



# Emerging Business Models in Cancer Diagnostic Startups in India and Lessons for African Countries

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## INTRODUCTION

India has a dynamic and innovative MedTech (medical technology) sector that has been growing despite an economic environment characterised by policy vacuum, regulatory lags and a low-value market for their outputs. So how are the firms driving this growth, and what are the supporting ecosystems for entrepreneurship and progressing innovations to the market?

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Over the last two decades, the Indian healthcare sector has made a gradual epidemiological transition, driven by a shift in disease burden from communicable to non-communicable diseases (NCDs). Among NCDs, cancer has emerged as a wicked problem due to the high cost of treatment, difficulty in early diagnosis and lack of comprehensive cancer control strategies. The mortality rate in India due to cancer increased by 6% between 2012 and 2014, while incidence from cancer registry data does not show an alarming rise relative to high-income countries (IARC, 2020). This emerging focus on NCDs and cancer has created a demand for affordable diagnostic technologies to detect and monitor cancer. The rising income levels among the Indian middle class, ageing population and private sector investment in healthcare have generated a significant demand for MedTech startups for technologies and services that improve access to cancer detection and monitoring services. The startups bridge the gap between need and effective availability.

However, the emergence of dynamic tech startups raises questions about the policy environment driving the growth of the Indian diagnostics sector. From an economic development standpoint, the role of learning in diagnostics firms has not been well understood compared to a mature body of scholarship on Indian pharmaceuticals and vaccines (Kale & Wield, 2018; Srinivas & Kale, 2022). This chapter focuses on business models adopted by emerging Indian innovative medical devices and diagnostic startups operating in cancer care. A business model mediates between the choice of technology and firm performance; as such, the selection and development of the right technology is a matter of a business model decision regarding openness and user engagement. This understanding of the business model provides an appropriate construct to explore Indian innovative startups' strategies to survive and succeed in a policy vacuum, low-value high-volume market and resource-constrained environment.

Cancer diagnosis and treatment are challenging issues for LIMCs. In India, between 1990 and 2016, the number of cancer deaths increased by 112% and disease incidence increased by 48.7% (GBD, 2017). In 2018, India had 2.25 million cancer patients and recorded more than 750 000 deaths due to cancer. It is suggested that every year, over 1.15 million people are diagnosed with cancer and close to 10% of Indians are at risk of developing cancer before they reach 75 (Kashyap, 2019). According to the Indian Council of Medical Research (ICMR), breast, cervical, oral and lung cancers constitute 41% of the cancer burden (Mathur et al., 2020).

It is also observed that India has a lower incidence of cancer than the US and several European countries. Still, mortality is much higher due to poor early diagnosis and late treatment (Verma, 2014). This need for early cancer diagnosis in India has fuelled the emergence of MedTech startups focused on creating access to cancer diagnosis and access. However, the policy- and market-constrained environment also makes it imperative for these startups to develop an appropriate business model for survival and growth whilst navigating local resource constraints.

From 2010 onwards, India witnessed a significant increase in medical devices and diagnostic startups developing innovative solutions to create access to appropriate cancer care for local populations. The emergence of this dynamic sector raises questions about how Indian startups are driving the growth of the medical diagnostic industry in an economic environment dominated by policy vacuum, regulatory lags and a low-value market. We engaged with the question by focusing on the business models adopted by the innovative Indian startups in this sector. This chapter employs case studies of three cancer diagnostic firms to explore their business models and their relevance for startups operating in other LIMCs. Primary data was collected through detailed open-ended semi-structured interviews with medical device and diagnostic firms in India, including interviewing the founders of the two startups that are part of this study. Our research highlights the importance of the state as an 'informal' provider of venture capital and international collaborations to plug the finance and knowledge gaps, respectively. This chapter concludes with a discussion on what business models are relevant and effective for firms operating in resource-constrained environments of LMICs.

## MEDTECH STARTUPS IN DEVELOPING COUNTRIES AND SYSTEMIC SCARCITIES

MedTech covers a wide range of medical devices, equipment, software and diagnostics companies, forming a significant and critical segment of the healthcare technology industry. MedTech is a focus sector for startups in India. A study of technology incubators in India showed that over 25% of incubated startups were in MedTech, the second largest industry after IT (Mukherjee, 2022). There are numerous examples of scientists, engineers or clinicians starting a venture by identifying an unmet clinical need based on their domain knowledge and understanding of the market gap. Several

steps are involved in moving from identifying a need to a market launch, each of which requires considerable expertise and resources.

In high-income countries, what drove the rise of MedTech startups is the financial capacity to pay for innovations, ageing populations that create demand for sophisticated medical technologies, and more organised procurement systems that facilitate rapid adoption of innovative products into health systems (Kale & Wield, 2018). However, LMICs provide a different challenge. Innovation is a context-driven process; innovations and technologies solving a problem elsewhere may not be best for a different situation. LMICs' markets present growth opportunities, but governments and consumers have limited financial ability to afford innovative but expensive products sold with high margins by emerging startups in high-income countries. The constrained markets, limitation of medical professionals and lack of basic infrastructure create a need for a solution more appropriate to local conditions. Srinivas and Sutz (2008, p. 130) elaborate on systemic scarcity observed in LMICs markets by pointing out that "scarcity conditions include problems at the level of infrastructure that is missing or is not up to date, of access to materials and equipment of the required quality or accuracy, of institutional support for the building of endogenous capacities, of enough people with appropriate skills to run projects or discuss ideas, and of money to rely on well-known solutions". Within this context, healthcare technology firms developing technology without considering these systemic scarcities will struggle to make a desirable impact.

This discussion highlights that the institutional environment of LMICs is characterised by systemic institutional scarcities. In contrast, traditionally observed resource gaps are incidental scarcities that may be filled by funding (Srinivas & Sutz, 2008). The broader set of systemic scarcities makes collaborative action complex in medical diagnostics (Kale, 2019b). Within this context, our focus is on the emerging business models adopted and continuing institutional gaps faced by Indian startups in cancer care. Building on that, we further investigate what business models are relevant and effective for firms operating in the resource-constrained environments of LMICs.

## THE BUSINESS MODEL IN CONTEXT

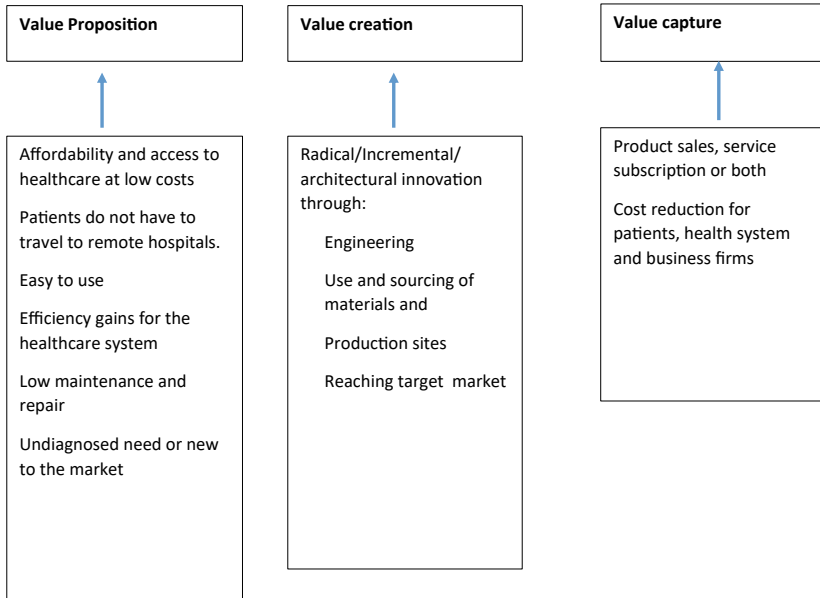
In many industries and sectors, there is growing awareness that for technological innovation to be successful, the business model must be an integral part of the process. Indeed, the business model concept is so vital that it can be argued that “a mediocre technology pursued within a great business model may be more valuable than a great technology exploited via a mediocre business model” (Chesbrough, 2010, p. 354). The business model is defined as a system that solves the problem of identifying who is (or are) the customer(s), engaging with their needs, delivering satisfaction and monetising the value (Baden-Fuller & Haefliger, 2013). A business model can be viewed as the logic of the company; how it operates to create and extract value for its stakeholders (Casadesus-Masanell & Ricart, 2010).

Hwang and Christensen (2008) point out value proposition, processes, resources and profit formula as four critical components of the business model. The value proposition, an affordable product or service that helps a customer perform a particular job effectively, represents a starting point for a business model. Firms bring together required resources such as people, equipment, finance, raw materials and so on to deliver the value proposition. Hwang and Christensen (2008) further suggest that firms create organisational processes and practices to create an efficient way of making these resources work together repeatedly. These routines are then ingrained in the business model. They further point out that a profit formula emerges based on the costing of resources and processes required to deliver the value proposition, profit margins, volumes and pricing.

Building on these four components, Winterhalter et al. (2017a) highlight value proposition, creation and capture as three interlinked tenets of the business model. The value proposition refers to critical attributes of a product or service that resolves specific or multiple needs of a customer in an affordable way. In contrast, value is created by identifying an innovative way to develop, manufacture, or deliver the product to the customer. The value created is then captured by product sales—apart from invaluable marketing effects (Table 9.1).

In the healthcare industry, the business model must consider the unique characteristics of the healthcare market, such as the absence of a retail market for products and intense regulatory demands on products and services. These characteristics result in multiple business models that

**Table 9.1** Key tenets of the business model for healthcare innovations in LMICs



Source Modified by the authors from (Winterhalter et al., 2017b, p. 7)

coexist with each other. These include a service model involving institutions that diagnose and solve the problem (hospitals), a product model involving firms transforming input resources into products of greater value and a hybrid model where a product and service model are delivered together through user networks (Hwang & Christensen, 2008).

In LMIC contexts, healthcare firms adopt business models with a primary focus on creating value in low-income environments dominated by the weak institutional environment and missing infrastructure (Hoskisson et al., 2013; Landau et al., 2016). These challenges and constraints force firms to adopt business models that create value for the business, people and social environment (London et al., 2010). As a result, in resource-constrained settings, business models serve their target customers and improve the entire healthcare system in the respective target market.

**Table 9.2** Startups under study

<i>Startup</i>	<i>Year established</i>	<i>Nature of equipment</i>	<i>Key cancer areas</i>	<i>Market</i>
Sascan	2015	OralScan using imaging technology	Oral cancer	Product and service
AiNDRA	2012	AiNDRA point of care based on AI	Cervical cancer	Product
Panacea	1999	Bhabhatron-II, an Advanced Digital radiotherapy Telecobalt machine	All types of cancer	Product

Within the Indian context, the rising significance of data, the launch of the digitalisation initiative by the Indian government and the increasing per capita income have accelerated the emergence of startups focused on creating affordable diagnostics. Moreover, the launch of a range of new R&D subsidies, early-stage grants by the Indian government and the availability of both Indian and foreign private investment underscore the need to evaluate business models in India.

## CASE STUDIES

This section presents three case studies of cancer diagnostics devices developed by Indian startups. All devices were developed by scientists or engineers using a diverse set of technologies targeting different types of low-resource context challenges (Table 9.1). The information was collected from secondary sources and semi-structured interviews with the founders of two firms (Table 9.2).

### SASCAN

Oralscan, developed by Sascan, is an innovative diagnostic device that uses imaging technology to diagnose oral cancer in resource-constrained urban and rural areas. Sascan adopted a business model comprising product and service aspects to capture the value.

Sascan was founded in 2015 by Dr Subhash Narayanan, a physicist with expertise in laser technology and Dr Ruhi Agarwala, who was a public health expert. The startup was incubated at the Technology

Business Incubator (TiMED) wing of Sree Chitra Tirunal Institute for Medical Sciences & Technology (SCTIMST), a leading medical diagnostic centre and device development institute in India. Startup financial support came from government investment schemes; the Biotechnology Industry Research Assistance Council (BIRAC) based at the Department of Science & Technology (DST), the National Initiative for Developing and Harnessing Innovations (NIDHI) and Kerala StartUp Mission. In later years, Sascan also received investment from Unicorn India ventures. One of the founders commented:

I was already doing work in that area [medical diagnostics] and had publications to show; it was easier for me to get a fellowship under the BIRAC grant, and once I got that, it was mandatory that we start an entity to get the funding, so we started a company with some of my colleagues from the same (author interview, 2019)

Sascan focused on the detection of oral cancer. The diagnostic technique used for oral screening was unreliable, and oral potentially malignant lesions (OPMLs) would often go undetected in the early stages (Kashyap, 2019). The existing clinical practice involves the detection of oral cancer via visual inspection of the oral cavity by a clinician using torchlight. If required, it is followed by biopsy-guided histopathological analysis. It was also observed that clinicians find it difficult to locate the optimal site for a biopsy based on conventional oral examination. Sascan identified this need in the market and focused on developing a hand-held imaging device to screen and detect OPMLs. This need shaped the key value proposition for the firm and the main driving force for the development of Oralscan. One of the founders highlights that the device's novelty comes from using the intraoral camera to capture oral malignant cells. Oralscan combines the use of a highly sensitive intraoral camera with a fluorescence technique to get a correct diagnosis of oral cancer. This was the novelty of the product, and it received a patent in India. The proprietary software helps to identify the most appropriate site for taking a biopsy, thereby assisting in the diagnosis of malignancy and reducing patient discomfort that might result from inaccurate biopsy-taking procedures.

Sascan has received the ISO 13485 and CE certification for the Oralscan, and the device has undergone multi-centric trials covering six hospitals across the country. However, one of the founders acknowledges



significant challenges, such as patient recruitment, doctors' attitudes and local culture in conducting clinical studies to validate the device. He pointed out:

Again, the problem was getting patients. Oral cancer, per se, is a poor man's disease. Even though some rich people get it; so those kinds of patients were hard to get. We did the study for nearly 3-4 months, and we couldn't get many numbers, so we had to stop the study there and had to go for some other studies, which could give us better numbers. People are reluctant to go for cancer screening. That is a bigger problem for us. (author interview, 2019)

These challenges in patient recruitment and doctors' attitudes towards the device have implications for the market acceptance of the product. One of the critical obstacles observed was the attitude of doctors to the use of the device. It became evident during the clinical trials that some doctors were not keen as they felt that they could spot malignant sites without the help of the device and conduct a biopsy based on their experience in the field. One of the founders commented:

Nobody realises that the mortality rates of oral cancer are more than 50% in the country. Why? People should admit to their deficiencies—doctors may never admit that they took a wrong biopsy. That is their fallacy. I don't know how to address this issue. When we start the sales, we may have resistance like this—we feel that over a period of time, we will be able to make it successful. (author interview, 2019)

Sascan is overcoming these market challenges and capturing value from innovation by employing a business model that combines social concern with profitability. One of the founders explained:

Both have to work simultaneously - social concern and profitability. With that in mind, we have different types of business plans and schemes. One is to sell the device directly to the hospitals for biopsy guidance. We feel that the direct sales model can work. But we also plan to have a pay-per-use model – where we would give the device at a much lower cost on a pay-per-use for each screen; they give us some money in return. That is long-term revenue. We have for NGOs that want to use the device for programmes and screening camps – we give it on a monthly rental basis. These different models take care of different categories. (author interview, 2019)

Sascaan frames the broad value proposition from a social concern and profitability perspective with utility accruing to the physicians/clinicians, hospitals and ultimately the patient. Given the cost barriers, Sascaan proposed a business model innovation: the pay-per-use model. This model overcomes the need to spend significant money (capital expenditure) upfront, especially for small-sized health facilities in urban and rural areas. With this model, these health facilities do not incur huge costs to acquire the equipment and only need to manage operating expenditures. For the entrepreneur, the value capture comes from the use of their equipment by many small and medium-sized facilities and a steady income from their equipment. Thus, the value proposition to the clinician or health facility is access to expensive machines with no huge upfront investment, plus patients accessing care. The entrepreneur captures value through a steady revenue stream from a pay-per-use arrangement.

## AiNDRA

The AiNDRA system, developed by AiNDRA, is an innovative diagnostic system that employs artificial intelligence (AI) technologies to facilitate early, affordable and accurate cervical cancer diagnosis in a clinical setting. It provides an alternative to the existing gold standard method of cervical cancer diagnosis and helps overcome the need for a trained pathologist.

AiNDRA was founded in 2012 by Adarsh Natarajan (CEO) and Abhishek Mishra to develop an innovative diagnostic device that facilitates the screening and detection of cervical cancer in women at an affordable cost. AiNDRA received funding from the Karnataka government and some private philanthropic foundations. One of the founder's commented:

We have been supported by the government of Karnataka as well—one of the early grantees of the ELEVATE 100 program. We were also incubated out of the Bangalore bio-innovation centre (BBC), which is directly supported by the government of Karnataka. (author interview, 2019)

Building on this initial financial support, AiNDRA received further funding from Villgro Innovations Foundation, Indo-US Science and Technology Forum and Millennium Alliance, which helped them develop computational pathology tools for the early detection of cervical cancer.

In India, the screening and detection of cervical cancer is a complicated and costly process. It has been suggested that it takes around 4–6 weeks in India and costs approximately INR 2000 (about USD 26.54) for the entire process from pap smear sample collection to report delivery, depending on the sample collection location (Balaji, 2019). The main hindrance is the limited availability of trained pathologists. It creates a significant challenge for early diagnosis of cervical cancer, resulting in approximately 74, 000 deaths annually, accounting for 1/3rd of the burden of cervical cancer deaths globally (Diamond, 2018). Early detection and treatment are vital for those diagnosed with cervical cancer. It is certainly possible to reduce the number of deaths from cervical cancer as the early detection of cancerous cells can result in a positive outcome with an effective and low-cost treatment. AiNDRA sensed an opportunity to develop an AI-based platform that can provide an accessible and quick point-of-care diagnosis for cervical cancer. CEO Adarsh Natarajan was reported as commenting:

Given the hype that technologies like AI and CRISPR have generated over the last couple of years, we see an increased awareness of the potential these technologies hold in the domain of oncology. This awareness has resulted in an easier adoption cycle for products that use this technology and solve the problem effectively. (Cheema, 2020)

AiNDRA collaborated with researchers at the Indian Institute of Technology Mandi (IIT M) to develop AI-based algorithms that enable the point-of-care device to undertake automatic screening for cervical cancer. The conventional system of diagnosing cervical cancer involves a ‘pap smear test’ in which cells are removed from the cervix are examined by a pathologist under the microscope. While this test has been the gold standard in screening for cervical cancer detection all over the world and has helped early detection, it also involves subjective analysis and interpretation. This test has therefore been associated with risks of the wrong diagnosis, and few studies have shown the accuracy of the Pap smear test to range between 60% and 85% (Balaji, 2019). It also involves patients travelling to the hospitals to take the tests, which is challenging for women living in rural areas or geographically distant regions that lack testing facilities. This creates barriers to testing and further delaying the results. In contrast, AiNDRA’s point-of-care system is portable and removes the subjectivity in pap smear tests for diagnosis.

In the system, biological samples are stained by an autostainer, converted into a digital image and then analysed by AI algorithms to differentiate between cancerous cells and healthy cells (Diamond, 2018).

AiNDRA's collaborator analysed the Pap smear images provided by the startup and characterised them as "normal" and "potentially cancerous". They developed a computer programme that could differentiate between the two. One of the collaborators was reported explaining:

We could demonstrate performance improvements over some of the contemporary methods, with relatively simpler and arguably more efficient methods. (Pharmabiz, 2019)

The developed algorithm is based on the deep learning paradigm of artificial intelligence and can be used to deal with a large amount and variability in data. The platform can sift through large numbers of samples and only escalate high-risk cases. In a country with a high patient-to-pathologist ratio, this has the potential to increase workflow efficiency, reduce costs and save lives (Diamond, 2018). One of the collaborators added:

Given the shortage of pathologists in India, these algorithms will help in automating the process of screening Pap -Smear images. Thus, there will be a significant reduction in time spent by the pathologist, thereby reducing cost and improving the screening accuracy. (Pharmabiz, 2019)

The value proposition from the quote and example above is the utility of the technology, its efficacy and, more importantly, its portability. This approach reduces the cost per sample, has higher accuracy (reducing subjectivity) and shorter time for the patient to get their results (1–2 hours) instead of 5–6 weeks. Thus, the value proposition is at three levels: the health facility benefits, the clinicians benefit in using a more accurate and portable technology, and the patient accesses their results within a very short time, which enhances the patient experience and reduces their costs on transportation if they live far away from the health centre.

Further, this screening can be done on-site at a clinic, eliminating the need for the tedious process of manual staining and the transport of large batches of samples to distant laboratories. As a result, a patient is told if they have cancerous lesions within 1–2 hours instead of 5–6 weeks (Balaji, 2019). The collaborator highlighted the practical advantages:

The difference between a conventional system and Aindra's point-of-care system is that the latter is portable and can be taken to potential patients. In the conventional system, the people have to visit the pathology laboratory to get themselves screened. (Pharmabiz, 2019)

AiNDRA applied for an international patent for the device and algorithm in 2016. The device prototypes have undergone clinical testing at some leading hospitals in Southern India and were found to be 88% accurate. AiNDRA has launched the product in the Indian market focusing on multi-component products and service offerings. But there have been significant challenges in realising the potential. One of the founders' commented:

After initial seeding, which helps startups develop a proof of concept but from the proof of concept to the product actually being used by beneficiaries or customers - there is a long journey that these startups are required to traverse through. What many of us felt is that there are not enough linkages in the ecosystem for entrepreneurs to get from point A to Z. There is no concerted way to fast-track the innovations that they themselves have spent money on and they have found in their own healthcare systems network. We have noticed that it is difficult after that point for us to actually see things happening in terms of us getting a pilot that can become a precursor to a larger role – nothing of the sort exists as mechanized. (author interview, 2019)

Stressing the need for a stronger government role in screening for cervical cancer, one of the founders explained,

So far, from what we have seen in our space in cervical cancer, it is largely not an effort that has been driven by the government healthcare system. It has mostly been NGOs who are trying to reach out to the larger section of society to get them to screen for breast cancer or cervical cancer, or any of the preventive conditions. It need not be necessarily driven by the government healthcare system, but it can be nudged through the private sectors as well. (author interview, 2019)

AiNDRA's value proposition is to create a diagnostic product that provides a significantly improved alternative in terms of accuracy, cost and time compared to the existing method of detection of cervical cancer in India. The firm has created value by employing AI and machine learning tools using local collaborators and research institutes to develop

the devices. However, the firm is struggling to capture the value due to entry barriers in the market and a lack of government support in driving screening and detection initiatives.

## PANACEA MEDICAL TECHNOLOGIES

Bhabhatron-II, an Advanced Digital radiotherapy Telecobalt machine developed and manufactured by Panacea Medical Technologies in India, improves automation, removes uncertainties and overcomes the need for trained manpower to operate it.

Panacea Medical technologies was founded in 1999 by a senior scientist and technocrat Mr G V Subrahmanyam, along with a group of technocrats with the aim of creating access to radiotherapy. Mr Subrahmanyam had a strong connection with IIT Madras, and that proved a critical breeding ground for developing ideas for developing technologically superior solutions to improve cancer care. The startup received financial support from a US-based venture capital fund called 'New Enterprise Association' from the early stage. Mr Subrahmanyam explained the motivation for entering the challenging area of radiotherapy,

One single item that has inspired me and another two colleagues who started this is about making more access to radiotherapy. This is about 20 years back when we started this venture. We understand that at that point of time, we were India focused because India was having a lot of inaccessibility to radiotherapy and cancer therapy in general. (ICCA India podcast series, 2021)

Radiotherapy treatment machines are expensive and need extensive maintenance. Further, it requires trained professionals who know how to handle these machines and also understand the impact of radiation on cancerous cells. India and other LIMCs suffer from a lack of resources and trained manpower to operate the equipment. Panacea prioritised engaging with these two issues by developing a machine that is affordable and reduces the need for trained manpower to operate the machines. Mr Subramanyam explained that:

India and LIMCs do not have the capex [capital expenditure resources] as well as the opex [operational expenditure resources] money to manufacture such a complicated machine. Most of these countries neither have trained

manpower. These three items that you have to look at when you want to make access to radiotherapy to every person across in their domestic environment. (ICCA India podcast series, 2021)

The company faced some key challenges in their efforts to emerge as the only Asian company making radiology and radiotherapy equipment. Sweden's Elekta and Varian Medical Systems of the US are the leading two companies that dominate the \$10 billion sectors of radiology and radiotherapy. The first product developed by the company was a radiation device based on brachytherapy, invasive radiation therapy for treating cancer. However, the company had to shelve the product four months after the launch as the radioactive isotopes, which were designed for those machines, were removed from medical use by regulators across the world. It was a big setback and resulted in two co-founders leaving the startup.

Despite these setbacks, the company started working with India's leading atomic research centre, the Bhabha Atomic Research Centre (BARC) and Society for Applied Microwave Electronic Engineering and Research (SAMEER) to design the tele-cobalt radiotherapy unit and linear accelerator. The collaboration focused on developing a machine that can be used in resource-constrained conditions without trained manpower. Mr Subramanyam explained that,

The cancer patient is in many situations in these countries which have been our focus area has not able to travel to the metro city, and therefore the treatment is not even started for such people, and that is what is the basis on which we have looked at innovations on how we can work this machine to deliver in conditions of where is no manpower. (ICCA India podcast series, 2021)

Panacea invested in identifying ways to improve automation, remove uncertainties and make every delivery the same irrespective of the skills sets of people that will operate these machines in urban and rural centres. In 2006, Bhabhatron-II, an Advanced Digital radiotherapy Telecobalt machine, was commercialised. The company took six years to design, develop, manufacture and get regulatory approval to develop the product. This device managed to strike a balance between precisely targeted radiation therapy and the peaceful use of atomic energy. Mr Subramanyam highlighted the value proposition associated with Panacea's business model:

There's nothing like we have brought in a solution which is out of the world but what we are confident is we have brought in a solution which is actually relevant to countries like India or LMICs from the initiation of any project idea or any product idea we take into consideration what the difference between what we will deliver versus what already exists in the market. (ICCA India podcast series, 2021)

By 2020, Panacea had installed this machine in more than 50 Indian hospitals, and the company is seeking to expand to the LMICs market. Mr Subramanyam explained the relevance of products for the LMIC market,

We have a globally relevant solution today, and that solution is also more focused on affordability. This has made it possible to deliver a solution to LMICs. This has been a focus for the company in the last 20 years, and we continue with that. (ICCA India podcast series, 2021)

The Panacea case represents a significant adaptation of innovation to the local context. Distinguishing the policy menus that support such innovation matters, especially because the industrial policies to support such deepening or diversification of capabilities are not straightforward (Srinivas, 2006).

## ANALYSIS AND DISCUSSION

This section discusses the factors that catalyse the growth of Indian startups and highlights the issues that create gridlocks for their further development. It also reveals key value-creating attributes associated with their business models and innovative products. Finally, it points out the key implications for other LMICs.

### CATALYSTS AND GRIDLOCKS IN INDIAN MEDTECH STARTUPS

Availability of finance, an ecosystem of incubation and technology institutions, and proximity of entrepreneurs and hospital systems for clinical trials has been critical for catalysing the growth of Indian MedTech startups. At the same time, there are challenges in translational pathways; taking the product to market and navigating dysfunctional public health procurement. This creates gridlocks for seamless development.



The evidence suggests the availability of adequate funding support from the government, venture capitalist and educational institutes. These funding sources have created and supported a vibrant innovation and entrepreneurship culture that led to the rise of dynamic startups in the medical diagnostic sector. Multiple government agencies such as BIRAC C-CCMP (Centre for Cellular and Molecular Platforms), Nidhi Prayas with DST run several funding schemes to support entrepreneurs. It is supplemented by external funders such as Indo-US collaboration funding and international venture capital firms, and internally by industry association schemes, state government schemes and private venture capitalists.

An ecosystem of incubation and technology institutions supported scientists and engineers to turn into entrepreneurs and convert their ideas into prototypes. The premier Indian technical institutes and public research laboratories stimulate the startup culture through funding schemes, inviting successful entrepreneurs on campus and facilitating linkages and collaborations with local industries. The development of prototypes is aided by the proximity of entrepreneurs and the Indian hospital systems. This facilitates user involvement in product development and clinical trials.

However, there is a need for more venture capital institutions, including the private sector, that cover funding for later stages of technology development and launch onto the market. Further, policy and institutional support needed to reduce market entry barriers and avoid the “valley of death” has been missing. The “valley of death” refers to the period where startups are yet to generate revenue and rely on investor funds. This lack of support towards the later end of the commercialisation chain is proving challenging for startups that need to reach a larger market and grow.

The lack of well-functioning health systems and dysfunctional procurement policies create a significant hurdle for startups in scaling up their businesses. One of the entrepreneurs elaborated,

I was clear that selling to the government is not the first thing that has to happen, but it has to happen at some time if companies have to scale or be able to demonstrate the complete impact of what they are doing. (author interview, 2019)

This highlights the need for support and modification of existing procurement rules that can accelerate access to the market. The absence

of an appropriate procurement policy and lack of well-functioning health systems creates significant hurdles for the long-term sustainability of startups. Scarcity-induced innovation recognises that among different types of innovative solutions, only some are best suited to their specific socioeconomic and institutional environment. The government may be indispensable for startups but not always the primary buyer. Lack of procurement agility has resulted in firms that received supportive public funding failing to effectively sell their products into the public health system.

The local healthcare systems need to be primed to buy local medical devices, and purposive policies should be implemented to support local entrepreneurs innovating to meet local market constraints. Innovative procurement by the healthcare sector can serve as an active industry policy to shape the local production of MedTech.

## BUSINESS MODELS: EVALUATING VALUE PROPOSITION, CREATION AND CAPTURE

The evidence highlights value creation based on key facets such as affordability, automation and high processing capabilities, early detection and quick turnaround for results, pay-per-use model—reducing CAPEX for resource-constrained hospitals and lower maintenance needs for cancer treatment machines. We adopt Winterhalter et al. (2017a) value framework (Table 9.1) to categorise these different facets associated with the business model adopted by the firms under study (Tables 9.2 and 9.3).

Each of these firms has a combination of different value propositions associated with its business model. Affordability was the critical value proposition associated with the business model adopted by each firm, but they also combined it with other value propositions. For example, in the case of diagnostic firms, early and accurate detection emerged as a significant value proposition. For example, one of the founders of Sascan explained their value proposition associated with Oralscan as follows:

Early detection is a key component of reducing the cancer burden in the country. If a device can do that, it is a boon for the doctors and much more for the patient. For the hospital, this may generate less revenue, but for the patient, it is a big support. (author interview, 2019)

**Table 9.3** Value proposition, creation and capture

<i>MedTech startups</i>	<i>Value proposition</i>	<i>Engineering</i>	<i>Value creation Use of sourcing and resourcing</i>	<i>Production sites</i>	<i>Reaching target market</i>	<i>Value capture Income</i>
Sascan	New to market Easy to use Efficiency gains	Reconfiguration of established technologies	Low-cost raw materials in India and China	India	Institutional and individual customers in urban and rural areas in India	Product sales Pay per use
AiNDRA	New to market efficiency gains	Using existing AI technology to develop software-based product for new purpose	Local production in India	India	Institutional and individual customers in urban and rural areas in India	Pay per use software as service
Panacea	Affordability efficiency gains	Cost saving through using existing technology	Low-cost raw materials In India	India	Institutional customers in urban and rural areas in India and African countries	Product sales

The Oral scan can also guide a clinician to the correct site to take a biopsy. In some cases, the visual impressions are not correct, and it creates a need for the right biopsy to be taken. This biopsy guidance has emerged as the key value proposition for using the oral scan device in urban clinical areas. Panacea combined affordability with efficiency gains through lower maintenance, increasing automation and high procession capabilities.

To achieve these ambitious value propositions, the firms have been creative in their value creation activities. For example, these firms manufactured locally and started creating local suppliers for high-tech components. Mr Subramanyam from Panacea explained:

We have been focused on all development and manufacturing that happens in Bangalore, but as has been our vision, we have to make things which will work in a very difficult condition. (ICCA India podcast series, 2021)

The value created by the firms was captured mostly by reducing expenses by minimising manufacturing and R&D costs and adopting a creative sales model. Mr Subramanyam suggests,

One more part which works is there's a bit of planning on how the treatment has to be delivered. If this can be done outside these remote locations, it can be centralised outside the tier 2 city, then it actually delivers the same kind of delivery as received by patients in a metro. If that can be achieved, then it actually means a lot. (ICCA India Podcast, 2021)

These firms are trying to adopt a mix of different sales models that can aid the value capture. For example, one model includes a consortium of providers running a government-approved programme where consortium members own different healthcare initiatives. These different partners then charge for their services on an OPEX model.

However, these firms are facing significant constraints in realising the value captured through sales due to a lack of government procurement. For example, a few of these startups can list their products for public health procurement due to archaic rules about the minimum size of the firms. Despite recent reforms (L1 reforms) in procurement policies, it remains a risky process for small and medium firms, thereby creating an issue of long-term viability.

## IMPLICATIONS FOR STARTUPS IN LMICS

The Indian model highlights the influential role of the state, universities and research institutes in funding and support for entrepreneurs in transforming ideas into significant products. The situation with medical device startup companies in Sub-Saharan Africa, though, is characterised by a policy vacuum, a dearth of early-stage funding, incubation hubs and technological upgrading support, difficulty putting new products on the market and having to rely on European governance institutions, which increases regulatory costs.

We interviewed a startup medical devices company based in South Africa, a country with relatively better innovation ecosystem support capabilities. However, the entrepreneur, a surgeon, chronicled the challenges they had trying to access funds from financial institutions. They eventually resorted to raising funds from other surgeons and private funders. Even after raising funds, they struggled to get local sources of medical-grade plastic to use for their device. They eventually collaborated with a local company and incurred the learning costs for the plastics firm acquiring knowledge of the new technologies and importing new equipment. However, their value proposition to the plastics firm was that they were helping them broaden their product offering hence new revenue streams. The plastics company agreed and promised to produce the technology for the medical device at a preferential cost because the medical devices had funded the upgrading to the new technology. Accessing the clinical setting was not difficult for the innovator, given their professional networks and understanding of how to bring surgical-related devices into the hospital. One of their most significant challenges came from having to rely on notified bodies in Europe. The local regulator could inspect their premises and they needed the local standards body to certify their product. However, the local standards body is not a notified body. Thus, the firm had to send their devices to Europe for certification at high cost and considerable delays in terms of getting the product on the market.

Thus, the case studies from India highlight many learning points from the perspective of building an enabling set of agents, institutions and infrastructures required to support technological change and entrepreneurial activity in the medical devices sector and its proportionate and adaptive governance that allows clinicians and health care organisations to deliver better diagnostics and medical devices for the benefit of the patient. In the case of African countries, there has been clear evidence that some startups operating in the fintech sector receive overseas investment and get a valuation of over US\$1bn without any financial support from the state (Pilling, 2021).

It has been suggested that the region is ripe for innovation in health and booming with entrepreneurial raw energy but it is let down by the overcautiousness of local financial institutions and the shortage of African venture capital (Pilling, 2021). African policymakers and financial institutions must focus on understanding and supporting new technologies and innovation, even if that means taking risks and confronting vested interests. For instance, working outside the big cities may create

logistical hurdles, but the customisation of service delivery may be an essential starting point for innovation. African policymakers and venture capital firms should ensure that entrepreneurs are supported throughout different stages of the product life cycle and not just in the early stages of development. It also shows that African entrepreneurs should focus on ideas rooted in domestic healthcare systems and that can work with local resource constraints.

## CONCLUSIONS

This chapter demonstrates that Indian startups operating in the MedTech sector have significantly benefitted from financial support offered by government schemes, financial institutions, universities and private venture capitalists. However, these firms are facing significant challenges in capturing value from their innovations due to a diverse set of issues that range from lack of last mile investment, medical culture and entry barriers for accessing the public healthcare market.

The business model framework helps to explain the value proposition, value creation and value capture strategies adopted by Indian startups. India is a unique, fertile ground for firms engaging in different types of innovations. By and large, the firms focusing on developing innovations closer to Indian problems are vibrant and technically proficient, and most are deeply committed to the cause of better diagnostics and outcomes in cancer.

Some of these innovations are adaptations of solutions that already exist in high-income countries but are not available in LMICs. At the same time, other types include innovations for problems mainly posed in LMICs and developed locally. However, only some of these business models are situated in the ‘sweet spot’ of long-term viability, and few currently have direct access to public health procurement which is an uncertain, risky process for small and medium firms. Unless these startups and innovations grow, LMICs will continuously adapt to the problems framed and solved elsewhere, predominantly in high-income economies.

Similarly, Indian business models—suited to their context—may eventually act in ways that are not always suited to highly diverse African contexts. As of now, Indian firms may have more answers for Kenya and Tanzania than firms from the US, UK, or Europe. As Chapter 6 has also discussed, specific industrial choices must be made to decide what is best suited for the ‘Cupboard Full’ situation. This is especially critical

because emerging business models respond to procurement initiatives or become divorced from public health policy priorities and the need for patient-centric and service-responsive business models (including location, timeliness, specificity and the vagaries of existing electricity, water, roads or other infrastructure availability).

There are clear implications for African policymakers and financial institutions. There is no shortage of entrepreneurial energy and innovative ideas in African countries. Still, the lack of strategic sector funding for innovation and entrepreneurship, linkage with procurement policies and provision of the last-mile support, are issues that need to be resolved if a vibrant medtech sector is to emerge.

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