Source: Official website of Office of the Controller General of Patents, Designs & Trade Marks; Asia IP website

Quotes from India Inc.:

- "I think there is an overemphasis on the whole 'IPR stifles innovation' argument. I am with Chomsky on this."
  - Vice president of an IT services firm

- "We are not interested in filing patents because we have no confidence that they will be enforced."
  - Co-founder of a start-up.

5 c. Strengths

- India is viewed favorably in comparison to countries such as China, Brazil and Russia in terms of IPR.

- The government is taking steps to strengthen the country's IPR regime.

  - The government recently unveiled its National IPR Policy 2016, a new vision document aiming to create and exploit synergies between all IP-related statutes and agencies, while also establishing an institutional mechanism for implementation, monitoring and review. The focus of the policy is on developing IPR awareness within the public, building capacities for teaching and researching IPR-related issues, and catalyzing IPR generation and commercialization. The policy also addresses the legal framework and aspects of administration and enforcement. Other highlights include:[206]
  - A proposal for a loan-guarantee program to encourage start-ups and cover the risk of genuine failures in commercialization, based on IPRs as mortgageable assets.
  - The Department of Industrial Policy and Promotion (DIPP) has been made the nodal agency for all IPR issues.
  - Films, music and industrial drawings are now covered under copyright law.
  - The government is seeking to establish intellectual-property units tasked with curbing IP offense, and plans to create or modernize infrastructural and personnel capabilities on the issue within law-enforcement agencies.
  - The government also seeks to setup commercial courts to adjudicate IP disputes, together with strengthening of mediation and conciliation centers for faster resolution of disputes.
  - The policy continues to be fully TRIPS compliant.

- The Indian Patent Office is being strengthened and provided with additional capacity. One of the main reasons cited for the high patent-application backlog (around 246,000 cases) is the shortage of manpower. For this reason, 373 additional posts in the patent wing have recently been approved by the central government. Additionally, the recruitment process for 459 vacant examiner posts has also been initiated. As a short-term measure, the government has also approved the creation of 263 contract-examiner posts.[207] With further additions proposed, India is expected to be on par with other jurisdictions in terms of time taken for patent grants by 2020 or 2021.[208]

5 d. Weaknesses and challenges

- A number of multinationals, particularly within the pharmaceuticals industry, have claimed that the Indian IPR regime is "regressive" and "unfair." Their primary criticisms focus on three points:[209]

  - Section 3(d): This section of the Indian IPR law restricts patenting of incremental innovations that do not significantly enhance the efficacy of an existing substance. By contrast, this is allowed in the United States. In the U.S., firms can file a new patent simply on the basis of an altered recommended dosage of a patented drug. In 2013, the Supreme Court of India denied a patent grant on an incremental innovation on the drug Glivec by Novartis, as the innovation could not be established as providing enhanced therapeutic efficacy. Many pharmaceutical multinationals asserted that the ruling was "against innovation," and that the courts were showing favoritism toward local generics manufacturers.[210]
  - Compulsory licensing: Section 84 of the Indian IPR law allows for the issue of compulsory licenses, through which India can enable domestic firms to launch cheaper variants of specific drugs in the broader public interest. U.S. companies regard this practice as a violation of their patents, and assert that it provides unfair advantages to generics manufacturers. Only one compulsory license has been issued by India to date, on Bayer's Nexavar, a cancer drug, which had been priced beyond the reach of most Indian patients. Other drugs including AstraZeneca's Onglyza are also under review.[211]
  - Price controls: The Indian government, through its Drug Price Control Order, has the right to control prices on life-saving drugs, which either makes an Indian launch less commercially viable or forces multinational patent holders to provide a license to a generics maker. Multinationals assert that prices are not a major deterrent to use of their drugs, as many of them have extensive "access programs" through which they support underprivileged patients.[212]

- Gaps seen in IPR enforcement.
  - IPR disputes are handled by regular Indian courts, which themselves face a huge backlog of cases. In some instances, cases have taken five or more years to be resolved.
- The process of filing a patent is cumbersome and lengthy, with approval time for patent applications in India averaging five to six years, compared to three years in the U.S. and UK patent offices.[213] Several start-ups interviewed for this report cited this fact in explaining why they see little value in filing patent applications.

5 a. Best practices and case examples

- China has emerged as a global leader in terms of intellectual-property filings. Thus, even as its policy regime and enforcement practices have been a topic of hot debate, its execution of filings has been exemplary. This has been possible in part due to government support in the form of financial incentives for R&D and patent filings, but also due to simple procedures for addressing infringement. The patent litigation procedure in China is very fast, often taking just six months from filing of a complaint to trial, and another three months for appeal. Total litigation time is generally less than a year, well under the several years typically required in the United States. More than 70% of Chinese patent lawsuits go all the way to trial without being settled or dismissed, whereas in the United States, only 10% of patent lawsuits reach the trial stage.[214] Some have alleged that litigation procedures in China are biased toward the local population, but foreign companies such as Motorola, Osram, Sony, Siemens, Kenwood, Bridgestone and Pfizer have all won patent lawsuits in the country.[215]

5 b. Key success factors

- A strong IPR regime is one provides balanced protection for inventors and innovators through adequate laws and strong enforcement, ensuring that there is incentive to innovate.
- In balancing their laws, countries must also respect individual rights and the larger public good, which creates differing claims across national contexts, peoples and cultures. At the same time, compliance with international laws must be ensured. Finally, laws need to be clearly written in order to ensure a simple and consistent interpretation.
- An adequate number of efficient and well-qualified patent examiners ensures the timely grant of patents, and thus enables innovators and inventors to obtain the full benefits of their work. Harmonizing practices across offices guarantees consistent and fair grants and rejections of patent applications.
- Creating separate IP courts can help speed dispute resolution, as this circumvents overburdened regular courts. At least one study has shown a positive correlation between the presence of specialized IP courts and the effective and efficient resolution of IP disputes.[216]

6. Ease of doing business

"A more favorable business climate is conducive to greater creativity and innovation."[217]

6 a. Overview

The ease of doing business in a country (with reference to indicators assessed by the World Bank, among others) has an indirect impact on its innovativeness. The easier it is to run an organization's day-to-day operations, the more time and resources (financial and human capital) an entrepreneur or company can invest in carrying out its competitive strategy, and therefore in innovation.

India was ranked at 130th place in the World Bank's Doing Business 2016 report. While an improvement over the previous year, this is still a major cause for concern (see Figure III.10).[218]

6 b. India Inc. views

Survey respondents indicated that the ease of doing business is an important driver of innovation in India, assigning it an average rating of 4.0 out of 5. Consistent with the World Banks' Doing Business rankings, respondents were unanimous in their dissatisfaction with this factor as currently manifested in India, giving it an average rating of 2.4 out of 5. Noting that a substantial part of their time is spent in surmounting bureaucratic hurdles, respondents said that improving the ease of doing business in the country would be among their top recommendations for Indian policymakers.

Quotes from India Inc.:

- "If you are spending much of your time fighting the red tape in the system, where is the time and mental bandwidth to innovate?"
  – Vice president of an Indian hospitality company.

- "You can forget about getting contracts enforced here – this acts as a deterrent to co-innovation."
  – Business head for an automotive supplier.

6 c. *Strengths*

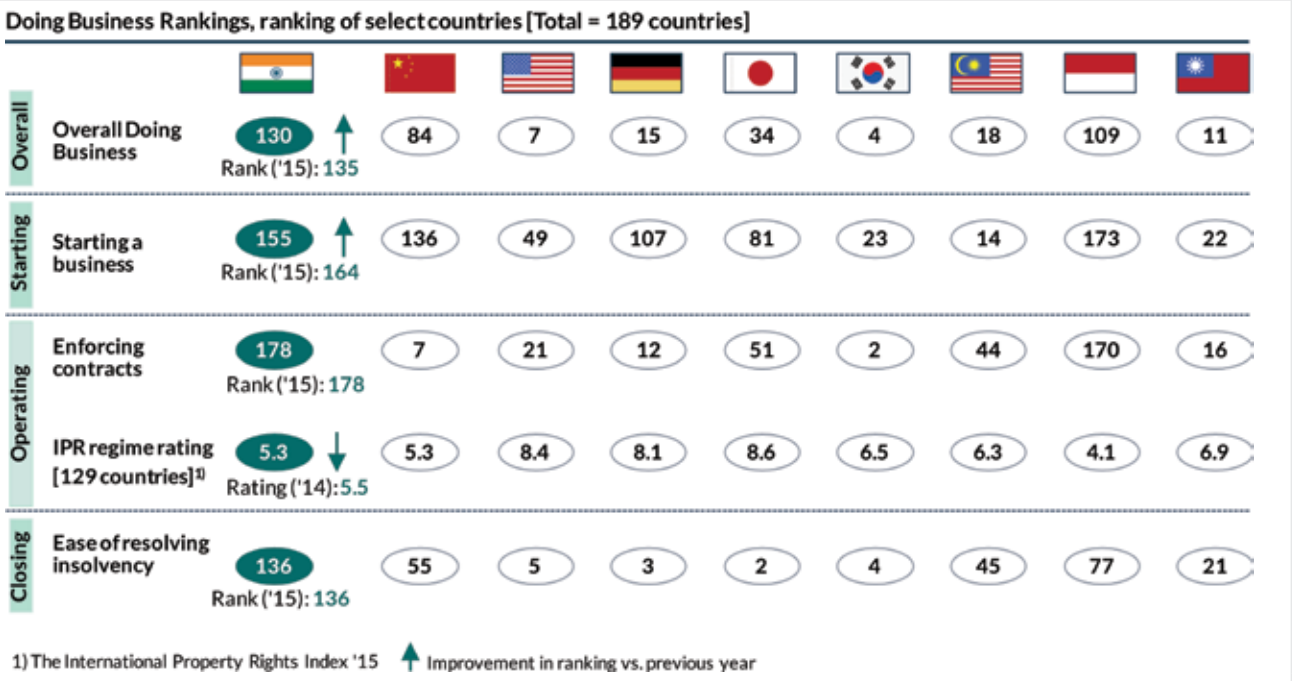
- Improving the ease of doing business in the country ranks high on the government's agenda.
  - The government realizes the importance of improving the overall business environment, not just to drive innovation, but for the country's overall economic-development agenda.[219]
  - Initiatives seeking to cut red tape are already underway, both at the local-government level (e.g., eliminating the minimum capital requirement, simplifying and speeding the process of getting an electricity connection in New Delhi, establishing a single window system for processing building-permit applications in Mumbai) and the central level (e.g., online systems for filing and paying corporate taxes).[220]
  - Improvement in some areas is already visible. For example, the number of days required to start a business has declined significantly, from 127 in 2004 to 29 days in 2015.[221]
- India shows good performance vis-à-vis the rest of the world on certain Doing Business sub-rankings.
  - In terms of protecting minority investors (e.g., shareholders in companies), India ranks 8th worldwide, ahead of countries including Germany, the United States, China and Japan.
  - India also does relatively well in comparison to countries such as China and Japan with regard to the legal rights of borrowers and lenders, and in ensuring availability of credit information. India ranks 42nd on the World Bank's "getting credit" indicator, while China and Japan are tied at 79th place.

6 d. *Weaknesses and challenges*

Starting a business

India has made significant progress since 2004 with regard to simplifying and speeding up the process of establishing a business, but it still has a long way to go. It was ranked at 155th place on this measure in 2016, a slight improvement over its 2015 ranking of 164th. The significant quantity of bureaucratic procedures (14 in total) lead to the high number of days (29) required to start a business.[222]

FIGURE III.10 **Ease of doing business, global rankings, 2016**



Source: World Bank; IPRI; Roland Berger

Enforcing contracts

Ranked at #178th place worldwide in 2016, India scores nearly at the bottom of the pack when it comes to enforcing contracts. This situation has not improved vis-à-vis 2015; on average, it takes 1,420 days to resolve a contract dispute, with an average cost of 40% of the value of the claim. In comparison, contract-dispute resolution in China takes an average of between 406 and 510 days, with an average cost of 15% to 17% of the value of the claim.[223]

Resolving insolvency

Given the inherent risk and high failure rate involved in innovation, having an efficient and effective bankruptcy system in place is critical to enable entrepreneurs and companies to mitigate their losses and try again. Moreover, a well-drafted bankruptcy law keeps investors' interests in mind, thus facilitating investment. India is currently ranked 136th with regard to the "ease of resolving insolvency," the same position held in2015. On an average, it takes 4.3 years to resolve an insolvency case, with average recovery rates of 25.7 cents on the dollar. In China, by contrast, average resolution time is just 1.7 years, with an average recovery rate of 36.2 cents per dollar of outstanding debt.[224] India's new Insolvency and Bankruptcy Code 2016 is expected to improve the country's rating on this indicator; however, effective implementation will be critical to the new policy's success.

6 e. Best practices and examples

Malaysia improved its distance to frontier (DTF)[a] in the Doing Business ratings from about 74% in 2010 to about 81% in 2014. This improvement was the result of a number of reforms.[225] Malaysia made it easier to start businesses by merging multiple procedures (company, tax, social-security and employment-fund registrations) through a one-stop shop. In addition, it reduced company-registration fees. The improvements were accomplished in part through the establishment of the Companies Commission of Malaysia, an autonomous body. This body implemented the reforms, and utilized IT and other modern management tools to improve the efficiency of the registration process without having to remove any steps. Moreover, the body also made it possible to file complaints in courts electronically by introducing computerized systems. Finally, Malaysia established dedicated commercial courts to handle insolvency proceedings.

6 f. Key success factors

- A reduction in the number of procedures. From starting a new business to construction or paying taxes, streamlining the operations and procedures that businesses must undergo reduces costs, effort and time required, increases convenience, and reduces opportunities for corruption.

- The use of information technology to automate various procedures. For example, online filing or other computer-supported case-management tools can make the judiciary more efficient, while online registration of new companies can save time and money.

- The creation of separate courts for commercial cases, thus enabling quicker resolution of contractual disputes, insolvencies and other related matters.

- Strong political leadership by top government officials. This is critical in ensuring that reforms are actually implemented, and in guaranteeing that decisions such as IT procurement are given a high priority.

a) DTF is defined as the normalized distance from the leading economy in a particular year with regard to overall ease-of-doing-business ratings. A score of 0% represents the lowest performer, while 100% represents the frontier. This is used when comparing the performance of a country over a span of years. We have calculated DTF based on an old methodology, and the data comparison is thus limited to the 2010–2014 period.

7. Other external influencing factors

Our survey revealed that other external factors such as the ability to leverage multinational spillover effects, intercompany cooperation, stable macroeconomic conditions, the degree of mobility of talent between companies, and the cost of talent were not considered to be important drivers of innovation in an Indian context. In the following, we present insights from our interviews regarding these topics.

7 a. Leveraging multinational spillover effects

The presence of multinational R&D centers in India has an impact on the innovation ecosystem in areas such as the movement of highly skilled employees, technology licensing from and to multinationals, and joint R&D collaborations with multinationals. However, interview respondents felt that leveraging these spillover effects was only moderately important with regard to driving innovation, assigning the indicator an average rating of 3.9 out of 5. While interview responses indicate that R&D collaborations between multinational R&D centers and Indian companies are still regarded as underdeveloped, respondents felt that exposure to the skilled employees working in these R&D centers was valuable in terms of promoting an innovation mindset more broadly.

7 b. Intercompany cooperation

Many respondents indicated that active intercompany cooperation, particularly in the area of pre-competitive research, can be an important driver of innovation. The panel thus assigned it an average importance rating of 3.8 out of 5. However, the level of satisfaction with regard to this topic was low, at 2.6 out of 5. Respondents indicated that such cooperation was almost non-existent in India. In developed countries, intercompany cooperation is a popular and accepted way to collaborate on joint R&D topics.

7 c. Stable macroeconomic conditions

Respondents indicated that stable macroeconomic conditions can provide a foundation for innovation, but did not regard it as a key driver. The average importance rating for this indicator was 3.7 out of 5, while the level of satisfaction was 3.6 out of 5.

7 d. Mobility of talent between companies

Overall, the mobility of workers between companies is considered to be moderately important for innovation. Some respondents believe that mobility between companies, particularly if it is across industries, can provide valuable skills and a "fresh perspective" when seeking to work innovatively. In terms of satisfaction, respondents believe that it is quite easy to move across companies in India, but that moving across industries is more challenging. This resulted in an average satisfaction rating of 3.6 out of 5.

7 e. Cost of talent

Interview respondents indicated that the cost of talent was not important for innovation, giving it an average rating of 3 out of 5. A number of respondents noted that while India's low-cost talent base is one factor attracting multinationals to innovate in the country, companies in fact locate in India primarily because of the quality of the talent available, and not merely because of its low-cost nature. Several respondents also said that skilled employees, particularly in specialized fields, are becoming more expensive in India, implying that companies are willing to pay for high-quality talent.

8. Key takeaways

- *Interviews conducted with India Inc. indicate that companies' internal innovation cultures (including innovation mindsets and organizational designs) and cross-functional cooperation are the most significant internal influencing factors affecting innovation.*

- *Although there is growing appreciation of the importance of intra-organization innovation culture, and some companies are even taking active steps to enhance their own cultures, this movement is still in its early days. A significant number of Indian organizations still suffer from an organizational culture in which power distances are large, fear of failure is high, and there is little appetite for risk. This stifles company employees' entrepreneurship and desire to develop innovative ideas.*

- *Our interviews indicated that the quality and availability of talent, the availability of capital, and a strong entrepreneurial culture are critical external factors driving innovation. These influences were followed by close collaboration between industry and academia, the presence of a strong and enforced IPR regime, and the ease of doing business.*

- *India's private sector, academic institutions and government are undertaking a number of initiatives aimed at overcoming many of the challenges present in the Indian ecosystem. These will take some time to bear fruit. In the meantime, the focus should be on diligent execution and on leveraging the best practices that exist within and outside the country.*

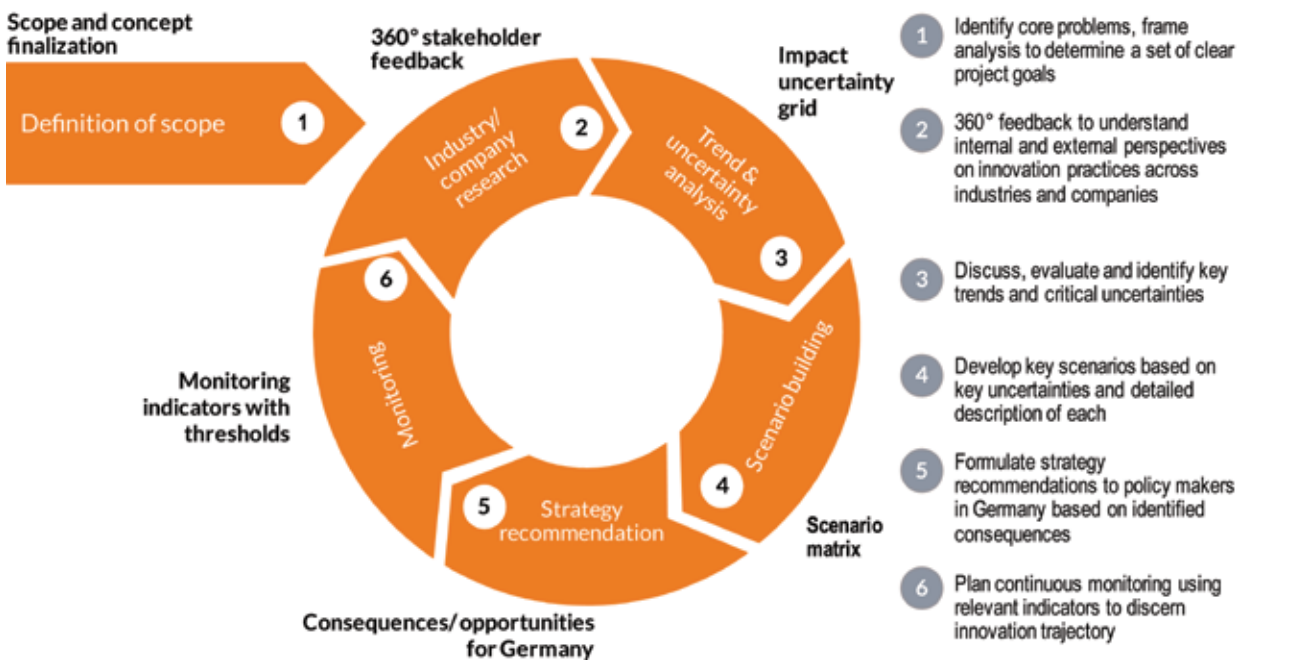
IV. FUTURE PROJECTIONS

A. Future of India's innovation landscape

Forecasting the future is challenging. Our analysis in this section is focused on the question: "What will India's innovation landscape look like in 2030?" The goal of this section is not to predict the future. Rather, it is to explore the possible paths for innovation in India, thus enabling Indian companies and policymakers to define their future strategies accordingly. Moreover, this exercise will also allow German stakeholders to develop strategies for engagement with the Indian innovation ecosystem's various players based on each scenario.

In conducting this analysis, we have applied Roland Berger's Scenario-Based Strategic Planning approach. This is a detailed six-step process (see Figure IV.1) that starts by defining the scope of the issue and moves through detailed industry and company research, trend and uncertainty analyses, scenario-building, and recommendations regarding the way forward. Our recommendations based on this exercise will be covered in detail in the Recommendations section (see page 106).

FIGURE IV.1 **RB-HHL methodological framework for scenario-based strategic planning**



Source: Roland Berger analysis

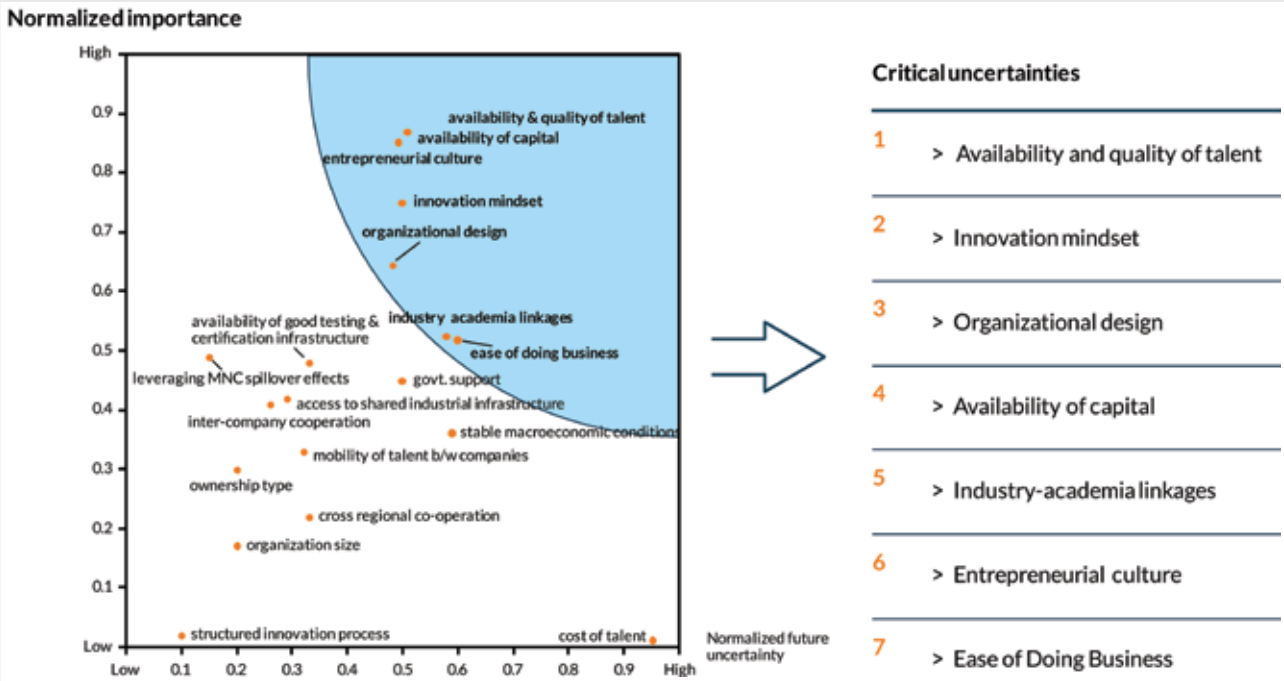
B. Our methodology

In order to create scenarios, we analyzed the most important factors of influence as identified by the approximately 150 innovation practitioners in our interviews, and plotted these on a matrix with axes respectively representing the issues of importance and future uncertainty (see Figure IV.2). This analysis takes the form of a 360-degree exercise, as we not only interviewed senior members of the innovating companies themselves, but also received input from policymakers and external experts from industry associations, academic and research institutions, and incubators.

On the matrix, we identified which factors were important and certain, and which were important but highly uncertain. While the former category is important across the various scenarios, its elements do not serve as the foundation on which the scenarios are constructed, as their outcome is by definition already ascertained. We therefore chose to focus only on those factors that are important and highly uncertain. This resulted in the identification of seven critical uncertainties – that is, factors that are critical to the future of Indian innovation, but whose future is uncertain. These include:

- **Quality and availability of talent**, which refers to the availability and quality both of young (entry-level) and experienced potential employees.
- **Innovation mindset**, which refers to the degree to which an organization's culture is attuned to innovation – that is, how aligned the company's innovation strategy is to the overall strategy of the firm; the attitude of the organization toward failure and risk; and whether the firm's structure allows for bottom-up innovation.
- **Organizational design**, which refers to an entity's formal organizational structures, systems and processes, and the degree to which these are conducive to innovation – that is, whether there is a dedicated body that drives innovation within the organization, how innovation projects are managed, team composition and budgets, the way in which teams are governed, whether incentives and KPIs are designed to drive "intrapreneurship," etc.
- **Availability of capital**, including equity and debt capital, from banks and NBFCs, but also from the VCPE community.
- **Industry-academia linkages**, which refer to the formal and informal links between industry and academic and research institutions. This includes the ease with which people can move between the two types of organizations, the degree of collaboration on research topics of mutual interest, and the prevalence of jointly developed or commercialized technologies.

FIGURE IV.2 **Importance-Uncertainty matrix**



Source: Roland Berger Survey, January–June 2015

- **Entrepreneurial culture**, which refers to the combination of an enabling innovation-policy environment and a facilitative innovation infrastructure, which in turn indicates the existence of incubators and accelerators, access to shared industrial infrastructure, and the public availability of testing and certification infrastructure external to an organization. While the policy environment is created by the government, the elements of the innovation infrastructure can be put in place by the public or the private sector.

- **Ease of doing business**, which refers to the role played by the government in facilitating a pro-innovation ecosystem. This specifically references the World Bank's ease-of-doing-business indicators as they affect established companies and start-ups. This impacts an organization's innovation potential, as a country that ranks highly on the ease-of-doing-business index enables its entrepreneurs and companies to focus on building their businesses.

C. Critical uncertainties and dimensions

The seven identified critical uncertainties were clustered and subsequently condensed into two key dimensions – organizational entrepreneurship and innovation-ecosystem attractiveness (see Figure IV.3). While the first dimension, entrepreneurial organizations, refers to the critical uncertainties that are important to build innovation-oriented enterprises, the second dimension, ecosystem attractiveness, refers to the external environment, and encompasses the role played by external state (local, federal-state and central governments) and non-state actors (such as banks and VCPEs, academic and research organizations, incubators/accelerators, etc.) in the innovation ecosystem.

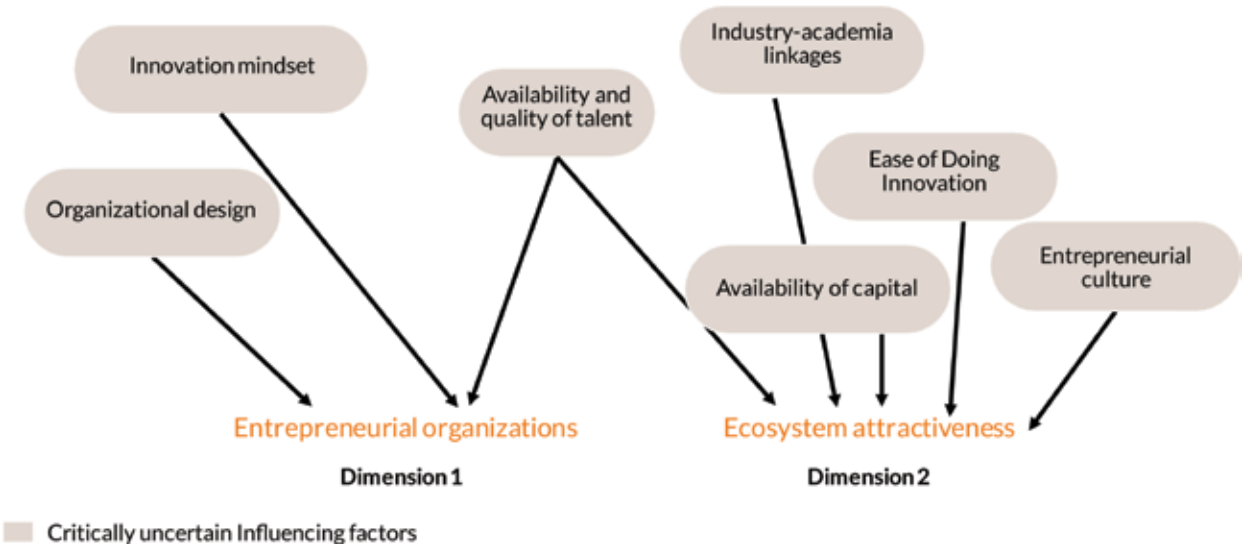
1. Organizational entrepreneurship

This refers to the critical uncertainties that are necessary to build innovation-oriented enterprises. On the right side of the axis, we see organizations that have a high level of entrepreneurship. These have the following characteristics:

- A clearly articulated innovation strategy that is in line with the organization's overall corporate strategy, and takes into account the current and potential external regulatory and competitive environment.

FIGURE IV.3 **Clustering of critical uncertainties**

Relationship diagram



Source: Roland Berger

- The organizational leadership provides the budgetary and managerial freedom to innovate, and creates bottom-up and top-down innovation platforms to drive such behavior across the organization.

- The organization has established formal and informal mechanisms to support both incremental and disruptive innovation, including cross-functional teams, appropriate governance structures and physical infrastructure, and KPIs and incentives that reward "intrapreneurship."

- The organizational culture is shaped by employees from diverse personal and professional backgrounds, thus encouraging an interdisciplinary approach to solving problems, and ensuring that the quality of an idea is given higher priority than the designation of the person supporting or attacking it.

At the other end of the axis are organizations with a low level of entrepreneurship, which are more interested in immediate financial results than in maximizing long-term sources of competitive advantage. These typically lack a clearly articulated innovation strategy, and their top management does not provide the financial support and/or executive attention needed to drive innovation projects within the organization. These organizations have few or no formal or informal structures supporting innovation, and their cultures are risk-averse with large power distances, and characterized by a strong fear of failure. There are few or no incentives to engage in entrepreneurial projects within the company, so employees see little or no reason to work on ideas outside their core responsibility.

2. Ecosystem attractiveness

This refers to the critical uncertainties regarding the external environment, as they relate to innovation. This dimension is represented along a vertical axis. At the top of the axis would be an ecosystem that is highly attractive, and which has the following characteristics:

- A plethora of talent, both in terms of quality and quantity. Entry-level employees have a strong theoretical foundation, a deep conceptual understanding of subject-area content and some practical experience. Intermediate and experienced employees have had hands-on experience and are abreast of the latest technological developments in their fields of expertise. A number of continuing-education and skills-development avenues are available.

- The presence of deep and well-developed capital markets, providing access to debt and equity capital. Moreover, even high-risk and early-stage capital is available for new and capital-intensive companies.

- The presence of an entrepreneurial culture that has pro-innovation policies as well as dedicated institutions that coordinate and drive innovation across the country. Moreover, a supportive, stable and transparent policy environment is in place that provides a clear focus on top government priorities such as skills development and education, intellectual property, science, technology and innovation, the ease of doing business, and public procurement, while providing sector-specific inputs where necessary. The government's innovation policy and roadmap serves to guide industry-academia collaborations. Moreover, the environment offers strong incubators or accelerators, shared industrial infrastructure that gives companies access to cost-intensive equipment, and testing and certification laboratories.

- The presence of strong industry-academia linkages, facilitating a high degree of mobility between the two types of organizations. Academic and research institutions are well-funded, autonomous and high-performing bodies, with a proportionate outcome-oriented focus on both fundamental and applied research. Strong and efficient technology-transfer offices at the institutions enables the smooth transfer of technologies and know-how from academia to industry. This also leads to a variety of collaborations on high-priority applied-research topics involving multiple industries and research organizations. Faculty and student spin-offs, creating new firms from ideas developed at universities, are common, and mobility between companies and academia is robust and encouraged.

At the bottom of this axis would be an ecosystem that is neither attractive for or conducive to innovation. This type of ecosystem is characterized by a lack of available high-quality talent, with potential employees having little or no practical know-how; shallow and limited capital markets; a small appetite for risk; and a challenging culture for entrepreneurs, with limited access to knowledge sources such as incubators, accelerators, and research or academic institutions, and no access to shared industrial infrastructure. Moreover, the policy environment is volatile, erratic and highly opaque. Industry and academia operate in their respective silos, with only a limited amount of information exchange.

D. Scenario development

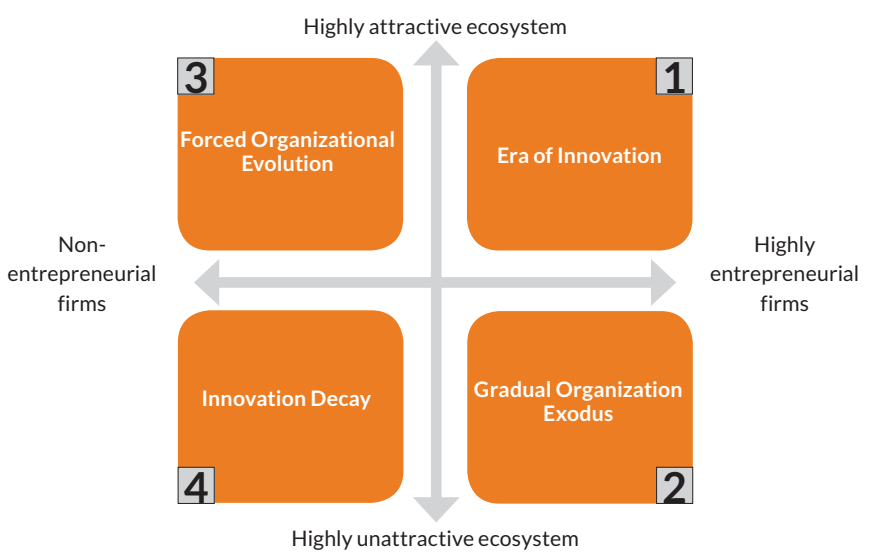
1. Creation of scenarios

Based on the two dimensions outlined in the previous section, we have identified four potential scenarios that could unfold with regard to innovation in India (see Figure IV.4). These are not designed to be exhaustive, but rather provide us with a starting point, providing enough direction that stakeholders can begin to prepare themselves for alternative potential outcomes in India.

1. **Era of Innovation:** Great talent is nurtured in world-renowned Indian universities and research institutions; strong vocational-education institutions develop capable and employable workers; there is abundant and easy access to credit; and the government, through a transparent and pro-innovation policy environment and consistent on-ground implementation, has facilitated a vibrant ecosystem that is extremely conducive to innovation. On the organizational front, companies evolve into highly entrepreneurial organizations in which employees are empowered to be "intrapreneurs." Start-ups continue to proliferate, including into new and uncharted domains, since they have access to funding at all stages of development. Given that the ecosystem is so attractive, there is also intense competition between companies both for the most talented potential employees and for customers, creating a virtuous cycle of further differentiation and innovation.

2. **Gradual Organization Exodus:** In an environment stressed by a fast-growing population, in which the country's demographic dividend devolves into a demographic burden and unemployment rates rise significantly, the government is forced to dedicate resources to social-welfare and bail-out schemes instead of focusing on an innovation-oriented policy regime. Heavy expenditure on social programs limits the availability of funds to invest in public research, and research initiatives are deprioritized in favor of an increasing focus on educating and providing skills and employment for as many youths as possible. Educational institutions are overburdened with students, creating stress on the system and adversely affecting the quality of education. As a result, the quality of graduates is poor, with many essentially unemployable. Availability and access to credit is limited as foreign investors deem India's demographic challenges to be a serious issue and reconsider their investments in the country. In this external environment, enterprising organizations are forced to operate within significant constraints. Finding high-quality talent is a challenge, and companies are forced to invest significantly in training entry-level employees. As a result, they do not have enough capital to reinvest in R&D. Since the organizations are entrepreneurial, they still strive to succeed and innovate in this challenging environment, but focus more intensively on frugal and business-model innovations. Some may eventually choose to use India purely as a manufacturing hub and market, while

FIGURE IV.4 **Scenarios based on the two dimensions**



Four Future Scenarios

1. In an extremely attractive ecosystem and with highly entrepreneurial organizations, innovation would flourish
2. Entrepreneurial organizations in an unattractive ecosystem would reduce innovation focus and some may leave the country for more supportive ecosystems
3. In an attractive ecosystem, which breeds healthy competition, even non-enterprising firms would be forced to 'innovate or perish'
4. In an unattractive ecosystem and unenterprising firms, innovation would decay

Source: Roland Berger

relocating their R&D entities outside the country. Multinationals also innovate outside India (potentially in other emerging markets such as China), while treating India simply as a market. In light of the deteriorating external environment, a number of entrepreneurial companies may decide to leave India in favor of healthier economies, leading to a gradual industry exodus.

3. **Forced Organizational Evolution:** In an extremely attractive ecosystem (see the ecosystem-related aspects of the Era of Innovation scenario), competitive pressure intensifies, and non-entrepreneurial firms are forced to innovate or perish. Strong academic institutions produce high-quality talent. Some of these graduates join non-entrepreneurial firms and force an internal restructuring. Since there is abundant access to capital, other talented individuals create their own organizations, which are nimble and entrepreneurial. In light of the positive external environment, more multinationals decide to establish an R&D presence in India. Non-entrepreneurial organizations that are unable to transform quickly enough perish. However, given the highly attractive external environment, many are able to evolve in order to survive.

4. **Innovation Decay:** In a situation where the external environment is challenging (see the ecosystem description in the Gradual Organization Exodus scenario) and organizations are non-entrepreneurial, the Indian innovation scenario deteriorates considerably. Demographic challenges divert the government's focus from capability creation to social-welfare schemes for the large group of unemployed youths. Non-entrepreneurial organizations continue to produce tried-and-tested products and services, with little to no focus on innovation. There is a dearth of highly skilled manpower, both at the entry level, due to the pressure on academic institutions, and at more experienced levels, since organizations do not push employees to be creative and entrepreneurial. Highly skilled individuals choose to leave the country for better career prospects at more entrepreneurial organizations. An unattractive ecosystem and the non-entrepreneurial organizations within it mutually reinforce each other, creating a vicious cycle of innovation decay.

E. Analysis of scenario-planning exercise

Scenario planning typically works with extremes. In our assessment, both the extremely negative (Innovation Decay) and extremely positive (Era of Innovation) scenarios are unlikely to transpire in the next 15 years. In terms of which scenario most closely mirrors the current situation in India, we find one small set of entrepreneurial organizations and a larger group of relatively less entrepreneurial organizations. The level of ecosystem attractiveness differs by industry; however, we believe that the overall ecosystem is moderately attractive. While the government, investors and academic institutions are undertaking multiple initiatives to strengthen the current innovation ecosystem, significant challenges persist (discussed in Section III). This could play out in two ways. If ground-level implementation of the various government initiatives (e.g., skills-development policy, start-up policy, etc.) starts to bear fruit, we believe the ecosystem will improve and entrepreneurial organizations will become even more innovative. The less entrepreneurial players will also be forced to innovate or perish. Conversely, if the government initiatives exist only on paper, with little or no impact on the ground, the ecosystem will stagnate. Entrepreneurial organizations will continue to operate in India to benefit from the large market, but may choose to innovate elsewhere. Non-entrepreneurial organizations will continue not to innovate and will play a low-value-add game, competing largely on the basis of cost.

A number of metrics may provide some insight with regard to understanding which of the scenarios is likely to unfold in India. For example, India's ranking on global innovation indexes (e.g., the Global Innovation Index, the Global Competitiveness Index, etc.) can provide a metric shedding light on India's overall innovativeness. Since the rankings take into account a large number of input and output measures of innovation, these could be a good starting point. In addition, India's performance on the two main dimensions identified in this study – entrepreneurial organizations and innovation-ecosystem attractiveness – could also be monitored via proxies.

For the entrepreneurial organizations dimension, the following indicators could be monitored: the number of Indian companies featured in global rankings of innovative companies (e.g., Forbes, Fast Company, Bloomberg); the number of Indian start-ups obtaining secondary rounds of funding (after the initial institutional or Series A funding round); average R&D expenditures made by companies in India, as well as this trend; the number of patent applications filed by Indian companies, along with the number approved; the number of new products or spin-offs, and so on.

The second dimension, of innovation-ecosystem attractiveness, could be monitored using a different set of indicators, such as the number of multinationals establishing or expanding the scope of their R&D activities in India; the size of investments and number of transactions in India carried out by VCPE funds (including foreign VCPEs); the number of Indian universities or research institutions featured in global rankings; the number of Indian institutions featuring in global rankings of citations per paper; the number of patents filed by Indian academic or research institutions; and India's performance on the World Bank's Doing Business index. While no single indicator can provide a complete picture, monitoring the country's progress using a variety of these metrics could provide a reasonably accurate picture of which scenario India is heading toward.

F. Key takeaways

- *Our trend and uncertainty analysis of the factors influencing innovation highlighted seven that are both critical to innovation and whose future is uncertain: quality and availability of talent, innovation mindset, organizational design, availability of capital, industry-academia linkages, entrepreneurial culture, and ease of doing business.*

- *Clustering these seven factors enabled us to create two key dimensions: entrepreneurial organizations and ecosystem attractiveness.*

- *These two dimensions became the basis for four future scenarios developed with regard to possible innovation conditions in India in 2030:*

  - ***Innovation Era** – In an extremely attractive ecosystem with highly entrepreneurial firms, innovation would flourish in India.*

  - ***Gradual Organization Exodus** – Entrepreneurial firms in an unsupportive ecosystem would not have sufficient resources to pursue R&D, resulting in limited innovation. Some firms might leave the country and choose to innovate in other, more supportive ecosystems.*

  - ***Forced Organization Evolution** – In a supportive ecosystem, non-entrepreneurial firms, facing competition from foreign multinationals entering the Indian market as well as highly skilled local individuals choosing to start their own entrepreneurial ventures, would be forced to innovate in order to survive.*

  - ***Innovation Decay** – In a situation in which the external environment was challenging and firms were non-entrepreneurial, the state of Indian innovation would deteriorate considerably. The unattractive ecosystem and the non-entrepreneurial organizations within it would mutually reinforce one other to create a vicious cycle of innovation decay.*

- *The Innovation Era and Innovation Decay scenarios are extreme, and India is unlikely to find itself in either situation by 2030.*

- *Depending on how the ecosystem evolves, firms will either flourish, decay, or exit depending on their level of entrepreneurship.*

- *A number of metrics (e.g., India's performance on global innovation rankings could be monitored to gauge which of the scenarios is likely to play out). In addition, India's performance on the two main dimensions entrepreneurial organizations and innovation-ecosystem attractiveness could also be monitored via some proxies.*

  - *For the entrepreneurial organizations dimension, indicators could include the number of Indian companies featuring in global rankings of innovative companies; the number of Indian start-ups obtaining secondary rounds of funding (after the initial institutional or Series A funding round); the average R&D expenditure by companies in India and its trend; the number of patent applications filed by Indian companies as well as the number approved; the number of new products and spin-offs; and so on.*

  - *For the ecosystem-attractiveness dimension, indicators might include the number of multinationals establishing or expanding the scope of their R&D activities in India; the size of investments and number of transactions carried out by VCPE funds; the number of Indian universities and research institutions featured in global rankings; the number of Indian institutions featured in global rankings of citations per paper; the number of patents filed by Indian academic or research institutions; and India's performance on the World Bank's Doing Business index.*

V. IMPLICATIONS FOR GERMANY

A. Introduction

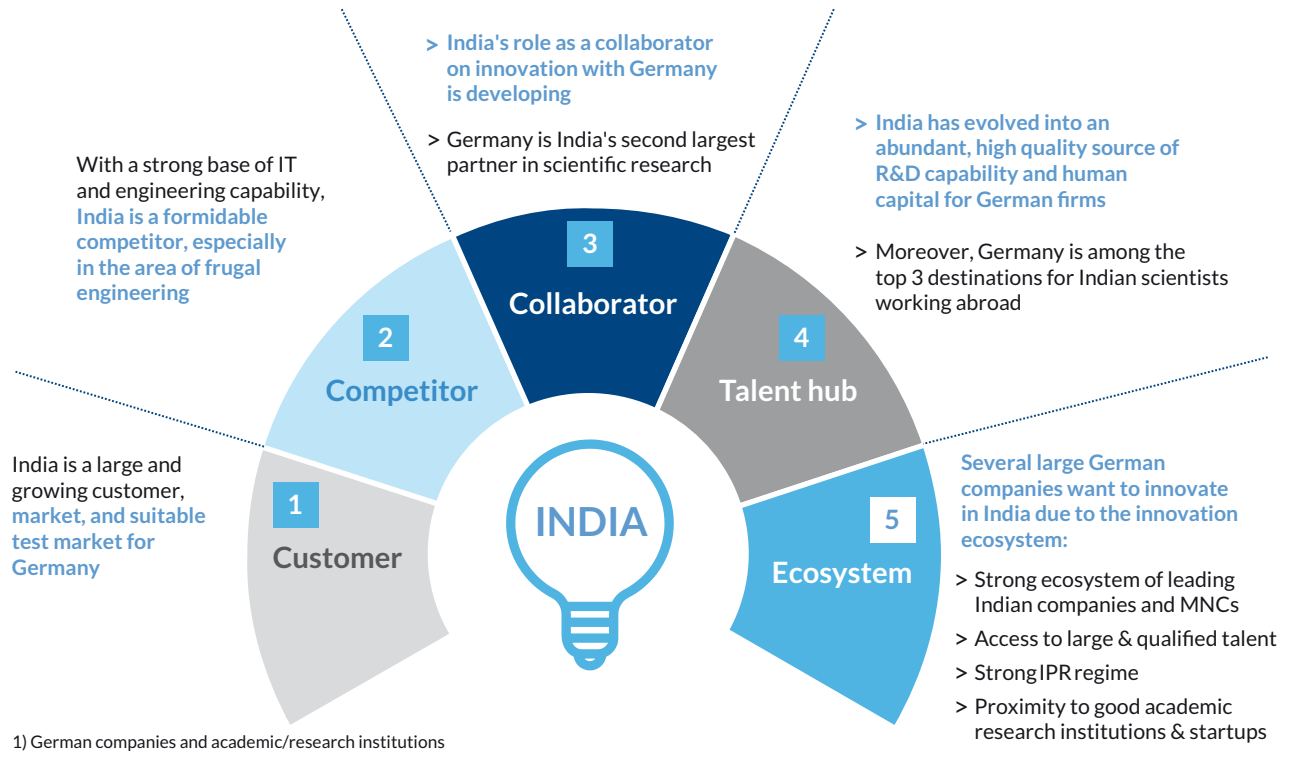
Given the world's volatility, uncertainty, complexity and ambiguity (VUCA), well as the increasing pace of globalization, events in one country have an impact in other nations. Trade relations, FDI and foreign institutional investment, migration, and knowledge and cultural exchanges have made countries more interdependent. India and Germany are no exceptions; and innovation in India thus clearly has implications on developments within Germany. Through our study, we have observed that even in the context of innovation, India plays the role of a **customer**, a **competitor**, a **collaborator**, a **talent hub** and an **ecosystem** for Germany (see Figure V.1).

B. Customer: India is a large and growing customer, market and suitable test market for Germany

1. Overview

India is already a large customer for and importer of German high-tech innovation, particularly in the automotive and heavy- and precision-engineering equipment industries. In 2015–2016, India's imports from Germany were worth USD 12 billion, with the bulk of this coming from nuclear reactors, boilers, machinery and mechanical equipment (USD 3.6 billion); electrical machinery and equipment and related parts (USD 1.2 billion); precision equipment such as medical and surgical

FIGURE V.1 **Implications of innovation in India for Germany**



1) German companies and academic/research institutions

Source: Secondary research, Roland Berger

instruments or optical, photographic and cinematographic equipment (USD 0.98 billion); and vehicles and related parts and accessories (USD 0.9 billion).[226] This accounted for 0.8% of Germany's exports and approximately 3% of India's imports for that year.

Moreover, with a population of 1.2 billion, India is a large and growing market that offers huge potential not just for large German companies, but even for the small- and medium-sized enterprise sector (the so-called Mittelstand). German companies have already realized the importance of doing business in India. According to the Indo-German Chamber of Commerce, nearly 1,600 German companies are registered in India, and 28 of the 30 companies listed on the most significant German stock index, the DAX, have activities in India.[227] Mittelstand companies also feature among the 1,600 German companies in India, some of which have a direct presence, while others have created joint ventures in the country. However, while German companies have established a considerable presence in India, a comparison with China – where nearly 5,200 German companies are registered – shows that there is still considerable room for improvement.[228]

2. Opportunities for Germany

- India's stable macroeconomic fundamentals and projected growth (annual average rates of 6.5% between 2018 and 2030)[229] reveal a large and growing market for German firms to tap into. As Indian customers (B2B and B2C) grow in terms of disposable income and purchasing power, their demand for high-tech products and services will grow in parallel. Given the country's size, diversity, heterogeneity and complexity, India can offer German firms valuable experience that will help them innovate and compete elsewhere in a VUCA world.

- Emerging markets will grow to account for 63%of global GDP by 2030.[230] India, regarded as the second-largest emerging market in the world,[231] could be an ideal test market for German companies that wish to enter and compete in emerging markets, as it offers a large size, multiple market segments, and low product- and service-penetration rates.

- A number of the product categories Germany exports to India (e.g., automobiles or robots) are underpenetrated in India, indicating significant potential for growth.

3. Threats for Germany

- While demand for high-tech offerings is expected to grow in India, it will remain a price-sensitive market. Therefore, German companies targeting Indian customers should avoid trying to sell offerings originally developed for mature markets without first adapting them for the Indian market. Price is not the only issue here – even design, features and functionality must be modified to meet Indian customers' needs.

- Numerous countries and companies have grasped the importance and significant potential of the Indian market. Thus, competition from other countries' multinationals is expected to intensify in the coming years. German companies must therefore try to develop a unique value proposition for Indian customers, which will require them to look at clean-slate approaches to innovation.

C. Competitor: With a strong base of engineering capability, India is emerging as a formidable competitor, especially in the area of frugal engineering

1. Overview

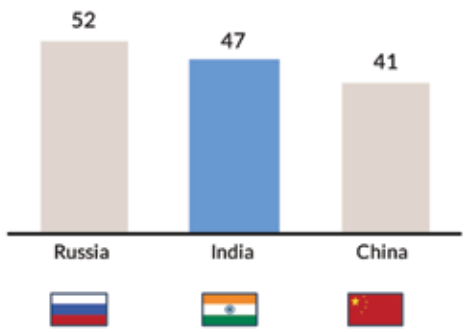
There are many examples of medium-sized and large Indian companies entering and winning in international markets. This is particularly true in areas such as the engineering and automotive industries, where India has successfully produced a number of hidden champions such as Bajaj, Bharat Forge and Motherson Sumi, who are increasingly taking on and beating their global competitors in foreign markets.

For instance, Indian motorcycle manufacturer Bajaj is the number-one or number-two player in more than 60% of the international markets in which it operates, including Uganda (88% market share), Sri Lanka (80%), Bangladesh (54%), Colombia (44%), Nigeria (43%), Congo (37%), Philippines (30%), Central America (28%), Egypt (26%), and Peru (19%).[232] Another example is that of Suzlon, which has emerged as one of the world's top10 wind-energy producers with a global market share of 4.9% and a global installed-capacity share of 7.1%.[233]

These companies succeeding internationally do so through a carefully developed value proposition, a meticulous focus on operational excellence and frugal engineering, and where required, strategic acquisitions of foreign (in some cases German) companies in order to gain technology and

FIGURE V.2 **Indian acquisition of German firms**

No. of acquisitions of German companies by emerging countries, 2005 -2014, cumulative



> India is the second-largest acquirer of German companies among the emerging markets

> Germany is the third largest acquisition target (among developed markets) for Indian companies after the US (265) and the UK (121), cumulatively over the period 2005 to 2014

Notable examples

Bharat Forge

> Bharat Forge acquired one of Germany's largest forging firms, Carl Dan Peddinghaus GmbH (CDP) in late 2003, making the combined company the world's second-largest forging firm at the time

> The acquisition was aimed to strengthen Bharat Forge's presence in Europe and enhance its technology capability, particularly in the PV segment

> In late 2004, the company acquired CDP Aluminiumtechnik (formerly a part of CDP) – the acquisition marked Bharat Forge's entry into the aluminium component business

Motherson Sumi

> In mid-2011, Indian auto supplier Motherson Sumi acquired 80The acquisition was aimed to provide Motherson Sumi access to the latest plastic and polymers technology and provide market access to European OEMs

> % of Peguform, a German auto interiors manufacturer

Dr. Reddy's

> In early 2006, Indian pharmaceutical major acquired the fourth-largest German generic drug maker, Betapharm Arzneimittel GmbH – at the time, it was the largest overseas acquisition by an Indian pharma company (EUR 480 m)

> The acquisition was aimed to make Dr. Reddy's a mid-sized global generics company and provide access to Europe's growing generics market

Source: AHK report, Secondary research, Roland Berger

market access. While some have chosen to go global in search of global market opportunities, others such as Bajaj have done so primarily in order to counter challenges in the domestic market.[234]

One emerging trend is that of Indian companies acquiring German Mittelstand firms. Indian firms narrowly trailed Russian firms in terms of the number of acquisitions of German companies during the period 2003–2014 (cumulative). Bharat Forge's acquisition of Carl Dan Peddinghaus GmbH (CDP) in late 2003, Motherson Sumi's 80% acquisition of Peguform in 2011, and Dr. Reddy's acquisition of the erstwhile fourth-largest generic drug manufacturer, Betapharm Arzneimittel GmbH, are all notable examples (see Figure V.2). It is worth noting that Chinese firms are rapidly catching up with their Indian counterparts with respect to acquisitions of German firms. During the 2005–2013 period, however, Indian firms remained well ahead, with 44 acquisitions compared to Chinese firms' 30.

2. Opportunities for Germany

- The frugal-engineering prowess of India's hidden champions could offer important lessons for their German competitors.

- As many of these Indian firms are willing to enter partnerships or merger and acquisition arrangements, German companies could serve as natural partners. Moreover, since these Indian companies typically offer products and services at a different price point and with a different value proposition than their German counterparts, they could provide complementary offerings to German companies' products and services.

3. Threats for Germany

- German companies should monitor these Indian companies, as they could emerge as competitive threats in the future. The global economic crisis has greatly altered the buying behavior and purchasing power of consumers in a number of developed markets. Indian companies with frugal offerings could gain more traction with these customers than traditional German companies with their higher prices and technology-driven offerings.

D. Collaborator: India's role as a collaborator on innovation with Germany is developing

1. Overview

As it seeks to strengthen its research output, India is increasingly collaborating with other countries. Moreover, Germany has also grasped the importance of collaborations with other countries in the areas of research and innovation. The German government's Federal Report on Research and Innovation 2014 clearly states that "today, internationalization is an indispensable basis for excellent research and innovation in Germany."[235] The federal government even developed a Strategy for the Internationalization of Science and Research in 2008.[236]

India's role as a collaborator on innovation with Germany is still developing, however. Germany is India's second-largest partner in the area of scientific research. Currently, there are more than 150 joint science and technology research projects, and 70 direct partnerships between Indian and German universities.[237] The primary such collaborations are listed in sub-section 1a. However, while India has shown the largest increase among the BRICS nations in the amount of German funding devoted to research collaborations since 2008 (EUR 8.7 million investment in 2012), the absolute sum still falls significantly short of the investments that the German government was making in China (EUR 18.5 million in 2012) or Russia (EUR 10.1 million in 2012) at the same time.[238]

Recognizing the need to accelerate this partnership, the two governments forged four agreements in the area of science, technology and research and released them at the Indo-German Intergovernmental Consultations in October 2015. Both countries' heads of state "reaffirmed their commitment to support mutually beneficial science and technology partnerships which will create knowledge and innovative technologies for addressing societal challenges."[239]

1 a. Main collaborations

- One of the main Indo-German cooperative ventures in the area of innovation and research is the Indo-German Science and Technology Center (IGSTC), which was established in 2010. A joint creation ofthe Indian government's Department of Science and Technology (DST) and the German Federal Ministry of Education and Research (BMBF), IGSTC has provides a co-funding mechanism for approved projects and has led to an intensification of activities in specific program areas.[240] Since its inception, India and Germany have each contributed EUR 2 million per annum to this center, which serves as a model for scientific- and industrial-research collaborations, particularly in the

FIGURE V.3 **Indo-German collaborations**

Centers of collaboration	Indo German Science and Technology Centre (IGSTC)	> India and Germany each contribute EUR 4m annually to the Centre, which serves as a model for Public Private Partnerships for scientific and industrial research > Focus on application-oriented research, especially in engineering and life sciences
	German House for Research and Innovation (DWIH)	> DWIH, a consortium of German universities, research institutes, and disseminates information about higher education, research landscape and funding sources in Germany > Activities at DWIH are coordinated by German Research Foundation (DFG) office in India
Scientist and student talent exchange	Federal Ministry of Education and Research (BMBF)	> BMBF announces yearly calls with Department of Biotechnology, Department of Atomic Energy, CSIR[1], and ICMR[2] for Indian project participants
	Deutscher Akademischer Austauschdienst (DAAD)	> Funds various scholarships for interns, graduate and post-graduate students, post-docs and senior scientists > Under the scheme "A New Passage to India" many scholarship modes are being intensified
Field specific research units (non-exhaustive)	Max Planck Society	> Max Planck Society has 2 dedicated research units in India in partnership with various Indian Institutes of Technology in fields of lipid research and computer science
	Indo-German center for sustainability	> Indo-German center for sustainability is joint collaboration of IIT Madras and TU9[3] > It does research in fields of waste management, bioenergy, energy efficiency, development policy, renewable energies, and hydrology

1) Council of Scientific and Industrial Research; 2) Indian Council of Medical Research; 3) TU9 is the alliance of leading Institutes of Technology in Germany: RWTH Aachen University, TU Berlin, TU Braunschweig, TU Darmstadt, TU Dresden, Leibniz Universität Hannover, Karlsruhe Institute of Technology, TU München, University of Stuttgart

Source: AHK report, Secondary research, Roland Berger

area of applied sciences. The success of this model can be seen in the fact that the mandate for IGSTC has been increased through 2022, with its annual budget increased from EUR 2 million to EUR 4 million.[241]

- The German government has also established the German House of Research and Innovation (DWIH) in New Delhi. Operational since 2012, the New Delhi center is one of five global centers, the others of which are located in New York, Sao Paolo, Moscow and Tokyo. DWIH New Delhi is a consortium of 15 participants encompassing German universities (including the University of Cologne, RWTH Aachen University, Technical University of Munich, etc.), research institutions (including the Max Planck Gesellschaft, the Alexander von Humboldt Foundation, the Fraunhofer Gesellschaft, etc.) and funding organizations (the German Research Foundation). DWIH serves as a one-stop-shop for information on topics related to German science, research and innovation, and also helps direct attempts to find Indian students, researchers or partner organizations that might be interested in collaborating with German institutions on specific research projects or topics.

- Please refer to Figure V.3 for more details.

While these represent positive initiatives implemented by the German and Indian governments to encourage collaboration between the two countries, more can be done. Our interviews revealed that the joint funding provided by the two countries is often sporadic, and is not systematic enough. Respondents said they believed that funding is not a problem on the Indian side, and that India's Department of Science and Technology is even open to increasing funding. Execution is more of a problem, as the administration of funding programs is complex, bureaucratic and time-consuming. Those at the cutting edge of research do not want to spend time fighting this system, and often choose to focus on working with institutions within their country or region instead. Within Germany, there is limited understanding of how the Indian academic and research system works, and some lack of trust with regard to the capability and commitment levels of Indian researchers.[242]

However, positive examples do exist. Achira Labs co-founder and CEO Dhananjaya Dendukuri, who is taking part in a project funded by IGSTC in 2016 (further detailed in the case study below) believes that the collaboration between Indian and German partners is working well. He said his project was off to a promising start, that there was good communication between and coordination across all

Case study 25:

Projects funded by the Indo-German Science and Technology Center (IGSTC)

The Indo-German Science & Technology Center (IGSTC) actively funds and promotes Indo-German collaboration in the fields of research and technology. Through contributions from India's Department of Science & Technology (DST) and the German Federal Ministry of Education and Research (BMBF), IGSTC provides impetus to research collaborations across the two countries. IGSTC has a program under which it funds research projects working under a 2+2 partnership model – that is, with the involvement of one research or academic institution and one public or private company from each of the countries. One of the projects selected by IGSTC for funding has focused on developing a new test for diabetic foot ulcers. To this end, Manipal University's School of Life Sciences has been researching the bacterial content of diabetic foot ulcers in collaboration with KMC Hospital in Manipal. A surgeon operating on these ulcers needs to know which antibiotics will successfully cure the infected ulcer. Working in partnership with Achira Labs (India), Fraunhofer ENAS and IZI-BB (Germany), and BiFlow Systems GmbH (Germany), they are now trying to develop a diagnostic test that will help answer this question. Every partner in this partnership brings complementary expertise to the table. Fraunhofer has vast experience in translational research, microfluidics and microarray technology, which can ease the process of identifying the bacteria. BiFlow Systems has developed an in-house technology thatcould be used to automate the diagnostic tests. Achira Labs provides chip-based microfluidics technology with in-house manufacturing in India. This collaboration was one of three to five projects chosen from numerous applicants competing in the 2014 call for proposals. Under this partnership, the academic and research institutions have been awarded a grant, while the corporate partners are expected to match the contribution they receive. Project progress is reviewed annually. While it is too soon to ascertain the success of this collaboration (the project commenced in January 2016 and will end in 2018), it is an example of how cross-country collaboration in areas such as healthcare and biotechnology can lead to a mutually enriching partnership.[244]

Case study 26:

GreyOrange, an example of Indo-German collaboration[245]

Collaborations need not be only about research. GreyOrange is a unique example of Indo-German collaboration of another kind. Many Indians are aware of the start-up's tremendous success in its five years of existence. What few know, however, is that this is an example of collaboration between a senior German national (grey) and two young and enterprising Indian engineers (orange), all of whom were passionate about robotics. Wolfgang Hoeltgen, a German engineer with a successful 20-plus-year career at IBM, had been concerned over Germany's changing demographic profile and the consequences that would have on his country's innovation capacity. Recognizing that striking partnerships with India's talented young engineers could result in mutual benefits for the two countries, Hoeltgen began to visit India through his other venture, the German-India Business Center, in an effort to educate German Mittelstand companies on the need to invest in and collaborate with Indian companies. On one visit to India, he met Samay Kohli and Akash Gupta, then high-school students who had built the first Indian humanoid robot, Achyut. The three stayed closely in touch, with the young engineers running business ideas by Hoeltgen, and the German engineer providing advice and mentorship.

Recognizing Kohli and Gupta's talent, Hoeltgen advised the pair to focus on solutions inthe area of industrial automation. The trio met at the end of 2011 to draw up a business plan. Hoeltgen prematurely closed his life-insurance policy and provided the GreyOrange founders with seed capital in exchange for equity, on the condition that they would keep him involved in the business. The combination has been extremely successful. While Kohli and Gupta focused on developing the product, Hoeltgen provided the strategic and operational inputs necessary to get the business off the ground. For example, he was instrumental in developing the start-up's business, strategic and marketing plans. Hoeltgenalso developed the customer presentations and the pitch presentations for investors, and recruited the first set of GreyOrange employees. Conscious of the stresses associated with the company's meteoric growth, from 20 people to more than 360 people in a span of five years, Hoeltgen has ensured that the young company invests in state-of-the-art systems, from lead-management software such as SalesForce to engineering-management systems such as Windchill and enterprise-management software such as SAP HANA. Hoeltgen views his role as "seeing things that the others don't see" – the indefatigable engineer is now focusing on expansion plans for GreyOrange.

the partners involved, and there was excellent professional camaraderie between the individual members. [243]

2. Opportunities for Germany

- There is considerable potential for research collaborations between German academic and research institutions and Indian companies. This is explored further in the Recommendations section.
- An increase in work-exchange or guest-researcher programs between Indian and German research institutions could help to improve intercultural understanding, identify topics of mutual interest, and strengthen engagement.
- German academic and research institutions could work with Indian institutions to set up joint doctoral and advanced-degree programs. The recent collaboration between RWTH Aachen and the Indian Institute of Technology, Madras (Chennai) is one such example.
- There is considerable further potential for collaboration in areas of mutual interest and complementarity. Specifically, given India's strength in software and engineering services and Germany's dominance in hardware and engineering, there is broad potential for productive joint activity in areas such as Industry 4.0, healthcare, frugal engineering, and so on. This is explored further in the Recommendations section.
- Germany could capitalize on the large number of Indian students who choose to pursue specialized degrees abroad (in light of the relatively weak higher-education system in India).
- German academic and research institutions could capitalize on the relatively poor industry-academia links in India by partnering with Indian companies on focused applied-research projects.

3. Threats for Germany

We do not believe there are any threats to Germany from engaging in greater and more intensive collaboration with Indian academic and research institutions. However, German policymakers should be careful to avoid allowing access to India's vast talent pool distract from the need to develop a highly skilled domestic workforce.

E. Talent hub: India has evolved into a high-quality source of abundant R&D capability and human capital for German firms

1. Overview

As in the case of other transnational innovators, some large German multinationals – including but not limited to Bosch, Siemens, BASF and Mercedes Benz – have set up R&D centers in India. These have evolved from using India as a pure cost-arbitrage opportunity to leveraging India as a critical and integrated node in their global innovation network. The German companies we interviewed cited the availability and quality of talent in India as one of the main reasons for this. In terms of availability alone, India produces around 1 million engineers every year. [246]

The Siemens Corporate Development Center in Bangalore is comprised of 6,000 employees who develop software solutions for Siemens' 30 business units worldwide. "Today, we have full responsibility for the software used in complete products from various business units in all Siemens divisions", says Gerd Hoefner, managing director of Siemens Technology and Services Pvt. Ltd.[247] Hoefner adds that IT challenges are going to become more complex in the digital age, and that "Every year, hundreds of thousands of IT specialists flood the labor market here, so we're able to implement major software projects much more quickly in India than in other countries."[248] Hoefner notes that some European colleagues question whether the productivity of Indian employees is as high as that of their counterparts elsewhere. His response is that aside from the initial training needed by entry-level Indian employees due to the lack of practical training at the university level, "our productivity corresponds to the international standard."

SAP's asset-management-related IoT portfolio is being led out of India. One major reason that SAP vested this responsibility with India is because the talent pool there is extremely capable, young and enthusiastic, with most new employees working productively within two to three months of joining the firm. Moreover, they are flexible and comfortable using new technologies and platforms. However, the team has found it challenging to find some specialized skills profiles in India – for instance, outside of IISc and IIT-Bombay, it has been a challenge to find data scientists in India who are able to understand and adapt their knowledge to the work at SAP, since they come from a theoretical background and are often unable to apply their knowledge to corporate R&D demands.[249]

While some German companies engage in R&D in India, a significant number of German companies (including large enterprises and Mittelstand companies) have established manufacturing and/or distribution facilities in India, but no R&D center. Others have created small R&D facilities, focusing on limited areas such as application development. Reasons for this are varied; for instance, these companies may already have R&D facilities in other countries, may want to keep their R&D functions in-house or may have concerns about IPR in India (particularly in the case of pharmaceutical and biotechnology companies).

2. Opportunities for Germany

- Germany is expected to face a growing skilled-labor shortage in the coming years, while India offers a huge pool of talent available at relatively low cost.
- Highly qualified Indians with specialized skillsets, for example related to IT or process chemistry, can help fill gaps in Germany's own labor force.

3. Threats for Germany

- German policymakers must be careful to ensure that this access to highly skilled Indian workers does not create a loss of skills at home. The "sinking of skill ladders", a term coined by Nirmalya Kumar and Phanish Puranam in their book India Inside, refers to the domestic loss of low-skilled positions – and subsequently of the high-tech skills that entry-level employees would have developed with time and experience – as a consequence of outsourcing junior-level jobs to emerging markets.[250] To avoid this danger, German policymakers could develop a skills roadmap aimed at retaining key skills.
- German companies with an Indian R&D (or manufacturing and distribution) presence will have to ensure that employees across geographies are able to develop cultural and professional understanding. Efforts such as those taken by Bosch Engineering and Business Solutions (RBEI) to promote strong cultural and technical alignment across its various locations could prove to be valuable.

F. Ecosystem: Many large German companies want to innovate in India due to the innovation ecosystem

1. Overview

Many large German companies have chosen to innovate in India due to the ecosystem advantages provided by certain Indian cities. This extends beyond the availability of high-quality potential employees, as discussed in the previous section. The ecosystem advantages that certain Indian cities offer German companies also include:

- A vibrant and heterogeneous market, with multiple customer segments ranging from the ultra-premium to the bottom-of-the-pyramid (BoP) segment.
- Proximity and access to:
  - Other multinationals that are innovating in India.
  - A huge start-up ecosystem.
  - Good academic and research institutions.
  - A growing and collaborative university-industry community.

Interviewees said that cities including Bangalore, Mumbai, Puneand Delhi-NCR, where several German companies have manufacturing and R&D centers, offer collaboration and co-innovation opportunities that are rarer in their headquarters locations. The head of SAP Labs India's IoT unit explained that he prefers to recruit graduates from Bangalore-based universities because the students have typically already interacted with many of the leading companies situated in the city, such as Microsoft, Google and IBM. These companies interact quite extensively with the student (and faculty) community, creatingstudent challenges and competitions, offering internships, and engaging in other outreach activities. This means that by the time a student graduates and joins a company, he or she may already be quite comfortable with the work and culture of these firms, and is therefore able to adjust and contribute quickly.

As of June 2016, SAP Labs India had established its own accelerator program called SAP Start-up Studio, which will provide mentorship, infrastructure and technology support to early-stage start-ups. The program will run for one year (with an extension possible) and will focus on internet-of-things (IoT), big-data and cloud-computing start-ups. In special cases, the company may also take equity stakes in the start-ups within its accelerator. Currently, it has selected seven start-ups as part of its first cohort, covering a wide range of areas such as cloud-based healthcare services, artificial intelligence, e-commerce, energy management and enterprise productivity.[251]

Other German companies are also interacting closely with start-up communities in cities such as Bangalore. Multiple models for such interaction exist, ranging from informal meetings at conferences, to structured and formal collaborations such as incubation, technology licensing and

FIGURE V.4 **Incubation models at two German firms – Siemens and Bosch**

	Siemens India Ltd.	Bosch India Ltd.
Type of incubator	> Hybrid incubator – Supports external start-ups internally like an in-house venture capital arm > Physical incubator	> Hybrid incubator – identifies external start-ups and licenses/ acquires their technology > Virtual incubator
Motive for incubation	> Building internal capability in certain technologies > ROI on commercialization	> Develop new business areas with revenue potential of EUR 50 m in 4 years > To develop businesses in non-core areas > To obtain capability in new innovative areas
Incubation model	> Separate budget is allocated for incubation of new ventures > Focus in areas such as Renewable Energy, Energy Efficiency, Environment care, Healthcare and IT > The start-ups are incorporated within existing BUs or a new BU is created on maturity > **Services offered:** Advisory/mentoring, Funding, Infrastructure, Equipments, Labs, Market access, Technology, Process know-how, Legal/company services, Active management	> Rights-based incubation model; typically royalty is taken linked to sales, can also be part upfront payment & part royalty > Focus on developing non-core technologies in areas including health, energy, food, water etc. > Idea is to eventually create a new standalone SBU within Bosch > **Services offered:** Advisory/mentoring, Funding, Market access, Government access, Technology, Process know-how, Legal/company services, digital marketing, Active management

Source: AHK report, Secondary research, Roland Berger

even acqui-hiring.[a] For instance, both Siemens and Bosch have launched incubation activities in India, supporting external start-ups in specific domains (see Figure V.4).

Bosch has a team of 100 engineers in Bangalore working on IoT applictions, with a focus on retail, telecommunications and fast-moving consumer goods. Manufacturing will also be added subsequently. The company's Robert Bosch Engineering and Business Solutions (RBEI) division believes its Bangalore location gives it a massive advantage for new IoT technologies. In addition to having access to specialized talent such as data scientists and visual experts, many of the global leaders in new technologies, such as Intel and EMC, are also present in Bangalore. Because of this ecosystem, cooperation, partnering and the formation of networks becomes significantly easier than in Stuttgart, Bosch's hometown. In addition, new technologies are easier to leverage without the disadvantage of legacy. As RBEI President Vijay Ratnaparkhe put it: "We believe we have a real opportunity to create value for our customers and the global Bosch organization by pursuing orthogonal technologies, i.e., technologies such as open source, HTML5 and others, that complement the capabilities of Bosch globally. These technologies will enable Bosch to successfully transition from the old world to the digital world and will drive growth and relevance of our center."[252]

2. Opportunities for Germany

- Ecosystem advantages in cities such as Bangalore offer German companies the opportunity to innovate in an environment that is not easy to replicate in Germany.
- German research institutions, particularly in areas such as computer science, engineering and biotechnology, stand to benefit by establishing facilities in ecosystems such as Bangalore in order to work in new and exciting areas of research.
- German start-ups and Mittelstand companies could benefit through engagement with the vibrant start-up ecosystem in India.

3. Threats for Germany

In an extreme scenario, German companies and start-ups could relocate a significant part of their innovation activities to India in order to benefit from ecosystem advantages lacking in Germany. This could result in the loss of some jobs within Germany.

a The act of buying out a company primarily to gain access to the skills and expertise of its staff or start-up team.

G. Key takeaways

- *Innovation in India has certain implications for Germany. India plays the role of a customer, a competitor, a collaborator, a talent hub and an ecosystem for Germany.*
  - *India is a large **customer** of Germany's high-tech exports. India's stable macroeconomic fundamentals and projected annual growth of 6.5% between 2018–2030 would provide a large customer base and testing ground for German companies, particularly in the area of frugal innovation.*
  - *India has been successful in producing champions in certain sectors that have made their mark on the global market; indeed, some have even acquired German Mittelstand companies. The frugal prowess of Indian companies could prove to be **competition** for German companies in the future, while co-innovation and M&A could prove beneficial for both sides.*
  - *Germany is India's second-largest partner in terms of **collaborative** research. Institutions such as IGSTC are promoting collaborative projects, but there is still potential for broader and deeper collaboration on topics of mutual interest and complementarity. India's strength in software and engineering services and Germany's dominance in heavy and precision-tools engineering could be harnessed to drive further co-innovation.*
  - *With over a million engineering graduates every year, India serves as a vast **talent hub** for skilled labor, particularly in light of Germany's current demographic profile. Some large German companies such as Bosch, Siemens and SAP Labs are already leveraging this talent pool. Other German companies could stand to gain from leveraging India's R&D talent pool more extensively.*
  - *The **ecosystem** provided by Indian cities such as Bengaluru offers German companies a diverse market along with collaboration and co-innovation opportunities. The presence of other multinational R&D centers and a vibrant start-up ecosystem offers multiple models of collaboration such as formal joint ventures, incubation and technology licensing. Some German multinationals are already seeking to take advantage of these opportunities by becoming active participants in the Indian ecosystem, recognizing that some features of the Indian environment are rare or unavailable within Germany. More German companies and academic or research institutions could leverage this opportunity further.*

VI. RECOMMENDATIONS

As established in the previous section, innovation in India does have an impact on Germany. In this context, we have outlined a set of high-priority recommendations that would enable both countries to capitalize on the growing momentum of innovation in India. Moreover, we also identify a number of areas where the two countries can collaborate so as to develop a synergistic innovation partnership. The recommendations specific to each country can further be categorized into recommendations for companies, academia and governments, while the Indo-German recommendations are organized along specific themes. Figure VI.1 provides an overview of these recommendations.

FIGURE VI.1 **Recommendations for India, Germany and Indo-German collaboration**

1 Recommendations for India	2 Recommendations for Germany
Companies/ Industry • Foster an innovation-driven intra-organizational culture • Build bridges with important stakeholders in the ecosystem	**Companies/Industry** • View India as more than a marketplace and leverage India's R&D capability • Leverage and learn from India's competitive advantage: frugal mindset
Academia/research bodies • Improve educational outcomes and develop talent that is innovation-ready • Aspire and work towards becoming a world-class research institution • Foster strong linkages with industry	**Academia/research bodies** • Capitalize on India's weak research outputs and industry-academia linkages to collaborate with Indian companies
Government • Support academic institutions in developing top talent • Strengthen public research institutions • Leverage global best practices to drive better industry-academia collaboration	**Government** • Increase availability of highly skilled labor to retain status as high-technology innovator • Strengthen internationalization strategy with increased scope of collaboration with developing countries, such as India

3 Recommendations for Indo-German collaboration
• Explore and leverage the complementary demographic profiles of both countries • Drive industry-academia linkages between India and Germany • Develop a project-specific inter-industry consortium between the two countries • Develop a bilateral start-up exchange/ collaboration portal

Source: Roland Berger

FIGURE VI.2 **Summary of recommendations for India**

1 Companies/Industry associations
a. Foster an innovation-driven intra-organizational culture
b. Build bridges with important stakeholders in the ecosystem

2 Academia/Research bodies
a. Improve educational outcomes and develop talent that is innovation-ready
b. Aspire and work towards becoming a world-class research institution
c. Foster strong linkages with industry

3 Government/Specific ministries
a. Support academic institutions in developing top talent
b. Strengthen public research institutions
c. Leverage global best practices to drive better industry-academia collaboration

Source: Roland Berger

A. Recommendations for India

In the previous sections, we identified the most critical areas with regard to strengthening innovation performance in India. These include: 1) developing and strengthening the innovation-driven intra-organization culture within Indian companies; 2) improving the quality of human capital in India; and 3) improving the quality of research outputs and strengthening industry-academia linkages. While other factors such as the presence of an entrepreneurial culture, the availability of capital and the ease of doing business are also important for the development of an ecosystem conducive to innovation, many initiatives focusing on these topics are already underway, and we believe the focus should now be on executing these initiatives rather than on embarking on additional ones.

Our recommendations for India are organized by the three main stakeholders in the innovation ecosystem – that is, companies, academic and research bodies, and the government. An overview of the key recommendations is found in the graphic below.

1. Companies

Recommendation 1a: Foster an innovation-driven intra-organizational culture.

Rationale: As mentioned in Section III-A, interview respondents believe this is the most important internal factor driving innovation, and are less than satisfied with respect to the intra-organizational culture at Indian companies. While some large companies have made an effort to set up formal systems and mechanisms to promote innovation in both a top-down and bottom-up way, this is not consistent across the vast majority of Indian companies.

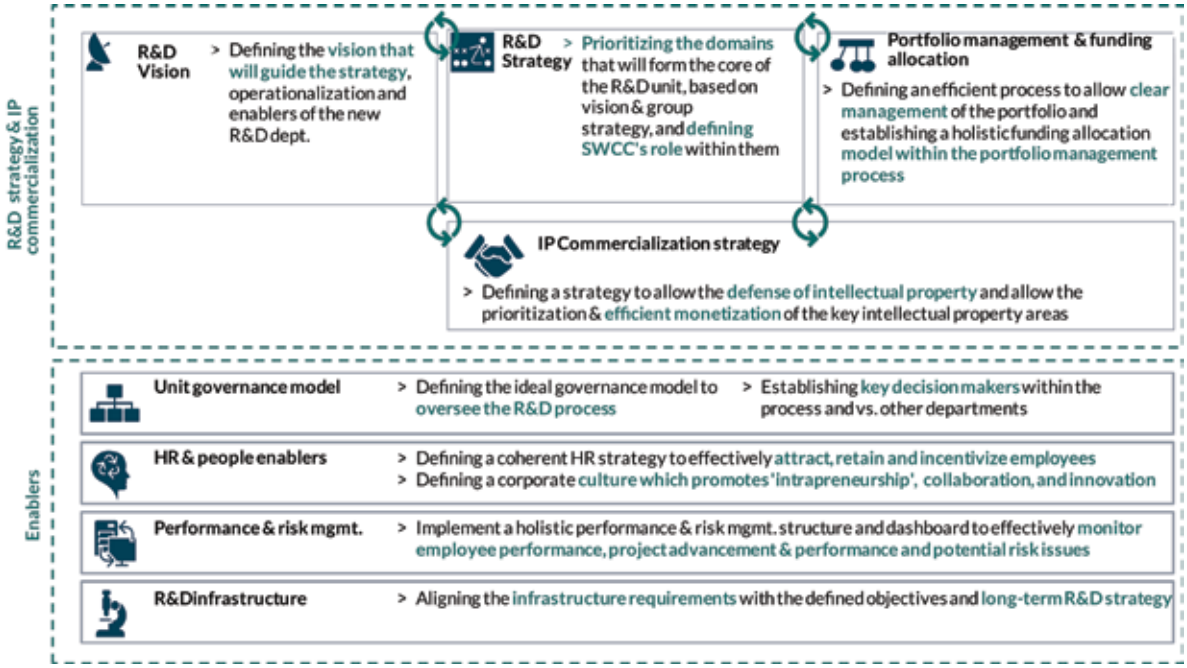
Idea: Indian companies should 1) take proactive steps to build a culture of innovation within their organizations and 2) supplement this by designing or if necessary modifying organizational structures, systems and processes to foster and nurture this culture.

Stakeholders: CEO, strategy team, R&D head, individual business-unit and functional heads.

How it would work: The innovation culture within the organization should foster a culture of "intrapreneurship" by empowering, supporting, recognizing and rewarding employees who possess the drive to build something new. The firms' top executives and other business-unit and functional heads should believe in, communicate and demonstrate tolerance for failure, a commitment to taking ideas at face value no matter who proposes them, and the value of taking risks. Moreover, this culture should be supported by "enablers" in the form of innovation-friendly organizational structures, systems and processes that support the firm's innovation or R&D strategy. This should include the development of platforms for top-down and bottom-up innovation within the organization, the allocation of sufficient resources to support innovation projects, the creation of clear metrics and hurdle rates for innovation projects, the creation of teams and allocation of dedicated personnel with clear KPIs and a corresponding set of incentives and recognition, the leveraging of cross-functional and interdisciplinary knowledge from across the organization, the creation of innovation processes that allow for creativity and blue-sky thinking while also ensuring rigor and emphasizing high-quality outcomes, the creation of competencies for

FIGURE VI.3 **Roland Berger Intellectual Property Strategy Framework**

Indian companies should develop a holistic innovation strategy including a commercialization strategy and enabling framework



Source: Roland Berger

innovation within the organization, and the establishment of governance mechanisms to monitor and promote the innovation. The case studies contained in earlier sections of this report, such as those of HCL and Wipro, show how some Indian companies are successfully creating and designing an innovation-friendly culture that champions "intrapreneurship" in the way described above.

Please refer to the **Roland Berger R&D and Intellectual Property Strategy Framework** below.

Recommendation 1b: Build bridges with important stakeholders in the ecosystem.

Rationale: Companies cannot innovate in a vacuum. They need access to the latest research, communication with start-ups developing new technologies, and the ability to collaborate with competitors and suppliers on industry-wide pre-competitive research topics. It is thus vital to develop an open innovation system that integrates external stakeholders. Many large companies understand the need to engage with the external ecosystem. However, participants in our survey agreed that they could do more to promote this activity. Specifically, they identified weak areas with regard to industry-academia collaborations and industry-level pre-competitive research collaborations.

Idea: Companies should develop an integrated "open innovation strategy" that encompasses the following: 1) strong links with academia; 2) formal and informal engagement with the start-up ecosystem; 3) an increased intensity of intercompany cooperation, particularly with regard to pre-competitive research; and 4) activity as a constructive partner to the government.

Key stakeholders: Companies (primary stakeholders), academic and research institutions, start-ups, private or standalone incubators and accelerators.

How it would work:

1) Develop strong linkages with academia: Companies should identify the areas in which they need support from academic or research institutions and identify suitable partner institutions. With respect to research collaborations, companies and academic institutions could invite master's and doctoral students to participate in short-term research exchange programs. For example, students could spend time working on a live project at the company's R&D center, and link this work to their master's or doctoral thesis. This would directly address the feedback received from several interviewees that many doctoral students in Indian institutions (other than those from top-tier institutions such as IIT or IISc) have a solid theoretical background but are unfamiliar with the latest technologies in

FIGURE VI.4 **xEV One, a pre-competitive research project in the Indian automotive industry**

Launch on		15th July 2016
Consortium members	**OEM**	Mahindra, Mahindra REVA, Ford, Maruti Suzuki, Tata Motors
	Industry bodies	Society of Indian Automobile Manufacturers (SIAM), Automotive Research Association of India (ARAI)
Components to be developed		> Motors > Controller > Charger > DC-DC Converter > Battery
Initial grant (budget)		> INR 22 Crore from DHI [1)] > INR 4.4 Cr for each EV model to be made by OEM
Number of EV/hybrid models to be developed		6 (PVs & LCVs)

1) Department of Heavy Industries, Government of India

Background

> Government of India plans to have 6 million electric and hybrid vehicles on the road by 2020 under National Electric Mobility Mission Plan (NEMMP) and Faster Adoption and Manufacturing of Hybrid & Electric Vehicles (FAME) – refer backup slide for details

> However current low level of electric/hybrid vehicle adoption is due to poor infrastructure and high price of these vehicle. One of the reasons for high price is that most critical components are currently imported into India

Objective

> To develop industry-wide product specification for under-the-hood components for two powertrains (Hybrid & Electric Vehicles) for PVs & LCVs

> To focus on design, development & manufacturing of 5 components used in electric/hybrid vehicle, build road-worthy prototype vehicles and evaluate the vehicles for performance and safety

> To build a supplier base by providing economy of scale (through launch of 6 EV/hybrids) to component manufacturer

Source: Roland Berger

their subject areas, and are often unable to apply their knowledge within a corporate R&D context. In addition to formal cooperation such as research collaborations and recruitment, companies could also cultivate semi-formal linkages to nearby institutions – for instance, by posing research challenges for students, or simply by interacting more intensively with the faculty. This would help keep institutions abreast of the latest industry trends and focus areas, while also enabling companies to find potential employees and academic partners that are more "industry-ready."

2) Engage with the start-up ecosystem: A number of Indian and global multinationals are developing formal and informal linkages with the start-up community in India. Setting up external incubators or accelerators is one increasingly popular way of doing this. However, companies who do not want to set up a formal entity for this function could simply partner with private standalone incubators or work to create relationships with individual start-ups. For instance, Roland Berger has set up a physical space in Berlin, called Spielfeld, where it helps large companies begin their digital transformation by curating their experiences, supporting them in developing a digital strategy and introducing them to adjacent-field start-ups with which they can collaborate on projects. As similar spaces are now emerging in India, companies can leverage these to interact with the start-up ecosystem.

3) Increase intensity of intercompany cooperation, particularly with regard to pre-competitive research: Companies should engage with competitors, suppliers and customers on pre-competitive research topics. Such activity can produce useful new ideas, facilitate cost-sharing on basic research tasks and reduce duplication of effort. While interviewees in our survey lamented the dearth of pre-competitive research collaborations in India, this is slowly changing. One such example is the recent launch of the xEV One project, a consortium of industry bodies and automotive OEMs seeking to develop a supplier base for electric- and hybrid-vehicle components (see Figure VI.4).

4) Act as a constructive partner to the government: Firms can play a vital role as a sounding board for government activities seeking todevelop an innovation ecosystem. This could range from providing constructive feedback on proposed regulations to advising the government on the development of an innovation roadmap, proposing topics for fundamental academic research, orhelping to create curriculum for industry-specific degrees and skills-development programs.

FIGURE VI.5 **Hands-on learning with BITS Pilani and Festo Didactic**

Context

> Students in Indian universities lack adequate exposure to industry while pursuing their engineering education

> It is a major reason for poor quality of entry-level engineering graduates from India

JInGEL: The concept

> The Joint Indo-German Experience Lab (JInGEL) is an initiative to merge practical and theory for engineering education in India

> True to its name, this lab aims to provide the students a physical experience of the theory they learn in classroom through experimentation and prototyping

Collaborating partners	Festo Didactic, BITS Pilani
Funding	Deutscher Akademischer Austauschdienst (DAAD) For a period of 4 years from 2016 to 2019 under its Practical Cooperation scheme
Aim of collaboration	> To learn from experiences of practical learning systems in developed countries to adopt them for Indian context

Proof of concept

> The concept of experience lab has been adopted from successful Experience Lab at TU (TU-BS)

> The attempt at BITS Pilani is a reference project to pilot the idea for Indian context

> The German company Festo Didactic is providing the systems for this experience lab at the lab on BITS Pilani campus

– These systems have already been enabled and evaluated for university education in a bilateral project between TU-BS and Festo Didactic

> The project has been a success in Germany but its success in India is yet to be observed

Sample successful products from Festo Didactic

Instrumentation and Process Control Training System

Radar Training System

Electrical Engineering training package

Mechanical Training System

Source: TU Braunschweig – https://www.tu-braunschweig.de/iwf/pul/forschung/projekte/jingel/index.html, Roland Berger

2. Academic and research institutions

Although Indian academic and research institutions have been the subject of considerable criticism, they play a vital role in the innovation ecosystem. As such they need to be strengthened through the adoption of creative solutions and by leveraging models that have proved successful elsewhere in the world. We find that Indian academic and research bodies need to focus on three crucial elements: 1) improving educational outcomes so as to produce better-prepared entry-level employees; 2) working actively toward becoming world-class research institutions; and 3) strengthening links with Indian industry.

Recommendation 2a: Improve educational outcomes and develop innovation-ready talent.

Rationale: Although a large pool of students enters the workforce every year, quality and employability statistics are quite poor. Institutional performance shows significant heterogeneity across the country. Institutions thus need to understand where their deficiencies lie, and execute a roadmap tightly focused on developing high-quality educational outcomes, including in the area of employability.

Idea: Institutions should 1) undertake a systematic review of performance, develop a detailed improvement plan, work closely with administrators and focus on diligent implementation; 2) support administrators in modifying curriculum; 3) identify and develop new pedagogical approaches in order to deliver a hands-on application-oriented education; and 4) develop continuing-education coursework.

Key stakeholders: Academic institutions (universities, colleges), state-level higher-education departments (supporting role)

How it would work:

1) Undertake a systematic performance review and implement an improvement plan: In seeking to improve graduate and post-graduate quality, Indian universities and colleges should begin with a deep and systematic examination of their performance as compared to other institutions. This should ideally be conducted by an external agency (sponsored by the government), which will be able to provide an unbiased outside viewpoint. Institutions should subsequently use the findings as the basis for a detailed performance-improvement plan.

2) Support administrators in modifying curriculum: Institutions should work closely with the University Grants Commission[a], the All India Council for Technical Education[b] and their own affiliated universities to review and modify the curriculum and evaluation requirements for undergraduate and post-graduate

a) The University Grants Commission is a statutory body withthe responsibility to provide funds and coordinate, determine and maintain standards in institutions of higher education.

b) The All India Council for Technical Education is a statutory body under the Department of Higher Education responsible for planning and the coordinated development of technical education in India.

degrees. The focus should be on turning out graduates who can question conventional assumptions, use critical reasoning, and apply this to the solution of real-world problems and issues. Industry contributions should also be solicited to ensure that the coursework is in line with industry needs. The creation of joint university-industry councils would be one useful way of achieving this goal.

3) Identify and implement new pedagogical approaches: Academic pedagogy should be modified, reducing reliance on traditional lectures in favor of discussion-based sessions, while also adopting other interactive methods such as role playing, simulations and experiments. Examinations should test students' understanding of concepts and ability to apply them to real-world problems. New methods of experiential learning could also be explored and applied.

For instance, recognizing the importance of a hands-on engineering education, one of the leading engineering institutions in India, BITS-Pilani, has partnered with the German company Festo Didactic GmbH, which specializes in developing learning systems for practical education. Drawing on the "Experience Lab" developed by Festo for Technical University Braunschweig, they are bringing a version of this model to the BITS-Pilani campus. This lab will have a combination of hardware-based training materials such as hydraulic and pneumatic training sets for students, as well as software training tools in the form of simulations, all designed to recreate a realistic manufacturing environment on campus (see Figure VI.5). This type of model, if successful, could be cosponsored by the Atal Innovation Mission and replicated across many more engineering institutions in the country.

4) Develop continuing-education coursework: Improving the quality of the entry-level workforce is only half the battle. India today has limited opportunities for continuing education and lifelong learning. Academic institutions should thus strengthen their continuing-education programs and adapt them to the needs of industry. The University Grants Commission is already providing support to institutions seeking to create or expand continuing-education departments. If academic institutions make this a priority, it could benefit industry and academia alike. Industry could sponsor employees to take courses, while academic institutions would in turn get access to the latest industry trends in new and emerging fields. A few institutions dedicated to continuing education have begun to sprout up in the country. The key is now to ensure that these win accreditation and maintain an acceptable level of quality.

Recommendation 2b: Work toward becoming world-class research institutions.

Rationale: A vibrant research infrastructure is imperative for innovation, from the level of so-called blue-sky basic research to industrial R&D. As discussed in Section II-B, pockets of excellence do exist within the Indian research and academic communities. However, these are not enough to compensate for the comparatively low-quality research outputs elsewhere in the country. One major message from our interviews was that applied research in particular is weak in India.

Idea: In order to improve their research outputs, institutions should focus on three main areas: 1) improving the quality of doctoral and post-doctoral programs; 2) developing a technology commercialization strategy, along with supporting frameworks and infrastructure; and 3) reviewing and aligning researchers' compensation and incentive structures to match those of leading global institutions.

Key stakeholders: Academic and research institutions in India (universities, colleges, public and private research institutions), international academic and research institutions (as collaboration partners)

How it would work:

1) Improve the quality of doctoral and post-doctoral programs: One way to achieve this goal would be to partner with international institutions to offer joint doctoral programs. For example, RWTH Aachen partnered in 2015 with the Indian Institute of Technology, Madras, to create a joint PhD program with funding from both the Indian and the German governments. During their period of study in this program, students spend a research period at the partner institution, with a home-university scientific supervisor and a host-institution supervisor jointly supervising the dissertation process. At the end of the program, the student is awarded a doctoral degree from both institutions. Such existing collaborations should be reviewed, and if successful, should be scaled across the country. This could attract more students to pursue PhD programs within India rather than going abroad. Additionally, institutions could partner with leading companies in relevant industries to design customized master's and doctorate programs. For instance, Bharat Forge has helped develop tailored master's and PhD programs with leading institutions such as BITS-Pilani and the Indian Institute of Technology, Bombay. In addition, particularly in fields where the technology is fast-changing, institutions could undertake a periodic review of their current programs by working

FIGURE VI.6 **MIT Technology Licensing Office**

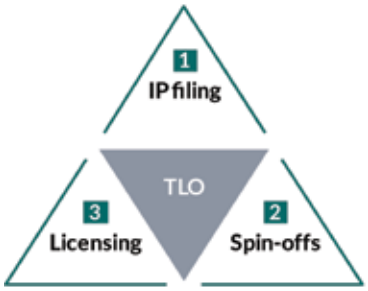
The TLO[1] at MIT is one of the top-ranked globally; in 2005 alone, it filed 469 patents, issued 91 licenses and started 28 companies

Technology Licensing Office (TLO)

> The mission of TLO is to aid the researchers and scientists at MIT in transferring their ideas from inside MIT to the world beyond where society can put it to use

> TLO brings in commercial investment for the development of inventions and discoveries flowing from research at the MIT and Lincoln Laboratory through technology licensing

Functions of the TLO



1 Support in patent filing services and gaining sponsors

2 Support in licensing technologies to companies

3 Starting up a new venture as a spin-off from research

Activities at TLO

> The TLO works closely with Office of Sponsored Programs to connect research groups at MIT with industry for project sponsorships

> MIT's technology is usually early stage and TLO searches for companies which can further develop it before a commercial product is ready for market

> One-third of the financial amount obtained from licensing goes directly to the inventor and rest goes to developing R&D at MIT Labs

Success of TLO activities

> The technology licensing office has attained success over the years in patenting as well as licensing MIT research

> For the fiscal year 2015, they had 795 invention disclosures, filed 469 patents and were granted 314 patents. It also issued 91 licenses and started 28 companies

1) Technology Licensing Office

Source: Roland Berger

with company R&D centers to ascertain whether specific doctoral programs are meeting industry needs and determine whether modifications are needed. This feedback should also be looped back into the institutions' continuing-education programs.

2) Develop a technology-commercialization strategy, with supporting frameworks and infrastructure: Here, applied-research institutions should develop comprehensive strategies for managing their intellectual assets, including in the areas of collaborative research, contract research, consultancy, spin-offs and start-ups, incubator facilities, licensing, and patenting. Moreover, the strategy should also facilitate the creation or strengthening of support infrastructure. For instance, our interviews revealed that only a handful of institutions have functioning technology-transfer offices (TTOs). Institutions with TTOs should review these offices and benchmark their performance against equivalent offices in other countries. Once a comparison is available, the institutions can identify their individual "gap to benchmark," and work actively to reach international standards (for an overview of MIT's Technology Licensing Office, see Figure VI.6). For institutions without a technology-transfer office, the government should undertake an assessment to determine whether an in-house TTO is necessary, or whether a regional office can be established to cater to the needs of multiple institutions in a given city or state. Over time, applied-research institutions should strive toward becoming more self-sufficient instead of being fully funded by the government. For example, funding could be derived from collaborative research, contract research services or technology licensing agreements.

3) Align researchers' compensation and incentive structures to international standards: Researcher compensation levels should be made comparable to those at leading research destinations, such as in the United States, and research bodies should aggressively recruit the best talent from around the globe. The government should support institutions in funding this initiative.

Recommendation 2c: Foster strong linkages with industry.

Rationale: Indian academic and research institutions will not achieve world-class standing until they are able to collaborate successfully with industry partners. In order to do this, a number of changes must be made to current industry-academia collaboration models.

Idea: 1) Develop industry-liaison offices within each institution; 2) hire "professors of practice" who have sufficient experience to advise other faculty members on industrial R&D collaborations; 3) strengthen technology-

FIGURE VI.7 **IIT Kanpur's collaboration with Boeing**

IIT Kanpur and Boeing have a long standing collaboration since 2008 to conduct industry-relevant R&D in aerospace engineering

Mission of the partnership

> To assimilate new ideas and innovative processes not only to meet the emerging needs in the country but also to meet the requirements of the global aerospace industry

Role of partnering organizations

> IIT Kanpur provides expert technological research support in the form of operating models (simulation or prototypes), designs and analytics along with the human capital to carry out projects and a platform for intellectual discourse

> Boeing provides scholarships to undergraduate and master students to encourage the uptake of aerospace engineering and provides students with an opportunity to interact directly with aerospace experts, practitioners and executives from Boeing

> It also extends funding to undertake industry-relevant research in areas of mutual interest

Operating model

> Boeing and IIT Kanpur jointly identify research topics in areas of mutual interest

> Boeing researchers work hand-in-hand with project team to develop these ideas into working and commercially viable prototypes

> Boeing provides project-wise funding which is renewed annually and is used specifically for the project that it is designated for

> Confidentiality agreements are signed to protect the company's proprietary information that the student/faculty may gain access to while working on the project

> Intellectual property of any kind created as a result of any of these projects is jointly owned by IIT-Kanpur and Boeing

Successful outcomes

> Some noteworthy projects from this collaboration have been integration of passive and active radio frequency identification, an autonomous navigation vehicle and a project on high lift aerodynamics

Source: Roland Berger

transfer offices; and 4) develop customized collaboration models with specific industry partners.

Key stakeholders: Academic and research institutions (universities, colleges, public and private research institutions), companies (secondary)

How it would work:

1) Develop industry-liaison offices within institutions: Applied-research institutions should introduce dedicated units tasked with liaising with companies on research collaborations. This unit, or industry-liaison office, should work closely with the technology-transfer office, and can support research teams in defining the scope and nature of collaborations, expected outcomes and timelines, while providing advice on intellectual-property-related topics.

2) Create "professor of practice" positions: Institutions could also create the role of a "professor of practice," a dedicated faculty member with industry experience who could help align academic research work with industry expectations, while also communicating industry trends and desires to ensure that institutional R&D output is market-ready. Some institutions have already begun to do this. For instance, the Indian Institute of Management, Indore, created this position in 2014.[253] In addition, research institutions should also encourage faculty mobility into and out of industry jobs. This will enable cross-sectoral learning while helping to improve the quality of industry-academia collaboration.

3) Strengthen technology-transfer offices: See Recommendation 2b.

4) Develop customized collaboration models with specific industry partners: There are a number of successful models for industrial R&D collaboration between Indian institutions and companies. These should be studied, understood, leveraged and scaled. For instance, IIT Kanpur's collaboration with Boeing, ongoing since 2008, could be studied and replicated in other industries by other institutions.

3. Government

In the past year, India's government has undertaken numerous policy initiatives aimed specifically at the goal of improving the country's innovation ecosystem. A number of these were discussed in Section III-B(3), on entrepreneurial culture as an external factor influencing innovation. In light of this activity, our recommendations focus here on the lacunae in the current innovation-policy landscape – specifically, on: 1) supporting academic institutions in developing top talent; 2) strengthening public research institutions; and 3) leveraging global best practices to drive industry-academia collaboration. The government should also simultaneously ensure that existing policy initiatives such as Start-Up India, Stand Up India; the new IPR policy; and the Atal Innovation Mission are diligently and effectively carried out.

Recommendation 3a: Support academic institutions in developing top talent.

Rationale: Central- and state-government education bodies can play a vital role in supporting universities' and colleges' efforts to produce world-class talent. However, conditions at a number of these institutions today are poor, requiring an overhaul. As Krishna Ganesh, director of the Indian Institute of Science Education and Research in Pune, explains, "Lack of even bare, minimal and sustainable funds for teaching, let alone research, has seriously plagued the quality and standards of science education."[254] Sri Krishna Joshi, former chair of the advisory committee of the University Grants Commission, says state-university students receive substandard educations. "Here there are no good science teachers, no good Indian textbooks, and most of the science laboratories are poorly equipped."[255]

Idea: 1) Develop a performance-oriented culture at educational institutions, and 2) make modifications in the curriculum and pedagogy to ensure that students develop cross-functional thinking.

Key stakeholders: Government bodies (UGC, AICTE, state higher-education departments, Ministry of HRD), academic and research institutions (universities, colleges)

How it would work:

1) Develop a performance-oriented culture at educational institutions: The central government, in conjunction with the state governments, should sponsor a comprehensive assessment of each of the 700 universities in the country, using key parameters measuring the quantity and quality of education and research outputs. As a starting point, the recently established National Institutional Ranking Framework[a] rankings could be expanded to cover more disciplines and different types of institutions. The rankings would help to identify high-, medium- and low-performing institutions. The government could provide incentives to high-performing institutions by issuing sizeable grants that could be utilized to further strengthen the quality of pedagogy, teaching infrastructure or other problem areas. For medium- and low-performing institutions, program administrators should identify reasons for the poor performance, develop an improvement plan in conjunction with each institution, and closely monitor progress. If low-performing institutions are not able to improve their performance over a specified period of time, they should be closed down. Depending on the findings of the assessment, policymakers should consider allocating additional funding to bring the lagging academic and public research institutions up to acceptable benchmark standards. This ranking framework should create a sense of competition as well as a performance-oriented culture within the institutional community, as is the casein the United States and China, for example. Policymakers should also modify compensation structures for teaching faculty and administrators in order to provide performance incentives. The United States model of compensating teaching faculty only for the duration of the academic year could spur faculty members to focus on research activities during the off-season.

2) Make modifications to the curriculum and pedagogy: Institutions such as the University Grants Commission and the All India Council for Technical Education (AICTE) should work with universities and colleges to make modifications to existing curriculum and pedagogical styles that encourage interdisciplinary and cross-functional thinking. The curriculum modifications should be done in consultation with industry to ensure that they reflect industry needs. For example, a joint committee with leading members of industry could be established to oversee this process. Examination requirements should be modified to test students' understanding of concepts and ability to apply those concepts to real-world examples and challenges.

India has a daunting task ahead of it as it seeks to overhaul its higher-education system. However, the government can steer this transformation process if it takes a planned and systematic approach. Over the past few decades, for example, China has successfully reformed its higher-education system. In the 2016 edition of the Universitas 21 Ranking of National Higher Education Systems, China emerged as the most improved country, with an overall gain of 12 places over four years (2013-2016).[256] Indian policymakers could thus draw from Chinese best practices in this area and adapt them to the Indian context. Figure VI.8 contains a brief analysis of China's successful Project 211 and Project 985.

a) The Ministry of Human Resource Development's (MHRD) National Institutional Ranking Framework (NIRF) offers a methodology for ranking institutions across the country. The parameters broadly include teaching, learning and resources; research and professional practices; graduation outcomes; outreach and inclusivity; and perception. Currently, the methodology has been designed to cover six categories of institutions – engineering, management, pharmaceutical, architectural, universities and colleges (NIRF website).

Recommendation 3b: Strengthen public research institutions

Rationale: Given the important role of public research institutions in national innovation ecosystems, and India's low research output compared to peers such as China and South Korea, Indian policymakers seek to strengthen the country's public research institutions.

Idea: To pursue this overall goal, the government should: 1) develop pilot programs with the aim of creating world-class research institutions, 2) formulate an equivalent to the United States' Bayh-Dole legislation (enabling research institutions keep rights to government-funded innovations) suited to India's needs 3) Develop research internationalization strategy.

Key stakeholders: Government bodies (UGC, AICTE, state higher-education departments, Ministry of HRD), Department of Science and Technology, Department of Scientific and Industrial Research, academic and research institutions (universities, colleges, public and private research institutions)

How it would work:

1) Develop pilot program to create world-class research institutions: Policymakers should identify an external and independent consultancy that could support and oversee this program. This independent agency should assess India's research institutions in terms of research output. Once the assessment of the institutions is complete, the agency should develop a blueprint for creating world-class institutions by studying successful international models and adapting them for the Indian system. It should then identify 10 institutions for participation in a pilot program: three high performers, three medium performers, and four low performers. It should then create a customized milestone-based improvement plan for these institutions, obtain funding from the government, and develop systems and processes to structure execution. Once the pilot is complete, a detailed review the process should be undertaken, with lessons incorporated into future strategic documents. The program should then be further fine-tuned and applied to a larger set of institutions.

2) Formulate an equivalent of the United States' Bayh-Dole legislation suited to India's needs: In the United States, policies such as the Bayh-Dole Act, which enables researchers to retain intellectual-property rights even for government-funded research, have been pivotal in shaping the landscape for collaborative research in the United States. However, such ideas

FIGURE VI.8 **Government-led higher-education reform in China**

China undertook a systematic approach to transforming its higher education system – today, it ranks as one of the most improved

		Project 211	Project 985
GOVERNMENT INITIATIVES	Goal of the project	> To strengthen 100 specific institutions amongst National Key Universities of higher education and key disciplinary areas	> To develop 'world-class' universities
	Key focus of development	> Aiding institutions with setting up overall infrastructure, develop key disciplines and courses, and improve public higher education system in addition to human resource training for faculty and scientific research	> Upgrading selected institutions to international standards by increased funding for R&D activities, holding international conferences, attracting world-renowned faculty and visiting scholars, and to help Chinese faculty attend conferences abroad
	Universities benefitted	> The project started with 99 universities in 1995 and has transformed 110+ universities thus far	> The first phase was launched in 9 universities in 1998 and today it has 39 universities under its umbrella
	Government funding	> During the first 10 years of the project USD 5.53 bn were allocated by the government to support the institutions	> A total of USD 10.21 bn funding was allocated under the project 985 under its first two phases from 1998 to 2006

IMPACT

> Project 985 was constructed on top of project 211; all project 985 institutes have been a part of project 211 initially

> Project 211 schools train 4/5th of doctoral students, 2/3rd of graduate students, half of students from abroad and 1/3rd of undergraduates of total Chinese students. They offer 85% of the state's key subjects, hold 96% of the state's key laboratories, and utilize 70% of scientific research funding

TEACHING REFORM

> Chinese education system has adopted performance based pay for its school teachers, which means that a teacher's level of pay would depend on his/her students' test performances

> Career progression for teachers and principals also happens on a competitive basis, high performers are better rewarded and are more likely to be promoted

Source: Roland Berger

may not be fully translatable to the Indian context. Policymakers should therefore be careful to address the specific weaknesses in the current system rather than simply seeking to replicate other countries' successful policies in India. The focus should be on creating adequate incentives for institutions, faculty members and researchers to develop high-quality research, both in terms of monetization potential and intellectual-property rights. However, adequate safeguards must be kept in place ensuring that the public interest is considered and that research institutions continue to develop inclusive and open innovations.

3) Develop research internationalization strategy: India's government should act decisively to encourage stronger collaborations with foreign institutions. Countries like Germany, with its state-of-the-art academic and research institutions, represent great learning opportunities for India. For example, India could follow Germany's lead in drafting its own research internationalization strategy, developing a clear and well-defined approach to achieving its research-outcome goals in the coming years. As a first step, policymakers could examine the domestic shortcomings revealed by the assessment of academic- and research-institution performance, and identify the countries that excel in these specific areas. Next, successful models of bilateral or multilateral partnership could be identified and adapted to an Indian context. Finally, the Indian government should seek to develop formal links with countries that have a thriving public research environment, with the goal of learning from them.

Recommendation 3c: Leverage global best practices and implement novel approaches to industry-academia collaboration.

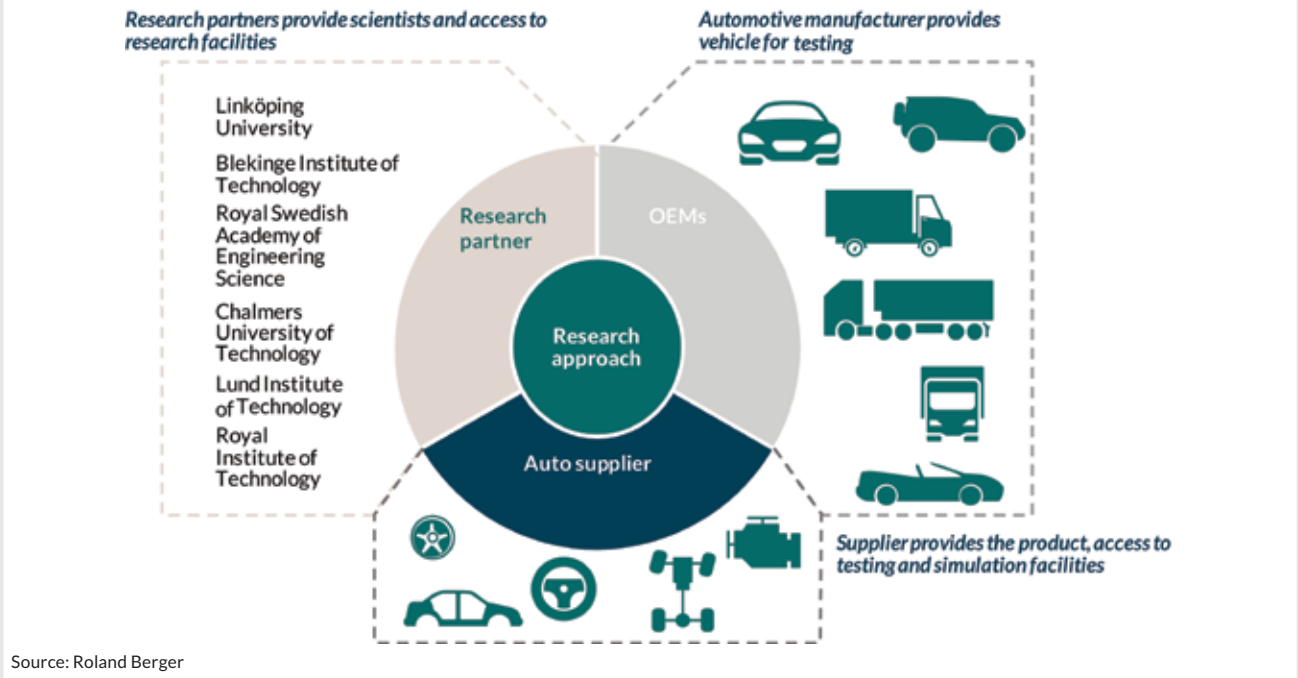
Rationale: If the government is to encourage innovation as broadly as possible in India, it should: 1) support innovation within MSMEs, and 2) help researchers gain greater exposure to current industry challenges. Given the difficulties in encouraging many micro, small or medium-sized enterprises (MSMEs) to innovate, the government could look externally for novel approaches to industry-academia collaborations.

Idea: India can draw on ideas from other developed countries that show successful industry-academia collaboration. For instance, Sweden has developed one such example in the automotive industry, with collaboration between a university, a supplier, and the customer – in this case, the automotive manufacturer (see Figure VI.9).

Key stakeholders: Departments reporting to the Ministry of Science & Technology (Department of Science and Technology (DST), Department of Scientific and Industrial Research (DSIR)); MSMEs; academic and/or research institutions; large companies (Indian or multinational)

How it would work: To illustrate how this collaboration might work, let's take an example from the automotive industry. The researcher or supplier might apply for a grant to India's Department of Science and Technology (DST). Grant applications would be reviewed and awarded by a joint committee comprising industry associations (e.g., the Automotive Component Manufacturers Association (ACMA) and the Society of Indian Automobile Manufacturers) and the relevant government department (e.g., the Department of Heavy Industry). For each project, a university or research institution would provide post-graduate students and research facilities. The supplier would provide the component or product that is to be tested, as well as the testing and simulation equipment, while the automotive manufacturer (OEM) would provide the vehicle for testing. The researchers would work with the supplier to develop the technology. None of the stakeholders – that is, the research institution, the supplier or the automotive OEM – would be required to provide funding. Instead, each stakeholder would simply leverage its existing assets and know-how. The supplier would provide the participating automotive manufacturer with the first right of refusal with regard to adopting the technology. The supplier would benefit because it would be able to experiment and test its products, which would have been difficult to do otherwise. The students from the university or research institutions would be given the opportunity to work on a live project, as well as being provided with proximity to the supplier and the OEM, thereby providing them with hands-on experience.

FIGURE VI.9 **Multilevel research collaboration in Sweden's automotive industry**



Source: Roland Berger

B. Recommendations for Germany (in the context of India)

As described elsewhere in this report, it is evident that innovation in India is real, and that its momentum is expected to grow in coming years. As we have seen in the previous section, India offers Germany (and other Western economies) numerous opportunities in the area of innovation. Here we outline specific recommendations for German companies, academic and research institutions, and policymakers that would help them capitalize on India's growing innovation momentum.

1. Companies

Recommendation 1a: View India as more than a mere marketplace, and seek to leverage India's R&D capability.

Rationale: In the years to come, a considerable share of global economic growth will be driven by emerging markets. India, as the second-largest emerging market and a country with a large labor force and heterogeneous and underpenetrated market segments, serves as an ideal testing ground for emerging-market innovations.

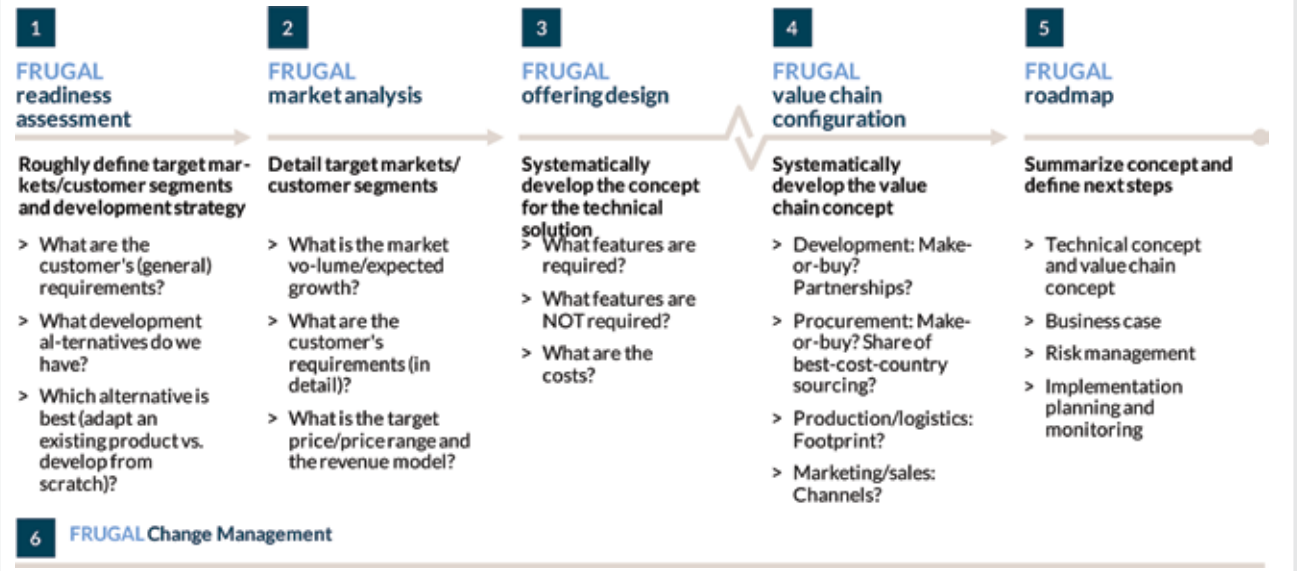
Idea: Leverage India's diversity to develop, test and launch innovative products and solutions for a variety of market segments.

Key stakeholders: German companies

How it would work: German companies with a sales or manufacturing presence in India should consider whether it would be appropriate to set up an additional R&D presence in the country. If senior management determines that an R&D unit in India could add significant value to the company's global innovation agenda, it would be necessary to devise a detailed R&D strategy for India that was well-aligned and integrated with the global R&D strategy. The company could start by assigning the Indian R&D center limited tasks such as application development and other smaller work packets, and then increasing the scope of responsibility over time. The R&D center should employ local engineers as well as global talent in specialized areas. After some years of successful operation, the Indian R&D center could even develop the capability to lead global design and development efforts in a number of areas. However, the parent company should invest time and effort in building cultural affinities and professional camaraderie between the Indian and international researchers. Moreover, the firm should proactively dispel views within the organization that the Indian center is merely a "body shop." This can be facilitated by encouraging exchanges between national facilities, allowing employees around the world to meet and develop a personal rapport. Finally, the R&D center should take advantage of India's vibrant innovation ecosystem to collaborate with local start-ups, academic institutions, and other multinational companies active in the city or region.

FIGURE VI.10 **Roland Berger Frugal Innovation Framework**

German companies should develop a systematic framework which they can apply to their frugal innovations



Source: Roland Berger

Through the course of this report, we have already seen a number of multinational (including German) companies leveraging their R&D presence in India to develop products and services for Indian and global markets. They are also actively participating in and drawing from the external ecosystem of which they are a part, by collaborating with start-ups, academic institutions, and even other companies in complementary industries. Examples such as Bosch, Siemens and SAP show how German companies can leverage India's innovation ecosystem to create R&D engines that complement and even drive their global innovation agendas.

Recommendation 1b: Co-innovate with Indian companies that have mastered the art of frugal innovation.

Rationale: German companies have much to gain from adopting frugal-innovation approaches. According to a study currently underway by the Fraunhofer-Zentum für Internationales Management und Wissensökonomie, more than 90% of Germans are today unaware of the concept of frugal innovation.[257] Nevertheless, by adopting this approach, companies can develop a range of products and services for emerging markets (currently constituting6 billion consumers), while preparing themselves for disruptive innovations arising out of developing countries such as India and China. Moreover, a frugal-innovation approach also helps companies focus on what is most important: the customer value proposition. The resulting frugal products and services could be offered in India as a complete product line (complementing the German company's original products) to meet the needs of different consumer segments. In addition, the innovations could be offered in other budget-constrained emerging markets, as well as in price-sensitive niche segments of developed markets

Idea: Develop frugal innovations in India.

Key stakeholders: German companies, Indian companies

How it would work: German companies should be open to cannibalizing themselves and using clean-slate approaches to solve new and existing problems, on the theory that it is better to partly cannibalize one's own sales than to have competitors erode one's market share (see Figure VI.10 for information on our Roland Berger Frugal Innovation Framework). Moreover, German firms should be open to co-innovating with their Indian counterparts, particularly in areas such as frugal innovation, and should identify and explore available collaboration models for doing so. One potential approach could be to license frugal products from Indian companies and launch them in the German market.

2. Academic and research bodies

Recommendation 2a: Showcase the capabilities and strengths of the German academic community in order to attract Indian students and spark industry collaborations with Indian companies.

Rationale: In light of the challenges in the Indian higher-education system, thousands of Indian students choose to pursue higher studies outside India every year. However, most prefer to go to countries such as the United States or the United Kingdom rather than Germany. Moreover, many Indian companies we interviewed lamented the lack of options for engaging in strong collaborations with Indian academic or research institutions, given the domestic weaknesses in that sector. That represents an opportunity for German institutions.

Idea: German academic and research institutions can capitalize on this opportunity to 1) attract more Indian students, and 2) collaborate with Indian companies on research projects.

Key stakeholders: German academic and research institutions, Indian companies, German House of Research and Innovation (DWIH), German Academic Exchange Service (DAAD)

How it would work:

1) Attract more Indian students: German institutions, in conjunction with the German embassy, DAAD[a] and the DWIH[b] should formulate a strategy to attract more Indian students. The strategy should include the roll-out of a marketing campaign that targets bright students. This could be supplemented by subsidized German-language courses. Moreover, the marketing campaign should highlight the significant cost advantages of studying in Germany vis-à-vis countries like the United States, given that tuition is free and students would only need to cover living and personal expenses. Moreover, fellowships such as those from Alexander von Humboldt or the Max Planck Gesellschaft should be advertised so as to raise awareness and attract more applications.

2) Collaborate with Indian companies on research projects: The DWIH could serve as a conduit between Indian companies and German institutions interested in engaging with Indian industry. In our interviews, we found that only a handful of Indian companies were aware of DWIH. Therefore, the German embassy in India should work with DWIH to develop a communications and marketing strategy that reaches out to India Inc. and communicates the capabilities and strengths of German academic institutions. German institutions could also learn from the Fraunhofer Gesellschaft, which has set up an office in Bangalore and is coordinating projects with Indian companies on a number of topics. As of 2012, the institution reported that it was already working with 30 of the 50 leading Indian companies, and was engaged in research projects worth EUR 1.3 million across various Fraunhofer Institutes.[258]

a) The largest (German) funding organization in the world supporting international exchanges for students and scholars.
b) The German House of Research and Innovation (DWIH), a consortium of German universities, research institutions and funding organizations.

3. Government

Recommendation 3a: Increase the availability of highly skilled labor in order to retain status as a high-technology innovator.

Rationale: Germany is at an exciting but challenging inflection point. Although the country still retains its status as a high-technology innovator and exporter, this could be in danger if the state does not take adequate steps to ensure a stable and motivated base of highly skilled labor. Given the country's changing demographic profile, this could prove to be difficult unless policymakers make a concerted effort to obtain talent from other countries.

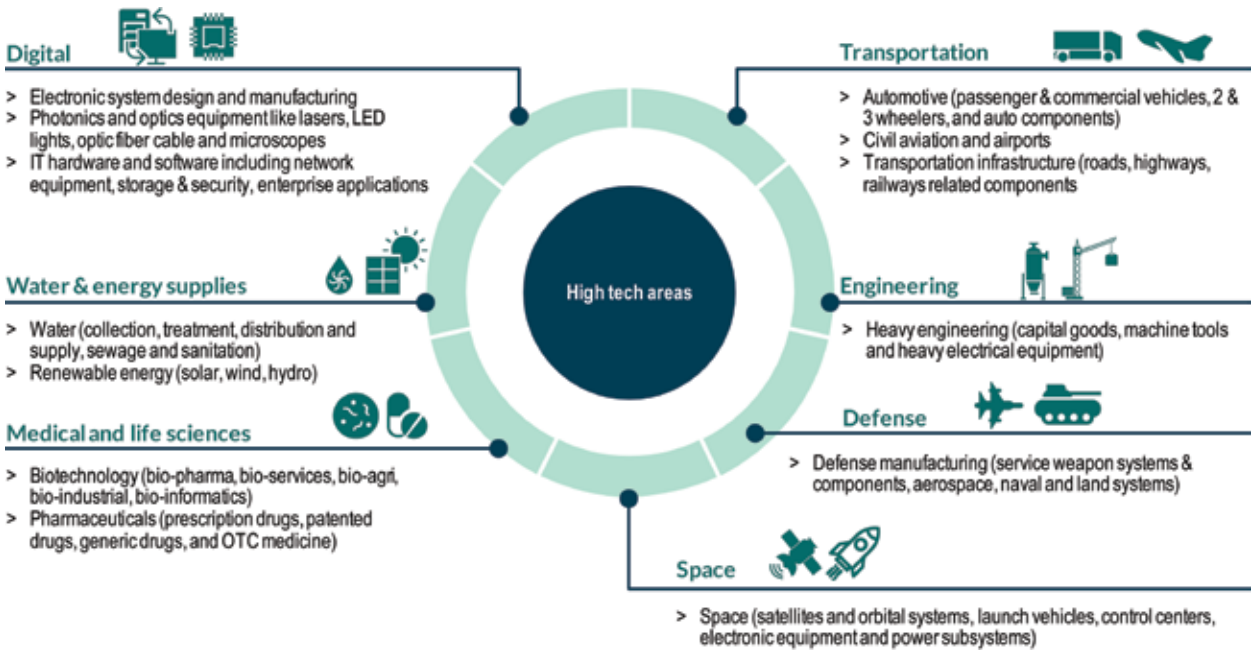
Idea: Identify areas with emerging skills or labor shortages, and develop partnerships with Indian institutions to fill these gaps. Develop a skills roadmap to ensure that Germany does not lose skillsets.

Key stakeholders: German government

How it would work: We believe that Germany should map its current skillsets, by industry and function, and identify current or emerging gaps. Based on this analysis, the country should formulate a skill roadmap in conjunction with its technology/ innovation roadmap, with the aim of retaining and developing skills that are essential to maintaining the country's competitive advantage in innovation. Furthermore, the country should develop targeted immigration policies for highly skilled workers, particularly in areas where Germany faces a skill shortage (e.g., experts in computer science and software development, metal engineering and welding technology, automotive engineering, and power engineering).[259] Given that India has a large pool of engineers, German policymakers should explore the creation of a formal skilled-labor partnership with India. This is further described in the section below on Indo-German collaborations (see page 120).

FIGURE VI.11 **Areas of potential Indo-German cooperation in the manufacturing sector**

The Indian Embassy in Germany outlined seven areas of potential cooperation between India and Germany in high-tech manufacturing



Source: Prospects for Indo-German Collaboration in High Tech Manufacturing, Embassy of India, Berlin, available at https://www.bibb.de/dokumente/pdf/Prospects_for_Indo-German_Collaboration_in_High-Technology_Manufacturing(1).pdf

Recommendation 3b:Increasethe scope and scale of collaboration with developing countries such as India.

Rationale: As we have seen in this report, innovation in emerging markets is unique and different from innovation in developed countries. There is significant value in understanding emerging-market innovation trends. In this context, given that Germany is already strong when it comes to high-technology innovations, the country should also look toward non-traditional and new types of innovation to keep up with emerging-market competitors.

Idea: Increase collaboration with India on specific topics of mutual complementarity.

Key stakeholders: German government (BMWi, BMBF)

How it would work: As we saw in Section V-D, the intensity of Germany's research collaboration with India is still below that with other BRICS economies such as Russia and China. Consequently, Germany should identify areas in which it can deepen collaboration with India, particularly in the area of innovation. German policymakers should begin this exercise by identifying specific strengths within the Indian innovation ecosystem, as well as areas in which Germany would benefit from collaboration. As a starting point, Germany could leverage studies that have already outlined a few areas of potential cooperation. For instance, the Indian Embassy in Germany undertook an analysis of "Prospects for Indo-German Collaboration in High-Technology Manufacturing" in 2015. The results of this study showcased a few potential areas within the manufacturing sector that appeared to hold collaborative potential (see Figure VI.11).

In addition, interview respondents suggested that combining India's software-engineering prowess with Germany's precision-engineering strength for projects in biotechnology, the internet of things and other such fields could create areas of mutual complementarity. Closer analysis on this issue will be needed to identify where and how Indian and German collaboration can most beneficially take place. Organizations such as the Indo-German Science and Technology Center (IGSTC) should drive this process forward and develop a roadmap. The Indo-German Project Group concept outlined in sub-section C, Recommendation 3, could also help focus intercountry and inter-industry collaboration on specific topics.

The German government could also learn from the Indian government in terms of utilizing frugal-innovation practices to provide cost-effective public or civic services. Initiatives such as RuPay and the unified payments interface (UPI) discussed earlier in the report (pages 49

and 51) could serve as valuable models for the German government.

C. Recommendations for Indo-German collaboration

Recommendation 1: Establish skilled-labor exchange programs between the two countries.

Rationale: Areas of complementarity exist for the following reasons: 1) German companies and research and academic institutions need young, highly skilled workers; 2) India needs access to specialized workers in key areas; 3) Indian academic institutions need to improve education outcomes; and 4) the Indian government needs to create and find jobs for the millions of young citizens who will enter the workforce in the coming decades.

Idea: The two countries should create a comprehensive skill-exchange and skill-building initiative. The following steps would lay the foundation for success in such a venture: 1) Mapping existing skillsets in both countries, and identifying areas of mutual complementarity; 2) identifying and selecting academic institutions in each country to participate; 3) developing mutual-recognition agreements within key areas of focus; 4) developing an online platform and partner with pre-placement career-testing sites; and finally 5) develop the integrated offering.

Key stakeholders: Governments (For India, the Ministry of Human Resource Development (MoHRD), the Ministry of Laborand Employment, the University Grants Commission (UGC), the All India Council for Technical Education (AICTE); for Germany, the Federal Ministry of Labor and Social Affairs (BMAS) and the Federal Ministry of Education and Research (BMBF)), academic institutions in both countries, companies in both countries

How it would work: First, both governments would need to map the skillsets within their respective countries by industry and function, and identify gaps. They would then identify areas of mutual complementarity (e.g., India has abundant software engineers, which Germany needs, while Germany has the data scientists that India lacks). Both governments would subsequently identify and select academic institutions in each of their countries that teach these degrees and produce graduates (ranging from vocational education to post-doctoral students) in the requisite fields. Qualifications, curriculum requirements and standards would be exchanged and harmonized by the two governments, and a mutual-recognition agreement could be forged for key skill areas. In parallel, an online portal could be developed (funded equally by both governments) that would serve as a one-stop-shop for institutions and companies. The portal would contain information organized by skill area and institution, and would list the number of students available. In addition, the portal could provide information on experienced German professionals who were interested in engaging with the Indian ecosystem, for instance by visiting Indian academic institutions as adjunct or visiting faculty, or by mentoring Indian start-ups.

Companies could pay a nominal subscription fee to access the portal. If a company found an institution whose students match edits human-capital needs, it could submit a formal request to the institution, and the two could establish a relationship. Interviews and testing could also be carried out through this portal, which could be integrated with pre-placement career-testing sites, thus accompanying companies and students through the entire placement process.

This type of collaboration would have a number of benefits. Both countries would gain access to needed talent. Simultaneously, Indian academic institutions could leverage the experience to learn from German institutions and improve their educational outcomes.

Recommendation 2: Promote industry-academia linkages between India and Germany.

Rationale: This form of international partnership would be mutually beneficial for the following reasons: 1) Large Indian companies need strong links with academic institutions to provide support on applied-research topics; 2) German academic and research institutions could capitalize on India's weak research capabilities; and 3) Indian academic and research institutions need to deepen their own industry-academia collaborations.

Idea: Facilitate and support the development of Indo-German industry-academia collaborations.

Key stakeholders: Indian government (Department of Science and Technology (DST)), Indo-German Science and Technology Center (IGSTC; a potential facilitator of these efforts), large Indian companies that are actively innovating in India and need access to academic or applied research, German academic or research institutions that perform applied research, Indian academic or research institutions that perform applied research.

How it would work: This project could be an extension of the Indo-German Science and Technology Center's (IGSTC) current program. DST would need to set aside an annual budget allocation to fund this initiative. DST could moreover develop a matchmaking portal linking Indian

companies and Indian and German research and academic institutions, supporting multiple industries and research topics. Indian companies would have access to this portal for a nominal fee, and could use it to connect with German research institutions with the requisite specialization on specific projects. If the two parties also partnered with an Indian academic or research institution, they could be eligible for funding. This project group (industry plus academic institutions from Germany and India) would then apply to the DST for funding, and a governance structure would be set up to review progress, ensure that each member is fulfilling their commitments and perform other oversight duties.

DST could fund approximately 10% to 25% of the project cost. If the project fell into a high-priority sector such as healthcare, pharmaceuticals, biotechnology, energy or transport, funding could be extend up to 25% of costs. Such an initiative would facilitate Indo-German collaboration and strengthen industry-academia links. Moreover, it would create tremendous learning opportunities for Indian research institutions, strengthening their industrial-research capabilities.

Recommendation 3: Develop a project-specific inter-industry consortium between the two countries.

Rationale: India and Germany have considerable complementary strengths and mutual interests. Collaboration could be facilitated by a structure devoted to identifying and promoting these complementarities.

Idea: Set up an Indo-German Project Group (IGPG) to drive specific inter-industry projects involving representatives from both countries, focusing on individual projects for periods of one to two years.

Key stakeholders: Governments (In India, the Department of Science and Technology (DST); in Germany, the Federal Ministry of Education and Research (BMBF) and the Federal Ministry for Economic Cooperation and Development (BMZ)), industry bodies (Confederation of Indian Industry (CII), National Association of Software and Services Companies (NASSCOM), Federation of German Industry (BDI)), large companies from each country (specializing in the project's specific topic), academic institutions from each country.

How it would work: We use here Industry 4.0 as an example of a project subject area that could easily fall under the IGPG model. In this case, large German companies involved with Industry 4.0 issues and large Indian IT players working on topics such as the internet of things (IoT), big data or analytics could be brought on board as "corporate champions." Academic or research institutions working on these topics from each country would serve as partners tasked with carrying out applied research and analytical work. The project group would identify the scope of the collaboration in consultation with the nodal body, develop a work plan, distribute tasks among members and work as one unit to achieve the objectives of the project.

Recommendation 4: Develop a bilateral start-up exchange and collaboration portal.

Rationale: Start-ups in the two countries could benefit from co-innovating, particularly in areas that require cross-industry or cross-functional skills. Moreover, a collaboration portal could provide a valuable platform for start-ups looking to launch in the other country.

Idea: Set up bilateral start-up exchange and collaboration platform linking incubators in the two countries.

Key stakeholders: Embassies in both countries (to provide information on incubators in their home countries, as well as support in facilitating visas, etc.), incubators in both countries, start-up cohorts[a] in the participating incubators

How it would work: Incubators from Germany and India could partner with one or more incubators in the other country. This would involve sharing information about each incubator's cohort with the other participating incubators. A simple online platform could be created that provided information on each participating incubator and its start-up cohort. Start-ups in each incubator could thus gain insight into each other's areas of focus and expertise, and obtain contact information. If they were interested in collaborating, they could reach out to other start-ups, and apply for a three- to six-month exchange program in the partnering incubator. Participating incubators would waive office-space rental fees, and the participating start-up entrepreneurs' travel and accommodation expenses could be partially subsidized by the national embassies. Initiatives similar to this already exist. For instance, the Startup Europe India Network (SEU-IN), set up by the European Commission's Start-up initiative; Cambridge University's Center for India and Global Business; Holland Fintech; and Crosspring in the Netherlands have successfully brought together various stakeholders in the Indian and European start-up ecosystems to facilitate interaction and stimulate growth and funding opportunities. The Indian and German embassies could jointly decide whether to collaborate with existing programs such as SEU-IN or launch a dedicated bilateral start-up collaboration program.

a) This refers to the group of start-ups participating at any given time in an incubator or accelerator program.

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