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Do Frugal Innovations Lead to Frugal Outcomes? A Case Study of Healthcare in India

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Do Frugal Innovations Lead to Frugal Outcomes?

A Case Study of Healthcare in India

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In the early 1970s, Professor P.K. Sethi, an orthopedics professor in Jaipur, India, realized that the prevalent prosthesis design for lower-limb amputees was poorly suited to India's sitting culture. He developed a waterproof, lightweight rubber-based prosthetic leg for less than 1% of the manufacturing cost in the US.

The nonprofit Bhagwan Mahaveer Viklang Sahayata Samiti (BMVSS) began distributing the Jaipur Foot internationally, selling not only to amputees, but also fitting war victims and polio patients. To date, the Jaipur Foot has reached over 1.3 million people and BMVSS has held artificial limb fitment camps in 26 countries across Africa, Latin America, and Asia.

In 1988, Mansukhbhai Prajapati, a rural innovator from Rajkot, Gujarat who failed his Class X exam, quit his job at Jagdamba Potteries. He borrowed Rs 30,000, began producing earthen pans with a modified hand press, and soon started his own earthen plate manufacturing factory.

After an earthquake in 2001, Prajapati was inspired to create Mitticool, a Rs 2500-3000 clay-based fridge run without electricity that can keep fruit and vegetables cool for up to five days. Customers and home appliance companies from over 40 countries have ordered from Prajapati's product catalogue, which has expanded to include a clay tawa and low-cost water filter.

In 2001, Vortex Engineering, a Chennai-based startup, sought to make banking services accessible in remote and rural locations across India by designing affordable ATMs powered by solar energy. These ATMs are over 50% cheaper than traditional ATMs, consume 95% less electricity, and offer a fingerprint scanning system for illiterate users.

Vortex has influenced competitors, forcing market leader NCR to launch a solar-powered ATM model, and forged export partnerships in Africa, neighboring Asian countries, and the Middle East¹.

Introduction to Frugal Innovation: *Doing More with Less*

Jaipur Foot, Mitticool, and Vortex Engineering are all popular examples of *jugaad* innovation, which in Hindi means “to make do.” *Jugaad* is a cultural mindset of “quick fixes” – solving problems with limited resources. In India, it is common to see makeshift motor vehicles, empty jars repurposed as containers, and washing machines used to churn milk.

The most commonly cited literature on the topic, *Jugaad Innovation: Think Frugal, Be Flexible, Generate Breakthrough Growth*, by Navi Radjou, Jaideep Prabhu, and Simone Ahuja, lists six principles of *jugaad*: seek opportunity in adversity, do more with less, think and act flexibly, keep it simple, include the margin, and follow your heart². Under these premises, US corporations adopt *jugaad* innovation strategies not by merely increasing their R & D budget, but rather by shifting from a structured, top-down approach to innovation to an open, adaptable culture that leverages stakeholder and employee creativity.

In C.K. Prahalad’s book *Fortune at the Bottom of the Pyramid: Eradicating Poverty through Profits*, he lists several principles of innovation for bottom of the pyramid (BOP) consumers (defined in 2004 as people living on less than \$1500 USD per day). BOP innovations reduce resource wastage; create a new price-performance envelope; co-exist with infrastructural challenges; are scalable, rugged, and transportable; deskill work; and reach customers efficiently³. The 10 Core Competencies of Frugal Innovation developed by the Frugal Innovation Lab at Santa Clara University are similar: ruggedization, lightweight, mobile enabled solution, human centered design (e.g. intuitive, easy to use, etc.), simple in features and functional requirements, new distribution models through non-conventional channels, adaptation to local conditions and constraints, high use of local resources, ecologically friendly, and affordability⁴.

In 2010, Vijay Govindarajan introduced “reverse engineering,” a related concept to *jugaad*, which involves designing first in emerging markets and then selling the products at a higher price in developed countries⁵. In “How Disruptive Will Innovations from Emerging Markets Be?,” Constantinos Markides proposes that for a reverse innovation to be disruptive, it must be superior in price and perform at an equivalent or higher level than competitors in order to attract mainstream markets⁶.

For the purpose of this paper, I define “frugal innovation” as a product or service from any source that cuts the price point significantly (over 50%), while offering a competitive performance level, as determined by international benchmarks in that industrial sector.

Lead Market Theory:

Our Frugal Future: Lessons from India’s Innovation Ecosystem, a report published by Nesta UK, proposes that India is an ideal environment for frugal innovation because of its growing middle class (estimated to reach 600 million by 2030⁷), price-sensitive and improvisational culture, extreme conditions and service disparities, strengths in business and service model innovations, new sources of social finance, and increasingly inclusive and ambitious science and technology policy, which aims to place India within the top five scientific powers by 2020⁸.

When evaluating India’s potential for frugal innovation, scholars invoke the lead market theory, comparing it to the Japanese and American advantage in consumer electronics and China’s reputation for cheap manufacturing⁹. Marion Beise explained, “A lead market is a national market, which primarily on account of the size of its domestic demand, its access to technological capabilities, and its embeddedness in the global economy provides key innovation impetus to a particular category of products⁹.” Christopher Bartlett and Sumantra Ghoshal elaborated, “Results of competitive battles in such markets usually have a great deal of influence on the future world-wide competitive positions of firms... Local innovations in such markets become useful elsewhere as the environmental characteristics that stimulated such innovations diffuse to other locations.⁹”

In the case of frugal innovation, conditions of high poverty and resource scarcity already persist in much of the developing world. Western middle-class consumers also represent a potential market for frugal innovation because of their countries’ large budget deficits following the 2008 financial recession, dwindling national resources, increased government pressure to lower costs, competition from low-cost international companies, and rivalry from disruptive startups².

Research Questions:

In this thesis, I investigate India's emergence as a lead market for frugal innovation by examining:

- Which external and internal factors have allowed select frugal innovations to scale and compete nationally? For the innovations that have not scaled, have they faced macro-level or micro-level obstacles?
- What is the potential for replication of these innovations in other environments worldwide? Has this been tried before and what were the results?

These questions are important because of the surprising lack of critical analysis to the rise of *jugaad* innovation. Many innovations referenced by the National Innovation Foundation, an autonomous government body with the objective of “scouting, spawning, sustaining, and scaling up the grassroots innovations,” have not been diffused or commercialized, which raises the concern that the frugal innovation success stories in news headlines may be more indicative of the availability heuristic than of a core competency for Indian companies.

Furthermore, frugal innovations can seldom compete with top-quality competitors. Although Mitticool's de-featured, natural refrigerators are commendable in design, they cannot compare to traditional refrigerators in their durability or capacity for temperature regulation. Demand will thus decrease in accordance with increases in customers' disposable income.

To design new support programs for innovation in India, it is important for stakeholders to understand the market for frugal innovation globally and the challenges facing tech, social, and grassroots entrepreneurs. Innovative ideas that are rejected by consumers and cannot yield financial returns similar to those of top national and international companies will not give India a sustainable competitive advantage for idea generation and manufacturing. Additionally, if all companies adopt frugal innovation and raise the price-quality ratio of their product and service offerings, it may increase industry entry barriers within India, while not necessarily providing India with higher brand equity internationally. Examining the roots of successes and failures in the field will highlight new factors in need of further investigation.

Case Study Selection:

I chose to focus on the healthcare sector because of the prevalence of notable frugal innovations with similar business models and the huge need in India for affordable healthcare. In spite of the government's expressed goal in the 2012 Twelfth Five-Year Plan to achieve

“universal health coverage,” healthcare in India currently suffers from poor infrastructure (only 1-2% of GDP is spent on healthcare annually, compared to 3% in China and 8% in the US), insufficient trained personnel in the formal sector, and low health insurance coverage, with only 15% of Indians owning insurance and 60% of health expenditures coming from out of pocket¹⁰.

For this paper, I used a case study framework to conduct a comparative analysis of two successful process innovations originating from within the Indian ecosystem (Narayana Health and Aravind Eyecare) and two successful product innovations stemming from highly resourced organizations abroad (GE and Embrace Global). While it was difficult to find public information on unsuccessful frugal innovations, I profiled the NIF to gain an understanding of why the majority of grassroots innovations in healthcare and other fields have not yielded profitable returns. Here is an overview of the organizations under evaluation:

Organization	Founder/Date	Type	Type of Innovation
Narayana Health	Dr. Devi Shetty, 2000	For-profit cardiac care and multispecialty hospital chain	Process
Aravind Eyecare	Dr. Govindappa Venkataswamy, 1976	Non-profit eyecare facility run as a charitable trust	Process
Embrace Global	Stanford students: Jane Chen, Linus Liang, Rahul Panicker, Naganand Murty, Razmig Hovaghimian, 2008	Hybrid non-profit/for-profit organization producing baby warmers	Product
GE Healthcare	American and British businessmen: Thomas Edison, Charles Coffin, Elihu Thomas, Edwin Houston, 1892	For-profit diversified multinational technology company that launched a “Healthymagination” initiative to bring affordable medical devices to emerging markets	Product
National Innovation Foundation	Prof. Anil Gupta, 2000	Autonomous government body under India’s Department of Science and	Product/process

		Technology that identifies, features, and accelerates grassroots innovations, such as herbal remedies	
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Methodology:

This study blends literature reviews of over 20 books and 20 scholarly articles, advanced coursework, and fieldwork. I spoke with representatives at each organization and visited the Embrace, Aravind/Aurolab, NH, and NIF offices and service centers, touring the facilities and conducting open-ended interviews with senior executives. I also enrolled in OPIM 892: Technology and Entrepreneurship in India, a Global Modular Course taught by Prof. Kartik Hosanagar at IIM-Bangalore, which explored the Indian tech entrepreneurship landscape through guest speakers from Biocon, Zoomcar, Uber, Forus Health, Myntra/Flipkart, and venture capital firms.

For each company, I analyzed business and financial metrics, including growth as a function of time, profitability, and number of consumers served, as well as any publicly available social impact metrics, in order to explore different definitions of scale and commercial success.

Furthermore, I created a database of around 50 frugal innovations referenced multiple times in relevant literature on India and classified innovations based on the educational and professional background of the founder(s), support received (funding, mentoring, participation in incubator or accelerator programs, etc.), and type (process, product, and/or business model innovation) to identify trends and correlations.

The paper will begin with an overview and analysis of NH, Aravind, GE, Embrace, and the NIF and extend into a broader discussion of the implications of frugal innovation for India’s entrepreneurial ecosystem and competitive positioning in the global landscape. Limitations of the study include the small number of companies explored in detail, the metrics chosen for evaluation, and the inaccessibility of hard sales data in the case of lesser-known and competitively protected innovations.

Narayana Health: Fixing Broken Hearts

Process Innovation

Globally, only 8% of the population has access to affordable heart surgery. “We need to perform two million heart operations in India and all the heart hospitals put together perform less than 120,000,” explained Dr. Devi Shetty, founder of Narayana Health. “Tertiary care only reaches 10-15% of the population.” According to Dr. Shetty, India needs two million hospital beds, one million doctors, and at least two million nurses to meet demand. Building the required 500 medical schools is expensive at a cost of ~\$40 million per building, and the government is unable to make significant capital investments.

Born and raised in Bangalore, Devi Shetty decided to become a heart surgeon in fifth grade and completed a graduate degree in medicine and post-graduate work in General Surgery at the Kasturba Medical College in Mangalore. He received cardiac surgery training at Guy Hospital in the UK and began work at the B.M. Birla Hospital in Calcutta. Shetty reflected on his experience at Guy Hospital: “My boss was the director of the London hospital. My job was to give him materials and data for presentations. The experience taught me about the business of running a hospital” (Personal interview. January 2, 2015). Shetty received start-up capital to build a cardiac hospital from his father, owner of Shankaranarayana Constructions (SNC).

Founded in 2000 by Shetty with the vision of providing “high quality healthcare, with care and compassion, at an affordable cost, on a large scale,” Narayana Health is a hospital chain in India with 7500 beds spread across 29 hospitals in 17 cities that focuses on affordable quality tertiary care, including cardiac care, neurosciences, oncology/cancer care, and organ transplant. “We didn’t intend to become a frugal innovation. We just didn’t have the money, so we looked at breakthrough innovations, like the mobile phone and the automobile, and how they gained traction,” explained Shetty. “There was no model in tertiary healthcare for us to follow” (Personal interview. January 2, 2015).

Funding and Financial Metrics:

NH runs a **cross-subsidization model** providing free or discounted surgeries to around 13% of all patients through revenue from paying clients. While the going rate for heart surgeries

was \$2,000 USD in 2014, foreign visitors may pay up to five times that price for a heart operation, specialist access, and deluxe private room¹¹.

“Yeshaswini,” a micro-insurance plan developed in partnership with the Governments of Tamil Nadu and Karnataka, helps three million rural farmers afford medical treatments for a monthly rate of ~\$6 USD. In addition to the non-profit micro-insurance, NH offers another scheme “Arogya Raksha” in the private sector, which provides access to 1,650 kinds of surgery for \$3 USD per month. Only 1% of patients need operations; therefore, micro-insurance allows the costs to be shared among a higher number of people.

Staffing:

The reputation of NH has spread through word of mouth, so the hospital does little to no formal recruitment. Its hospitals have 150 formal training programs for heart surgery, cardiology, and nephrology reaching ~1,950 PG, nursing, and paramedical students at a time. NH runs a cardiology diploma program in conjunction with Indira Gandhi National Open University. Graduates spend two-year terms in heart hospitals throughout India and return to NH to begin their practice. The desire to fulfill a higher calling of equalizing healthcare access motivates employees to accept 20% lower salaries than counterparts in private hospitals¹². Employees cited NH’s growth and reputation, ethical values, and talented and supportive staff as reasons for enjoying the work environment¹³.

To increase productivity and lower wage costs, NH **pays surgeons a fixed rate** and encourages them to maximize the number of surgeries performed instead of compensating them per surgery. To reduce turnover of the nursing staff, NH reports paying “higher wages to a core group of nurses in order to retain them...and [filling] other posts through a continuous flow of incoming cohorts from its own nurse-training institution¹⁴.” NH trains staff in continuous quality improvement, ensuring that workers not only acquire the necessary skills for their role, but feel empowered to identify and enact process improvements.

Supply Procurement:

The company developed a **Central Buying Unit (CBU)** to minimize inventory costs, which standardizes 95% of inventory and leaves only 5% of purchasing decisions at the discretion of the local hospital, and an **asset-light strategy**, which involves opening a specialty department within an existing hospital or partnering with other hospitals to share fixed costs (e.g. in Mumbai, NH joined forces with the Center for Child Development to build a super-specialty

children's hospital). Furthermore, NH has established partnerships with many for-profit companies, such as Biocon, reducing drug and equipment costs by up to 35%¹⁵ by negotiating prices regularly. As an example, NH collaborated on the development of digital X-ray plates, bringing the cost down from over \$80,000 to \$300 USD. Furthermore, when the cost of an ECG proved prohibitive at \$750, NH unbundled the software and hardware, replacing the existing software provider with an in-house software company responsible for writing the code. The total cost for collecting the data and transferring it to a computer was only \$300¹⁶.

NH also cuts costs by **leasing equipment and reducing building costs**. The cost per bed in the Mysore hospital is Rs 18 lakh compared to Rs 50 lakh to Rs 1 crore for similar facilities because the hospital restricts air-conditioning to intensive care units and operating theatres, uses window ventilation, and took over a pre-constructed building instead of building from scratch.

Internal Logistics and Technology Integration:

NH uses data analytics through a **cloud enterprise resource planning platform (ERP)**, sends **daily Profit and Loss updates through SMS messaging**, and operates a highly effective patient and staff **feedback loop**, which has satisfactorily addressed 99% of initiated complaints.

Through a **high volume of surgeries**, NH's surgeons, who are often the top in the country recruited by word of mouth, gain experience and efficiency, performing 1-5 operations and 70-100 consultations per day, thereby reducing the per-unit cost of surgery. Family training programs help people monitor the post-surgical recovery of loved ones,¹⁷ and at the Mysore Hospital visitors undertake a four-hour nursing training course to assist with basic caregiver tasks, such as bandaging wounds¹⁸.

Through an advanced **telemedicine facility** built with the co-operation of the Indian Space Research Organization, NH has been able to provide 55,000 consultations, free of charge, to people from around the world. Currently, patients from around the world send in ECG reports, CT scans, MRIs, and X-rays for diagnosis from NH's regular doctors via satellite, broadband, telephone, and Skype. These consultations only take one minute and can be performed in between a surgeon's other daily duties.

Rebranding:

In 2013, NH changed its name from Narayana Hrudayalaya Pvt. Ltd to offer other forms of healthcare beyond cardiac services. NH begun using their "healthcare city model" as a prototype for international expansion. JPMorgan and Pinebridge invested \$100 million and want

to see an after-tax profit margin of 8%. Hospitals in Bangalore and Kolkata contribute 35% and 20% of revenue respectively, so operating hospital communities abroad is expected to improve investor returns.

In early 2014, NH opened a 140-bed hospital center in the Cayman Islands in collaboration with Ascension Health at a cost of \$420,000 USD per bed, one-third of the US average of \$1.5 to 2 million¹⁹. Cayman Islands Health City uses iKare, a form of analytics technology, that screens for medical problems while monitoring lab results and strives to reduce response time to under seven minutes. Cayman Islands Health City is one of the few hospitals to operate a single profit center and to charge a flat rate covering all services and procedures. Dr. Shetty chose the Caribbean to provide more independence for islanders who rely on the US for their healthcare needs and plans to add 2,000 beds, a medical university, a research institute, and an assisted living facility. In the future, NH intends to expand to Malaysia and Africa.

Market Impact:

Shetty explained that NH has not seen many organizations try to replicate their model, although he would provide blueprints and cost structures upon request²⁰. He said, “We want more people to copy it. It’s a matter of time. Technology is the last frontier, which will level the playing field across developed and developing countries” (Personal interview. January 2, 2015).

Performance:

Ranked the Best Private Cardiac Hospital in India in 2013, the tertiary hospital performs over 4,000 surgeries per year, more than the top two hospitals in the United States, Cleveland Clinic and the Mayo Clinic. From 2000 to 2014, NH performed 107,000 cardiac surgeries and 275,000 cath lab procedures. Growing from 225 to 7500 beds, NH’s market share in heart surgeries stands at over 10%. NH’s volume of patients served per day is double that of its main competitors: Escorts, Apollo, Wockhardt, and Fortis²¹.

Exhibit A: NH Expansion Timeline



Source: “What Makes Narayana Health a Global Case Study”

As of 2013, NH’s costs for a bypass surgery were \$1,500, compared to \$144,000 in the US, \$27,000 in Mexico, and \$14,800 in Colombia. Cardiac surgeries cost \$2,000, compared to \$5,000 to \$7,000 in the rest of the country²². Through automation, detailed protocols, and feedback mechanisms, NH has achieved extremely low mortality (1.27%) and infection rates (1%) by international standards, with nearly zero incidents of post-surgery bedsores²³.

From 2007/2008 to 2012/2013, NH’s annual revenues increased by over 200% to Rs 827.35 crore (\$177 million). NH has experienced average annual revenue growth of 30 to 35% and hopes to continue at an average rate of 32%, as its current hospital units become more financially secure²⁴. NH’s after-tax profit margin of 7.7% compares positively to the 6.9% average margin of private American institutions²⁵. Its capital expenditure per bed in 2014 was low at \$44,000 versus the industry average of \$79,000²⁶.

Social Services and Outreach:

Each NH facility runs 25 outreach programs per month and reaches remote populations through mobile diagnostic vans, camps, and awareness campaigns. Girls from Jharkhand and West Bengal receive training to become Critical Care Assistants, as well as free room and board, which provides NH with a steady supply of cheap labor, while boosting local employment prospects. In addition, through Udayer Pathe, NH offers scholarships and mentoring to enable underprivileged children to pursue medical education.

Challenges:

“The greatest challenge was building the first hospital because we didn’t have a track record,” explained Shetty. Looking forward, Shetty said, “Balancing financial and social returns is always a challenge, and the goal is to keep your head above the water. The government has

offered support, but for us to scale, we need a lot of policy changes, such as the liberalization of medical education” (Personal Interview. January 2, 2015).

In an interview with IBN Live, Shetty discussed the labor shortage in the healthcare industry: “In another two years, there won't be any nurses because regulations don't allow career progressions to them. Admissions have already fallen by 50 percent. India is the only country where a nurse with 20 years of experience in critical care cannot legally prescribe even Paracetamol. Instead we have 200,000 to 300,000 doctors attending coaching classes for two to five years to attempt for a few thousand post-graduate seats. The US has 19,000 under-graduate seats and 35,000 post-graduate ones, while we have 45,000 and 12,000 instead²⁷.”

Opportunities:

When envisaging the future of the Indian healthcare system, Shetty explained, “Healthcare has to be a social enterprise. Without the government, you cannot make a big change. The government will not want to be involved in thoroughly profit-oriented companies, so as an organization, we need to stay connected to human aspirations and emotions. I believe that India will be the first country to dissociate healthcare from affluence. The government will most likely continue to provide primary and secondary healthcare and partner with private ventures for tertiary services” (Personal Interview. January 2, 2015). From his experience starting NH, Shetty realizes that when presented with an urgency to save lives, people will cooperate to optimize impact. By 2023, Shetty hopes to add 30,000 beds and reduce the cost of heart surgery to \$800 USD²⁸.

Aravind Eyecare: The Gift of Sight

Process Innovation

39 million people worldwide and 12 million in India suffer from blindness, a condition that restricts their autonomy and ability to work. 80% of blindness is treatable. According to Aravind, “a 10-minute cataract surgery will restore sight to 7.5 million and a pair of spectacles will help another 2.4 million see²⁹.” Unfortunately, less than 10% of this population has been healed. As of the 1993 revision of the Harvard Business School case study, the United States had twice India’s number of ophthalmologists (16,000) for a quarter of India’s population size and India’s infrastructure was disproportionately skewed to urban areas containing less than one-third of the country’s population.

Aravind Eyecare was founded in 1976 by Dr. Govindappa Venkataswamy to eradicate needless blindness first in his home state Tamil Nadu and then in the rest of India. Born in 1918 to farmers, Dr. V received a bachelor’s degree in medicine from Madras University in 1944. He retired from his medical career in 1976 as the head of the Department of Ophthalmology at the Government Madurai Medical College and head of Eye Surgery at the Government Erskine Hospital, Madurai.

Aravind is divided into several different operating divisions: Eye Care Facilities (Aravind Eye Hospitals), Education and Training (Aravind PG Institute of Ophthalmology), Eye Bank (Rotary Aravind International Eye Bank), Research (Aravind Medical Research Facility), Women and Children (Aravind Center for Women, Children, and Community Health), the Lions Aravind Institute of Community Ophthalmology (LAICO), and Aurolab. Dr. V maintained the principles that he would not turn anyone away because of inability to pay or compromise on quality and that his facility would be financially self-reliant. While cataract surgeries constitute over 50% of Aravind’s operations, Aravind’s eye hospitals also perform cornea and refractive surgeries, trab, squint correction, laser procedures, keratoplasty, and lacrima surgeries.

Aravind’s efficiency enables it to perform 2,000 eye surgeries per day, much higher than the national average of 300. In 2013-2014, Aravind performed a total of 378,035 surgeries, 241,440 of which were for cataract patients²⁸. Its efficiency results from a **steady patient and**

surgical flow, sufficient staffing, micro-planning through a state-of-the art IT system, and optimal use of available materials and equipment.

Staffing:

Aravind hires young women from local villages within a 100-mile radius between the ages of 18 and 23 to work in paramedic and administrative positions. Aravind provides these women, most of whom have not been educated past high school, with a comprehensive two-year training program in addition to room, board, and salary. Through continuous education and placements that match the girls' personal and professional strengths, Aravind has achieved less than 10% turnover in its ophthalmic assistants, with many people staying with Aravind for three to five years to develop confidence and leadership before returning to their villages to raise a family.

Dhivya Ramasamy, Faculty Associate at LAICO, said, "Initially, getting manpower and skilled labor was difficult, so we started a residency program" (Personal Interview. January 6, 2015). LAICO and the Aravind Postgraduate Institute of Ophthalmology offer short-term courses in intra ocular lens microsurgery, lasers in diabetic retinopathy management, and glaucoma diagnosis and therapy; eight long-term ophthalmology fellowships; training in the maintenance of surgical instruments; and post-graduate courses, leading to a Master of Surgery and Diploma in Ophthalmology from the Tamil Nadu Dr. MGR Medical University, Chennai.

Owing to Dr. V's charisma and connections, Aravind's reputation has spread globally, with many of the world's top doctors visiting to conduct research. Like NH, Aravind has been able to recruit without advertisements, relying exclusively on word of mouth and employee referrals. According to a case study of hospital staff at Aravind conducted by T.K. Ramahi, Aravind's **spiritual/social mission of serving the needy**, the **loyalty developed over a lifetime of training and working at Aravind**, the **meritocratic, learning culture**, and the **transparency about performance** contribute to Aravind's success with attracting and retaining employees³⁰. Pay was not a motivating factor for employees, as only 22% of the 51 interviewees surveyed agreed that they were well paid relative to colleagues in other hospitals.

Only 10% of employees cited that Aravind outperformed because of innovation, attributing the hospitals' success to **efficient work processes** (34%), **training** (31%), and a **clear command structure** (25%). Ramahi found that meditation on the altruistic teachings of Indian philosopher Sri Aurobindo was highly influential, with 37% of respondents agreeing with the

statement, “If Aravind hospitals were not helping the underserved communities for free, I would quit my job.”

Exhibit B: Motivation for Working at Aravind Survey Results

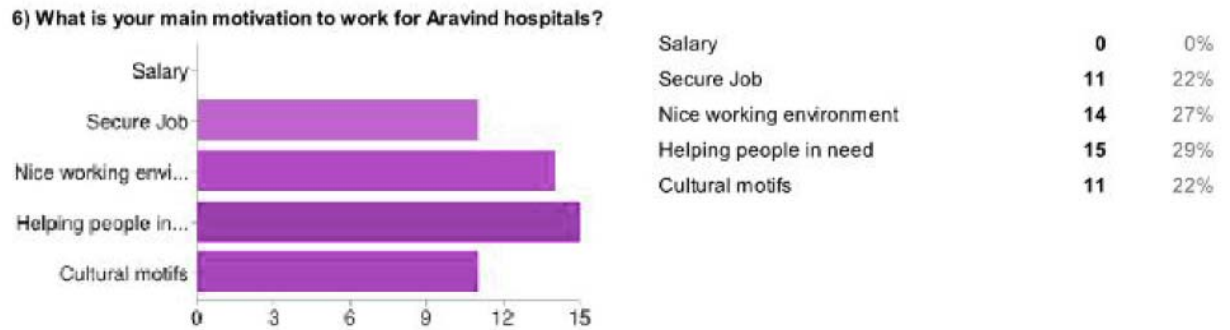


Figure 7: Closed questionnaire - Motivation to work for Aravind; Results Question 6 (graph/percentage)

Source: “Features of Organizational Culture Enhancing Performance,” by Tijan Ramahi

Funding and Financial Metrics:

After fundraising difficulties and a rejected bank loan application, Dr. V bootstrapped Aravind with seed capital from mortgaging his house. He recruited family members, who accepted salary cuts to work on his entrepreneurial project, and started the first clinic in a house rented from his brother. From the beginning, Dr. V aspired to sustain profitable growth, only adding floors when he accumulated sufficient surplus to undertake an expansion.

Although Aravind Eye Hospitals only charge for 25% of their surgeries, they are able to run profitably through an effective cross-subsidization model. All patients receive the same quality of healthcare; however fee-paying patients may enjoy more luxurious private, air-conditioned rooms, while free patients may stay on dormitory mats. Process consulting through LAICO is also offered free of charge to non-profit hospitals and organizations in developing countries.

According to *Infinite Visions*³¹, in 2009-10, Aravind made \$13 million in operating profit on \$29 million in revenue. Its historical financial summary from 1991 to 2013 shows an expenditure-over-income track record of between 43.75% and 69.03%, with income increasing

steadily over time. Since the beginning, Aravind has stayed independent of government grants and private donations. Aravind continues to see impressive 40% annual gross returns²⁸.

Supply Procurement:

Although Aravind initially asked for lens donations, the 25,000 lens collected per year soon fell short of augmenting demand. The challenge of providing low-cost services to Indian consumers led to the establishment of an in-house lens manufacturing facility, which would reduce transportation costs and fees for the middlemen. Dr. V partnered with David Green, a US-based entrepreneur and Ashoka Fellow, who worked with the Seva Foundation to found Aurolab in 1992 to produce low-cost lens for cataract treatment. A \$17.3 million social enterprise that produces within five divisions: suture needles, intraocular lens (IOL), pharmaceutical, blades, and equipment, Aurolab strives to “make high-quality ophthalmic products affordable and accessible to the vision impaired worldwide.” Lens cost \$2 to \$3 USD, 98% less than similar quality lens in the US³². To reduce costs, Aurolab partnered with IOL International, paying a one-time fee for the initial technology transfer³³.

Aurolab exports to 147 countries in Africa, Latin America, and Southeast Asia. Eventually, Aurolab plans to establish a presence in Europe and the US to increase profitability, so that sales in developed markets can cross-subsidize their work in developing markets. Aurolab’s entry into the marketplace encouraged other manufacturers to raise quality standards and lower prices. Through high brand equity in India and a strong dealer network with hospitals, Aurolab quickly captured 7-8% of the global lens market share. Aurolab has received several quality certifications, including the CE Mark, the ISO 9002 certification, and certifications from the US FDA and WHO-GMP.

Community Outreach:

Aravind runs 1,500 eye camps per year sponsored by local non-governmental organizations – mainly Rotary, Vivekananda Kendra, schools and colleges, and Lions Clubs. To reduce costs, Aravind provides the ophthalmology expertise, while its partner institutions finance the supplies, food, and facilities and promote the camp within a 25- to 50-mile radius. Upon consultation, patients requiring further treatment or surgery receive free transportation to Aravind’s larger hospitals.

The local availability of vision centers and eye camps, which can perform all evaluations in a single visit, minimizes travel and improves patient convenience and service.

Internal Logistics and Technology Integration:

Dr. V realized that ophthalmologists were spending a significant amount of time on routine tasks, such as preparing for surgery, calculating intraocular pressure, and evaluating refractive error, so he entrusted those responsibilities to mid-level ophthalmic personnel, which raised productivity by 400%³⁴. In a typical case, an Aravind surgeon will alternate between two operating tables and receive assistance from a team of four nurses, two of whom offer direct support and two of whom deliver medical instruments. This strategy, called **paraskilling**, involves breaking down complex duties that would normally require expensive skilled labor into more manageable tasks that can be completed without extensive training. Performing a higher volume of surgeries expedites the learning curve for new surgeons, allowing Aravind to lower the time per operation to 10 minutes, compared to the Western average of half an hour per surgery.

The IT system tracks surgeries performed, updates estimated waiting times, and generates schedules, taking into account the number of patients and predicted workload for that day. A computerized system generates case sheets for all patients at the free and paying hospitals and eye camps, providing crucial data for biostatistical research and analysis.

Aravind also uses IT kiosks for tele-advice, working with Indian Institute of Technology (IIT), Chennai, and the company n-Logue to place kiosks with web cameras across Tamil Nadu. Patients upload pictures of their eyes and email them to a designated doctor in Madurai, who provides a diagnosis and offers recommended next steps.³⁵

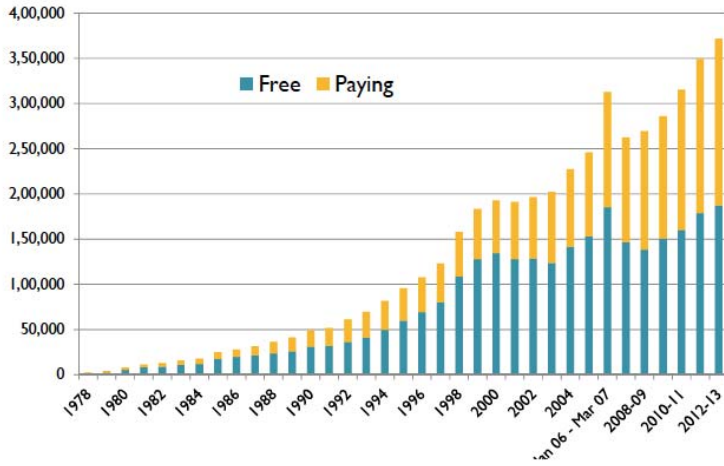
Growth:

Dr. V's first hospital opened in 1977 with 30 beds, generating sufficient profits to open a second hospital with 70 beds later that year that would provide surgeries free of charge to needy patients. In 1981 and 1984, respectively, Aravind opened a 250-bed fee-paying hospital and a 350-bed free hospital³⁶. From 1978 to 1987, Aravind focused on establishing more hospitals to expand reach. Its objectives shifted from 1988 to 1997 to a focus on internal scale through the additions of LAICO and Aurolab. From 1998 onward, Aravind has become more externally facing, experiencing growth in research and drug development, specialty care, and capacity building for other institutions³⁷. Many of the programs created by Aravind directly respond to organizational needs. For example, the training programs ensure a steady supply of eye surgeons trained to the same standard of excellence.

Exhibit C: Surgeries Performed Over Time, Revenues and Expenses

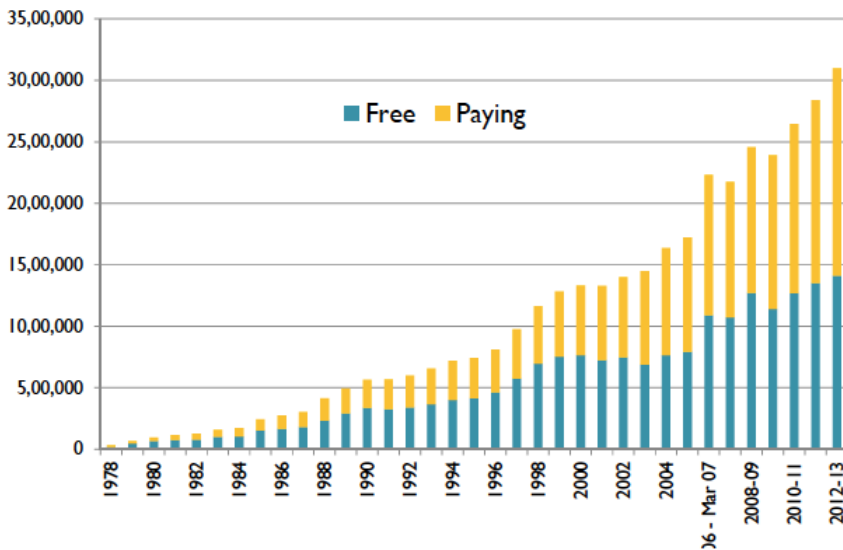
Patient Statistics: Surgeries & Lasers

Total Surgeries & Lasers till March 2013: 4,800,000

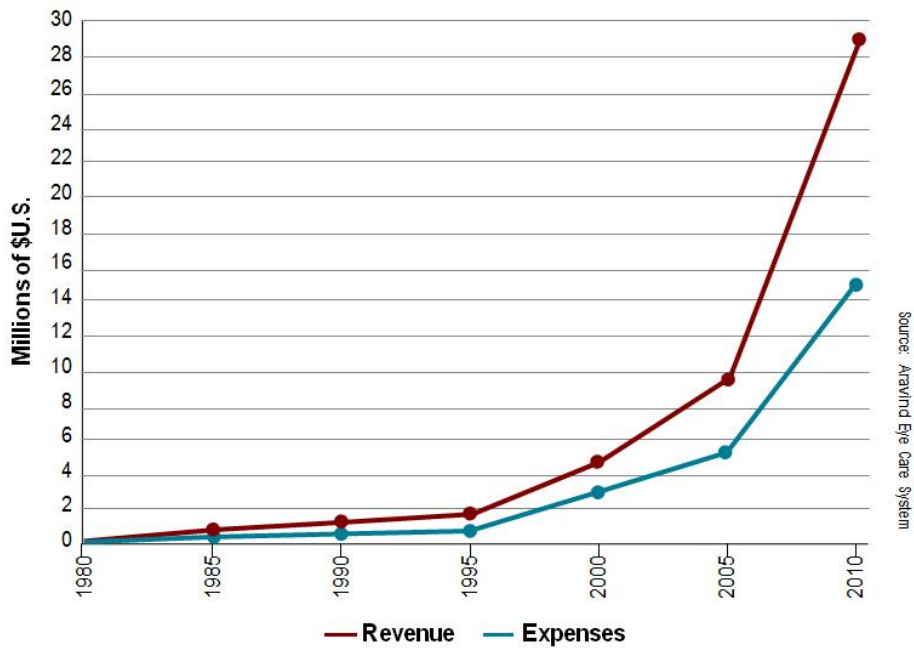


Patient Statistics: Outpatient Visits

Total Outpatient Visits till March 2013: 37,283,249



Aravind's Revenues and Expenses (1980–2010)



Source: Aravind Presentation Sliddeck

Performance:

In 2004, Aravind's infection rate was measured at 4 per 10,000 cases, lower than the 6 per 100,000 average published by the UK³⁸.

Exhibit D: Probability of Adverse Events During Surgery

Adverse Events During Surgery	Aravind, Coimbatore; N=22,912	UK National Survey; N=18,472
Capsule rupture and vitreous loss	2.0%	4.4%
Incomplete Cortical Clean up	0.75%	1.00%
Iris Trauma	0.3%	0.7%
Persistent Iris Prolapse	0.01%	0.07%
Anterior Chamber Collapse	0.3%	0.5%
Loss of nuclear fragment into vitreous	0.2%	0.3%
Choroidal Haemorrhage	-----	0.07%
Loss of intra Ocular lens into vitreous	0.01%	0.16%

Source: C.K. Prahalad, 2010

Global Replication:

Closely affiliated with the UK International Center for Eye Health and the US National Eye Institute, LAICO has offered consulting services to over 300 hospitals in 30 countries, improving operational efficiency by sharing how Aravind's model could apply to their specific situation. The mentoring process usually involves the Aravind team traveling abroad and members of the partner hospital visiting Madurai to gain a more nuanced understanding of local conditions, such as sociopolitical and economic characteristics, service area, population, and available human and capital resources. On average, the hospitals that receive support and mentoring from Aravind are able to increase their output, as measured by number of operations, by 40 to 50% in the following year, with more significant changes in hospitals where the leadership engages heavily in implementation (Personal Interview. January 6, 2015). "Many of the hospitals have also adopted the cross-subsidization model," said Ramasamy. "The biggest challenge that we face is sustaining the initial excitement of the leadership team. They need to be able to find their own doctors, organize good outreach programs, and locate funding sources" (Personal Interview. January 6, 2015).

The Seva Foundation has worked with Aravind to run similar hospitals in other countries and boost performance of their care facilities; however, only an estimated 20 percent follow Aravind's model completely. In India, Aravind has expanded to West Bengal and Gujarat, partnering with local institutions and staff who are familiar with the native dialect and customs³⁹.

Impact on Market:

The Indian eye care industry has seen competition from Sankara Nethralaya, a Chennai-based missionary eye hospital, started in 1978, and L V Prasad Eye Institute, a non-profit headquartered in Hyderabad, founded in 1987. Similarly to Aravind, these institutions offer multiple arms: clinical services, education, research, rehabilitation and sight enhancement, eye banks, teleophthalmology, and public health and outreach.

Currently, Aravind charges Rs ~6000 (~\$95 USD) for basic starting level surgeries, and ~\$750 rupees (~\$12) for subsidized surgeries, one one-thousandth of the cost of American surgeries. When asked about Aravind's impact on the eye surgery market, Ramasamy explained that "prices are regulated, though not because of Aravind." With the IOL, Aurolab was able to

create an entirely new market. Aurolab also cut the cost of sutures, stitches that hold a wound together, by 75% (Personal Interview. January 6, 2015).

Today, Aravind is the single largest provider of cataract surgeries in the world, with a 40-51% market share of surgeries in Tamil Nadu and around 5% cumulative share in India³⁸. This market share has translated into greater negotiating power with suppliers and the ability to forge partnerships with over 280 institutions, including the prestigious John Hopkins and Harvard Medical Schools.

Comparative Analysis: Aravind and NH

Aravind and NH are the most frequently cited examples in literature on frugal innovation and have employed economies of scale, process standardization, and resource optimization to enhance productivity. Both NH and Aravind run rural outreach camps, operate tele-advice technology, and offer educational programs as part of an internalized commitment to making healthcare accessible and affordable to those in remote and rural locations.

In recent years, NH has become more profit-oriented, opening locations in areas with lucrative business opportunities, while Aravind has not scaled at the expense of its Gandhian mission and asceticism. Although both NH and Aravind use a cross-subsidization model, as a percentage of total services, Aravind provides free or discounted operations to six times as many patients.

The aim of NH's new Cayman Islands facility is to eventually become a \$2 billion enterprise treating 18,000 patients. With the Cayman Islands situated only a one-hour flight away from the US and boasting the 14th highest standard of living in the world, the selection of Cayman Islands as NH's first expansion target outside of India has raised concerns that NH is trying to profit off of uninsured US patients, as 60,000 to 85,000 Americans go abroad each year for treatments.

"We're not considering this a medical tourism facility," Anthony Tersigni, Ascension's CEO, reported to the *St. Louis Post Dispatch*. "I'm not sure we're going to have U.S. patients at the Caymans... We're going to continue to take care of poor people in this country, and to try to take care of poor people in the Caribbean and South America⁴⁰."

Although performance data for the Cayman Islands project has not been formally released, the project's success will serve as a public statement on whether the Health City model and the concept of frugal innovation can survive in environments with higher overhead and labor costs than India. When building the hospital, the Cayman Islands removed barriers to entry by offering "tax breaks, lower insurance premiums, and [accreditation for] Indian licenses in the Caribbean⁴¹," which would not necessarily be possible in other countries, where the government has not prioritized economic diversification.

The large number of case studies written on both organizations is illustrative of the influence of visionary leadership and the founders' desire to propagate best practices

internationally. Dr. Shetty expressed openness to sharing cost reduction and capacity-building strategies with government and non-profit organizations to improve overall quality of care. During a tour of the NH facility, a surgeon explained that NH learned how to do liver transplants from the Children's Hospital in Philadelphia (CHOP) and, in turn, tries to train other hospitals in surgical procedures.

“We believe in making profits, but not super profits – enough money to pay good salaries to employees, maintain our infrastructure, and remain attractive to investors,” explained Shetty in an article for *Financial Times*⁴². “If you don't make a profit, no bank will lend to you and no donor will give you money.” Dr. V similarly related his professional work to his esteem for Gandhi and desire to fulfill an earthly calling: “We were not thinking of amassing money as our goal. We always aspired to some perfection in our lives⁴³.”

Aravind has maintained its commitment to not actively engage in fundraising. Although grants and unsolicited donations are accepted, these funds are not put toward core work, such as patient services, staff training or hospital expansion, and go toward the more peripheral services of LAICO, Aurolab, and research. Ramasamy believes that Aravind's focus on the greater good has not hindered scalability. She stated, “We're mostly limited by our ability to find high-quality staff who believe in the Aravind mission. We will probably open one or two new hospitals in the next year and eventually expand to other locations within India. Our goal was to start with the states that were performing most poorly [with regard to needless blindness] and bring up the [baseline]” (Personal interview. January 6, 2015).

When evaluating the potential for replicating the NH and Aravind model, we need to investigate whether their competitive advantages are scalable and sustainable. For example, NH spends only 22% of revenue on salaries, in comparison to 60% of revenue in western countries⁴⁴. NH also uses infrastructure, such as operating theatres and cath laboratories, for 12 to 14 hours a day, in comparison to other hospitals that run equipment for eight hours⁴⁵. This allows for the performance of over 30 CT scans per machine each day, almost six times the rate of similar machines.

Since it is culturally normative to work 48 hours per week in European hospitals, extending hours to achieve higher surgery volumes would not necessarily gain approval in countries where overtime translates into higher salaries. When James Militzer from NextBillion Health Care asked Shetty whether working the surgeons intensively for 60-70 hours per week

resulted in diminishing marginal returns, Shetty replied that quality improves because surgeons gain a high level of expertise and reduce their margin of error⁴⁶.

In both the case of Shetty and Dr. V, they started as skilled surgeons, who continued to hone their medical specialty and found others to manage business operations. Not only were Shetty and Dr. V exceptionally adept at their craft and knowledgeable of the local landscape, but Wharton Prof. Lawton Burns notes that they were exceptionally fortunate in the resources at their disposal, which allowed for preliminary bootstrapping³⁸.

Unlike peer institutions, NH and Aravind have deep roots in family ownership and involvement. Over 35 members of Dr. V’s family work across the organization, making strategic decisions aligned with his values⁴⁷. As expressed by Burns, Dr. V’s death in 2006 raised the question of whether the organization could stay true to its core values without the founder’s oversight and in light of financial pressures³⁸. Vasan, New Delhi Centre for Sight, and Eye-Q have gained traction as potential competitors to Aravind and are backed by private equity, which represents a change in the traditional government and grant-funded landscape⁴⁸. Although Aravind’s mission is well protected through current hiring procedures, future leadership must continue to prioritize social dividends over profit maximization.

To date, NH and Aravind have achieved tremendous financial and social performance; however, fast growth comes at the price of operational control. Leaders of other hospitals struggle to carry out the organizational models of Aravind and NH, in spite of the provision of open-source innovation, which presents the hypothesis that Aravind and NH succeeded in part because of circumstances – namely, they had the right people in the right place at the right time.

Summary:

Similarities	Differences
<ul style="list-style-type: none"> • Both have employed economies of scale, resource optimization, and process standardization to boost productivity • Cross-subsidization of poor, educational training, tele-advice, and mobile clinics make healthcare accessible and affordable • Guided by socially motivated founders skilled at craft of surgery • Families maintain high ownership stake 	<ul style="list-style-type: none"> • NH has become more profit-driven, opening locations in areas with lucrative business opportunities (Cayman Islands) • Different challenges to sustaining and scaling their competitive advantage – i.e. Can Aravind continue without outside funding? Will NH’s long work hours and overutilization of technology work in other environments?

Embrace Global: Keeping Newborns Warm

Process Innovation

15 million premature babies are born each year, with three million dying within the first month of their lives because of infection, low birth rate, asphyxia (lack of oxygen at birth), and birth trauma. Many people in under-resourced areas put premature infants near light bulbs, coals or hot water bottles, but these “solutions” are ineffective and often hazardous to the babies’ health. WHO believes that up to two thirds of newborn deaths are preventable and that half of babies in a developing countries do not receive skilled care at the time of birth⁴⁹. India in particular has a high mortality rate for newborns following hospital discharge.

Embrace is a social enterprise specializing in infant healthcare, founded by Jane Chen, Linus Liang, Rahul Panicker, and Naganand Murty. While enrolled in an Entrepreneurial Design for Extreme Affordability course at Stanford University in 2008, the team found hypothermia to be the leading preventable cause of infant deaths and started conducting more in-depth research.

Using the principles of design thinking, which emphasizes first-hand interaction with the end user, Liang traveled to Nepal. She saw that many of the hospital’s incubators were empty because babies were born in rural villages without access to medical facilities. With Chen, Panicker, and Murty, Liang created a prototype: a sleeping bag pouch made of paraffin. The team travelled to India for two years, conversing with parents, midwives, nurses, and doctors to refine their design based on observed and articulated local needs. In conducting clinical studies of 160 premature babies, they realized that their incubator needed to be able to run without electricity, so they made it capable of absorbing warmth from heated water⁴⁸. India was a prime location for the team to pilot the Embrace Warmer because the variety of socioeconomic levels and living conditions in the country required an adaptable, rugged design. Raghu Dharmaraju, COO of Embrace Innovations, headquartered in Bangalore, explained, “The team started with dolls and lambs at the University of Utah, then did clinical trials. With healthcare innovation, there are a lot of specific processes that you have to follow. It is different from launching an app and tweaking it (the typical lean startup model)” (Personal interview. January 8, 2015).

The product itself is composed of a small sleeping bag; pouch of phase-change material (PCM), which absorbs or releases heat in accordance with the baby's needs; and a heater that can retain optimal heat levels for up to 8 hours. The Embrace Warmer is inexpensive, durable, hygienic, safe, and portable, with waterproof materials that allow for easy cleaning and sterilization. During the prototyping stage, Embrace made many changes based on feedback from fieldwork. For example, upon realizing that mothers do not trust numerical temperature scales, Embrace replaced the numbers with the easy-to-interpret symbols "OK" and "Not OK"⁵⁰.



Embrace Warmer, Source: Globalhealthcare.com

The Embrace Warmer comes in two versions: Embrace Nest for hospitals and Embrace Care for homes. Nest is sold directly or through distribution networks to institutions, with private hospitals charging patients per day of use⁵¹. Care can be sold or rented as a prescription to patients.

Marketing:

Dharmaraju explained that the biggest challenge to sales and marketing is the slow pace at which governments adopt healthcare innovation and the need to figure out the intricacies of government systems in every state or country.

“The government system puts out common specs to find the cheapest medical device that meets the minimum criteria. The government cannot operate new innovations and the fear of

corruption impedes out-of-the-box thinking,” explained Dharmaraju. “We had to approach the top-most bureaucrats through secondary connections or cold calls. You try for the best doctors in state and you get them to do a small pilot, sometimes for free or you get them to buy a few units. These doctors would call a cross-functional team and get it approved by the budget. Then the central decision-making unit would decide whether or not to approve it” (Personal interview. January 8, 2015). 15 or 20 states have adopted the Embrace Warmer, but there is a lag between making the decision and taking action (e.g. Rajasthan and Gujarat have the incubator across the entire state, while in other locations, it has scaled more slowly). By the end of 2011 and 2012, Embrace had customers in more than 100 towns and several state governments on board. Dharmaraju stated proudly, “It is the fastest a first-of-its-kind medical device has been adopted in India” (Personal interview. January 8, 2015).

Embrace has tried to partner with multinationals, such as Swiss pharmaceutical company Novartis, but not with the greatest results. “There’s difference between strategic goals of top management and incentive structures for people on the ground, which focus only on daily sales,” Dharmaraju said.

Dharmaraju continued, “We are at Stage 1 of scaling, and we have big mountains to climb [to optimize our distribution]. The first 10-20 customers are difficult. The next 200 are less difficult. We haven’t hit the hockey stick growth curve yet and are still figuring out what it’s going to take. We talked to all the experts – too many experts – and tried to adapt to the market. In India, we initially went to large medical device distributors and MNCs, [which wasn’t necessarily the best approach]. If you’re truly trying to do something new, expect to put in a lot of elbow grease to determine how to position your innovation” (Personal interview. January 8, 2015).

Innovation Curve:

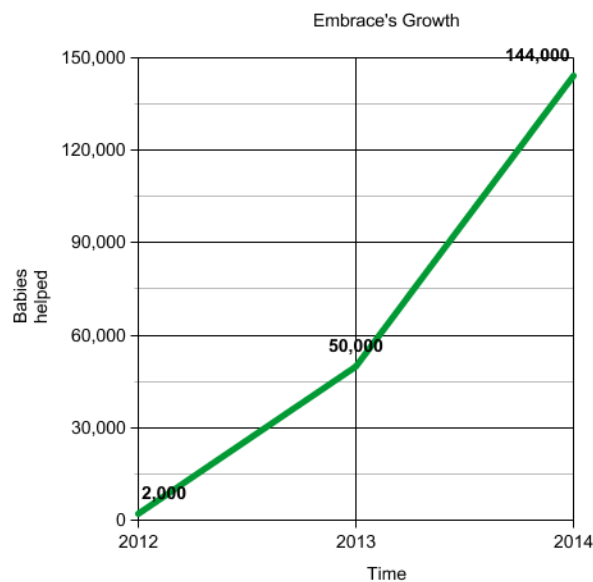
2011 – Product launches, with first infant warmer delivered to Little Flower Hospital in Kerala. Later that year, Embrace expands to Africa through partnerships with the American Refugee Committee and Banandir Hospital in Mogadishu.

2012 – Start of global donations and partnership with GE Healthcare impacts 2000 infants

2013 – Expands to 22 programs in 11 countries, helping 50,000 low birth weight babies

2015 – Embrace’s technology has reached 144,000 in 10 different countries

Exhibit E: Embrace Growth Over Time



Source: Embrace Website

Embrace co-founders describe on their website the challenges involved in the initial product delivery and how the Indian environment provided unique logistical obstacles: “We faced every challenge that could have possibly arisen in the days leading up to product launch, from a component of the product being stuck in customs, another not being delivered on time, to the washtags being placed incorrectly. With an amazing team effort, we were ready to deliver our first product on April 9th. Then, on the way to the clinic, we got a flat tire. Everyone in the car simply jumped out, piled into an auto rickshaw, and hand delivered the first unit to Little Flower maternity home.”

Funding Model:

After transitioning from prototype to product with commercialization potential, Chen, who assumed the role of CEO, realized that managing operations and fundraising for the growing organization consumed over 80% of her time⁵².

At first, Embrace relied on its board of directors, which includes high-profile investors and entrepreneurs, to suggest contacts of potential donors. Embrace’s success in the BASES Social E-Challenge and Jane’s selection as a TED and Echoing Green Fellow helped increase Embrace’s profile in the news. By hosting smaller events and meeting 10-15 friends of board members at a time, Embrace was able to secure additional funding for growth.

Chen and her team decided to create a unique hybrid model, with Embrace Innovations managing the manufacturing and sale of the warmer to governments and private clinics as a for-profit social enterprise and Embrace functioning as a non-profit responsible for donating infant warmers internationally. The non-profit model facilitated partnership formation, as some hospitals expressed opposition to working with a purely profit-driven company. Since investor pressure in the private sector would discourage Embrace from targeting low-income customer segments, the non-profit status helped Embrace attain its social goals. Chen used many considerations to develop Embrace's legal and financial structure:

Exhibit F: Embrace Financial Model Considerations

- **Vision/values** Is Embrace a commercial enterprise with social mission or a socially-driven enterprise using commercial practices?
- **Core competencies/assets** What are Embrace's current core competencies/assets – research and development, supply chain, education/advocacy? What does Embrace want to develop versus outsource?
- **Stakeholder considerations** What will be attractive to investors of interest? How will different legal structures impact our relationships/interactions with our value chain?
- **Sustainability/funding** Is a non-profit model a good fit with Embrace's proposed business model? Are Embrace's current funding sources sustainable or and will they allow it to scale?
- **Legal/taxation** What legal implications will each legal structure entail? What are the tax implications of selecting one structure over another?
- **Governance/compliance** What level of discipline/scrutiny and reporting structure is Embrace prepared to take on? What added regulatory and compliance costs does each structure entail?

Source: "Embrace: Deciding on a Hybrid Structure," Stanford Business Center for Social Innovation

As a nonprofit, Embrace owns the intellectual property for all products and covers operating costs through royalties on commercial sales, individual donations, and foundation grants.

Embrace Innovations' revenue comes from commercial sales and impact investors and is used to accelerate growth. In 2011, the company received Series A funding from Capricorn

Investment Group and the Khlosa Impact Fund. Chen explained in a Stanford Business case study that communicating the hybrid structure to stakeholders and potential donors was difficult: “[We needed to] make the message really simple, crisp, and clear⁵⁰.”

In addition to financing operations, funding for Embrace goes toward advocacy efforts, impact monitoring and evaluating, and education on hypothermia and newborn health, and profits from Embrace Innovations advance research and development.

The two sides of the organizations have slightly different cultures due to the diverse backgrounds of employees, but by establishing clear accountability and communication channels, they have been able to stay aligned on a core mission and values.

Dharmaraju explained with regard to Embrace’s funding model: “We’re still learning. I certainly think there are benefits, but also challenges, such as the fact that we’re still reliant on donations. While we have been able to scale, it is too early to tell as to whether it is sustainable in the long term.”

Future Plans:

Having tested a pilot at the Lucille Packard Children’s Hospital at Stanford, Embrace is looking to potentially expand to the US to access a larger funding pool and address the problem of neonatal intensive care unit (NICU) overuse.

500,000 premature babies are born in the US each year. The hospital stay for a premature baby is \$275,000 more expensive than that of a full-term baby. 95% of premature babies weigh over 1,500 grams and could be well suited for an Embrace Warmer. If the majority of these babies were placed in an Embrace Warmer instead of an NICU, the US would save \$13-\$14 billion annually⁵³.

In April 2015, Embrace Innovations launched a Kickstarter campaign, with the goal of raising \$98,000 over 45 days for Little Lotus, a baby product line featuring a swaddle/sleeping bag and blanket with proprietary fabric originally developed for NASA. Embrace is reverting to the social enterprise model employed by TOMS and Warby Parker by donating an Embrace Warmer for each Little Lotus product purchased.

Performance:

Embrace is ISO 13485 certified and Nest is CE marked, which provides hope for achieving FDA approval in the event of a US expansion. Embrace has received nearly every design award, including the Economist Innovation Award, chwab Foundation’s Global

Social Entrepreneur of the Year award, Fast Company's Innovation by Design Award, Emerging Company of the Year Award from the Government of Karnataka in 2012, and recognition from the World Health Organization (WHO).

The product can be reused up to 50 times and retails for ~\$100, less than 1% of the cost of a traditional incubator (~\$10,000). Cost savings compared to NICUs average \$50-\$100/day. Radiant warmers are cheaper than other types of incubators at ~\$3,000, but they require 700 watts of electricity and a diesel generator, which limits their accessibility in developing countries.

According to a survey of 53 pediatricians in Gujarat, results from Embrace trials were mixed. While almost all of the pediatricians were comfortable using the product, 94.1% did not remark weight gain in the infants and 54.9% expressed difficulty monitoring the health of babies inside the Warmer. 62.7% of those who used Embrace for babies at the mother's side found it to prevent hypothermia and 85.7% deemed the Warmer to be worth its price. Although the Embrace Warmer is supposed to complement Kangaroo Care (skin-to-skin contact), 7.7% of doctors using Kangaroo Care stopped the technique when adopting the Embrace Warmer because the Warmer requires less staff training, space in the hospitals, and managerial oversight.

In addition to selling and donating warmers, Embrace provides training on the prevention, diagnosis, and treatment of neonatal hypothermia and endorses Kangaroo Mother Care, encouraging mothers to bond with and breastfeed low birth weight children. Embrace investors have observed that the Warmer fares better in clinical settings where practitioners can receive training on how to identify babies with low body heat who would benefit from the product⁵⁴. To date, Embrace has led over 100 programs in 11 countries, trained 4400 healthcare workers, and educated 9200 mothers.

GE Healthcare: Reimagining and Redesigning for India

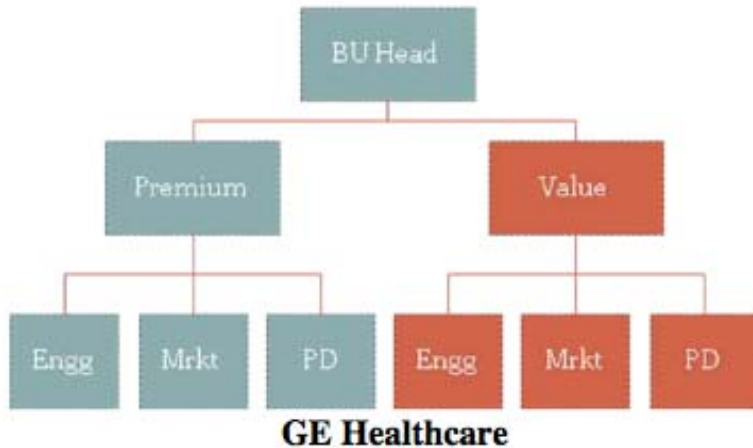
Product Innovation

GE Healthcare is an \$18 billion unit of the multinational General Electric Company. In 2009, GE Healthcare launched “Healthyimagination,” a \$6 billion dollar effort to provide high-quality affordable healthcare products in developing countries. GE is investing in India to increase the accessibility of consumer healthcare, with the anticipation that Indian revenues will reach \$1 billion by 2016-17. GE Healthcare currently has 25 products, developed out of the GE John F. Welch Technology Centre in Bangalore.

When GE entered India in 2001, the company realized that its premium positioning detracted from its ability to find a market niche. Through collaboration with leading engineers from Germany on a technology transfer and a partnership with the software company Wipro, GE was able to develop the MAC 400 in 2008 for one-tenth of the cost of premium-segment electrocardiograms (ECGs). GE lowered expenses by using commodity parts, such as ticket printers, and eliminating the costly motor. To reach a wider range of customers, GE recently founded GenWorks Health Pvt Ltd, a national network that distributes healthcare equipment in 450 Tier 2, 3, and 4 cities throughout India.

When innovating within India, GE changed its organizational structure, giving GE India full control over its budget, P&L statements, growth strategy, and product development decisions. GE India reports to the Global Growth Organization (GGO), which provides autonomy to emerging markets to identify and fund nascent market opportunities that might otherwise get overlooked⁵⁵. Within each business unit, GE has a single manager overseeing both the “premium” (developed market) and “value” (developing market) segments, “so that newly created value segments can leverage the knowledge and expertise that exists within the company⁵³.”

Exhibit G: GE Organization Chart



Source: “Lessons from low-cost healthcare innovations for the Base of the Pyramid markets: How incumbents can systematically create disruptive innovations,” by Aditi Ramdorai and Cornelius Herstatt

Design of the Lullaby Warmer:

When launching the Lullaby Warmer, a low-cost, high-performance baby incubator, Ashish Gupta, former Global Marketing Manager for Embrace, explained how the team achieved the stretch goal of cutting costs by 80% through reverse innovation.

The GE team first conducted market research surveys, interviews, and field visits to understand the competition and discovered that the Indian consumer does not lie on the typical price-value axis. The traditional $\text{Cost} + \text{Margin} = \text{Price}$ formula had to be switched to $\text{Price} - \text{Margin} = \text{Cost}$.

Many consumer products turn a profit through serviceability – selling the main product at a cheap price and then charging a premium for additional features (e.g. bundling a cheap razor with expensive accessories); however, the poverty and inaccessibility of materials in certain regions of India make these additional fees infeasible and unprofitable. Gupta told the story of a hospital incubator that ran out of a 50 cent fuse and was inoperable for six months (Personal interview. January 7, 2015). The Lullaby Warmer comes with a reusable temperature probe, so that healthcare providers can use the Warmer for a longer period of time.

The Lullaby Warmer drew inspiration from GE’s Giraffe Warmer, a high-end incubator which sells for ~\$25,000 and earned the Medical Design Excellence Award in 2008. The

Warmer required much iteration along multiple axes in order to gain customer acceptance and optimally deliver heat. Some of the challenges were designing a product durable enough to withstand pressures, such as power outages, and easy enough to operate for the untrained user.

Developers needed to remove unnecessary features to improve functionality and minimize costs. GE simplified materials, replacing motor control with a crank and handle⁵⁶. Most of the material was made of steel and plastic, with the bassinet created entirely out of clear plastic. Their normal suppliers could not make the incubator with transparent plastic at a high volume, so they found someone who could do it for a cheap price in Taiwan. The main pipe was originally a 2 x 2 cable, welded together and painted. To improve aesthetics, GE used a 1 x 3 pipe. Costs for metal were the same, but the pipe was oval, with curved edges and a white finish, giving it a more high-end appearance (Personal interview. January 7, 2015).

The finished product consists of an infant bed with an embedded heater, operates with minimal switches and settings, and provides graphic instructions for users with low literacy. The Warmer works without a voltage stabilizer, so that it can adapt to volatile electricity conditions, and uses 50% less electricity⁵⁷. Furthermore, the Warmer's resuscitation capacities prevent death from hypothermia and asphyxia. GE has also developed an LED phototherapy unit that treats hyperbilirubinemia, the cause of jaundice in 60% of full-term babies and 80% of premature babies.



Lullaby Warmer, Source: GE Healthcare

Gupta continuously stressed the importance of emphasizing with the customer when designing the product. “Never underestimate the sexiness of healthcare devices,” said Gupta. “Parents would bribe doctors to put their babies in the more expensive looking incubators. You have to be close to the market and walk in their shoes to understand how to make decisions instead of making assumptions of ‘poor people.’”

Product Segmentation, Targeting, and Positioning:

The GE salespeople used to go after the premium segment in the top 10 to 15 cities; however, they realized that the greatest need was in rural, underserved areas that did not have an existing sales force. Unfortunately, BOP innovations depend on the government, and government healthcare systems are slow to adapt to innovation. Gupta’s team decided to get started in the private market, including private nursing homes and mom-and-pop shops in Tier 2 and 3 cities.

Exhibit H: Comparison of Tier-1 and Tier-2&3 Cities

TWO APPROACHES, TWO MODELS Smaller-town hospitals are good business too		
Hospitals	Tier-1 cities	Tier-2&3 cities
No. of beds	More than 250	150-200
Average length of stay	One week	2-3 days
Investment	Rs 60-90 lakhs/bed	Less than Rs 50 lakh/bed
Return on capital	More than 26 per cent	About 50 per cent
Break-even period	About five years	About 3-4 years
Return per employee	About 20 per cent	About 40 per cent

Source: Industry Estimates

A global sales team attended conferences and trade shows and visited Ministers of Health in smaller countries. Often, team members would try to sell healthcare leaders one or two pieces of equipment and then after a successful trial pursue higher sales of 800 to 1000 products. To penetrate remote locations where GE lacked brand awareness, GE partnered with East Meets West, an international development agency, which trained rural medical personnel to operate GE devices⁵⁸.

On the ground, salespeople were picked for their ability to learn and execute a concept sale. The salespeople enlisted were commissioned to sell ultrasounds and other products for several companies and so it was necessary to keep GE's product top of mind. "You need to convince them of the merits of your product and that takes time," explained Gupta. "A smaller purchase price makes it easier to sell; however, the Lullaby Warmer is complex and a high-budget investment" (Personal interview. January 7, 2015).

The GE team started in Karnataka and then expanded to neighboring states. "We started getting really good adoption, but the private market was fragmented and shallow. Presenting for an audience and getting key opinion leaders to adopt the Warmer was key. We needed to create local champions. We would get them to use and prefer our product through low-risk trials and customer service – making sure we were there to answer questions," explained Gupta. "After getting it adopted in one area, the salespeople would ask local influencers to spread the news via word of mouth (i.e. 'Can you think of any of your friends to whom you would recommend it?')" (Personal interview. January 7, 2015).

Ultimately, GE experienced the most success with secondary-level hospitals, low- to mid-level hospitals that may have a distinct pediatrician to oversee babies, but that also suffer from overcapacity. GE mostly sold to places that already had a radiant warmer, thus it wasn't "changing behaviors, but [rather filling] gaps in neonatal care" by offering an alternative with enhanced features (Personal interview. January 7, 2015).

Gupta described, "Selling to doctors and government hospital institutions is a much longer process of tendering and changing the specs. We're trying to get them to purchase based on performance specs (how much heat do you want to transfer), not product specs, which is how the government has traditionally made purchasing decisions."

Performance:

GE holds all products to high FDA and CE standards, allowing for entry into US and EU markets. The Lullaby Warmer meets the International Electro-technical Commission qualifications and sells for \$3,000, 30% the cost of traditional warmers⁵⁹. It is now sold in over 80 countries, including in Western Europe and emerging markets in China, Russia, and Africa.

As a whole, GE Healthcare is growing at a CAGR of 30% in India⁶⁰, a welcome contrast to fairly stagnant growth in developed markets⁶¹. In 2011, John Dineen, chief executive of GE Healthcare, stated that the company held 35% of the medical device market in the categories it

had entered⁶². Ashutosh Banerjee, Director, South Asia, Wipro GE Healthcare, confirmed that GE was a market leader in India without providing concrete statistics and said that GE had the capacity to manufacture 5,000 warmers per year⁶³. Currently, around 40 companies produce 12,000 to 14,000 warmers annually, although this number is growing rapidly, as more premature babies receive access to proper equipment. Ashish Shah, General Manager of GE Healthcare, said that the Lullaby Photo Therapy Unit went from non-player in 2009 to 50% market share to 2011, while the incubator gained 17% market share in its first year⁶⁴, selling 1500 units were sold in the first year of operation⁶⁵.

Future Challenge:

GE's challenge lies in selling at scale, while still making a profit. Gupta explained that according to a cost-benefit analysis, it is only profitable to customize the product for larger markets. For smaller countries, GE can change the language of instructions, but not re-engineer the entire product.

Additionally, the copyright and engineering of the Lullaby Warmer may not be IP protected, and Gupta said, "It is only a matter of time before someone...is going to blatantly copy you part by part" (Personal interview. January 7, 2015).

Comparative Analysis: GE and Embrace

GE and Embrace both dealt with “a) an underfunded and non-transparent government health-care market and (b) a highly fragmented and poorly regulated for-profit private market⁶⁶.” From a distribution standpoint, both Dharmaraju and Gupta highlighted the necessity and difficulty of achieving government buy-in. Although Embrace and GE targeted different markets initially, with GE building a presence in Tier 1 hospitals in larger cities and Embrace concentrating on semi-urban and rural markets, their target demographics began to converge based on the needs of the Indian population.

There is not much empirical information on the effectiveness of the Warmers in reducing infant mortality, compared to other alternatives, as most of the articles and literature available online link directly or indirectly back to the organizations’ publicity and marketing materials. As an example of another solution to neonatal health risks, UNICEF responded to the finding that 10% of infants in the state of Madhya Pradesh die after release from the hospital, compared to 2.3 to 3.8% of babies outside of India. UNICEF employed an SMS-based tracking system, which provided families with dates of follow-up visits, a list of warning signs, and emergency contact information. The cost of messaging was low at around Rs 1 per child. From 2008 to 2010, the implementation of tracking technology reduced infant mortality by 4%⁶⁷. Embrace and GE only address one facet of infant mortality and so far have not published studies benchmarking the their products in terms of health outcomes.

GE and Embrace initially developed a partnership combining GE’s comprehensive distribution network, with Embrace’s lower per-unit price, but as Embrace developed its own distribution channels, GE dissolved the partnership. In contrast to the Embrace Warmer, the Lullaby is a more typical radiant warmer. Although it boasts a simpler interface than its competitors and pictorial warnings that respond to the need for language independence, it still runs on electricity. Embrace’s portable model can complement GE’s bulkier and more expensive Lullaby Warmer, as Nest and Care are not full-service incubators and may be inappropriate for extremely low-weight babies.

The marketing strategies of the Nest, Care, and Lullaby Warmers show that Indian consumers want affordability, but that this does not excuse poor product quality. Sales for the Tata Nano, heralded as the “world’s cheapest car” at a price of ~\$1,600, did not meet Tata’s

20,000-unit monthly target because price-focused advertising gave it a negative image in the mind of Indian consumers, who wanted to purchase a reliable product in which they could take pride.

The product orientation of Embrace and GE makes the companies much more protective of intellectual property than NH and Aravind. “As soon as you get something good, you get copycats,” said Dharmaraju. Gupta highlighted the trend of multinationals (Proctor & Gamble, John Deere, Nestle, Xerox, etc.), capitalizing on the BOP consumer goods market, instead of conducting more conventional corporate social responsibility⁶⁸. In 2013, around four years after GE and Embrace began publicizing their warmers, Phillips introduced the Efficia Warmer and Incubator targeted at Tier 2 cities, corporate hospitals, and primary health centers. In other categories of medical devices, Phillips has been a first-mover in the market. Gupta explained, “Phillips came out with the [frugal] ultrasound first in India and found that they can sell it back to other countries at 3-4 times the price” (Personal interview. January 7, 2015). Unlike service organizations like NH and Aravind, companies with a product portfolio are more likely to scale through their internal networks and manufacturing facilities than through consulting and advising programs.

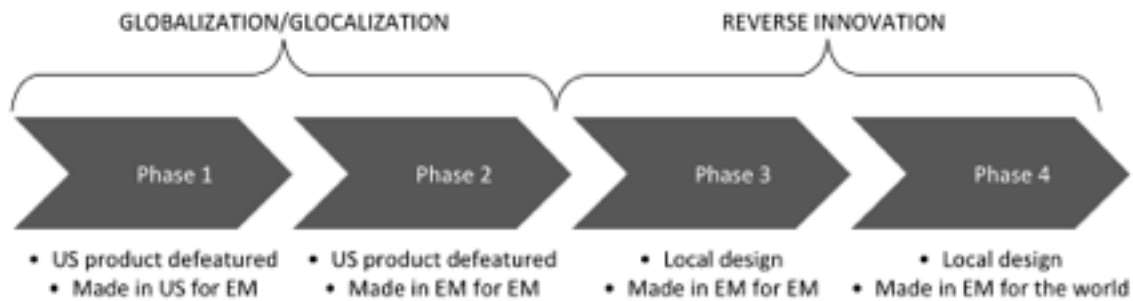
Both GE and Embrace benefitted from atypical circumstances. GE obviously has a huge marketing budget, an extensive supply chain with operations in over 160 countries, and the ability to make an up-front investment in research and design. When asked whether it would be possible to engineer the Lullaby Warmer without the resources of a multinational corporation, Gupta replied, “When it comes to medicine or electronics, you have to have a certain level of clinical or technical experience and research know-how, but many less complex projects can be created with smaller budgets” (Personal interview. January 7, 2015).

Although Embrace did not start with GE’s corporate clout, Chen and her team brought intellectual and social capital. With an educational background from Harvard and Stanford, Chen knew how to leverage different publicity platforms, speaking at the World Economic Forum and participating in AOL’s Makers Campaign. This resulted in Embrace receiving coverage in top media sources, like *The New York Times*, ABC News, *The Guardian*, *The Oprah Magazine*, TIME, Forbes, Fortune, PBS, and CNBC. Furthermore, Chen leveraged the Stanford alumni network, receiving advice and mentoring from Narayana Murthy, CEO and co-founder of Infosys⁶⁹. “[A history with name-brand institutions] lends you credibility and helps you with

entry,” said Dharmaraju, who added that the initial attention from celebrities, like Beyoncé, Barack Obama, and the former prime minister of Norway, did not help with the scaling process (Personal interview. January 8, 2015).

The GE and Embrace case studies reiterate the need for innovators from abroad to understand the local ecosystem and find grassroots partners. To achieve market penetration in rural India with the ECG, GE partnered with the State Bank of India, which offered poor doctors zero-interest loans to purchase the product. Although GE did not necessarily disrupt the market with the Lullaby Warmer, it is the first company to take full advantage of public-private partnerships, signing a memorandum of understanding with the government to upgrade medical technology and establish diagnostic imaging centers, with CT, MRI, ultrasound, and X-ray facilities, in medical colleges in Gujarat, West Bengal, and Maharashtra, which will train 100,000 healthcare workers by 2020⁷⁰.

Exhibit I: The American Multinational Approach to Emerging Markets



Source: “What is Reverse Innovation,” Tuck Dartmouth Blog

India currently imports 70% of medical devices and has no major VC firms dedicated to medical devices. GE’s “Made for India, by India” products represents part of a multibillion dollar investment in the country. In March 2015, GE Healthcare’s global head John Flannery announced that the company plans to launch 100 products in the next 5-7 years for global distribution and increase India sales by 10-20%⁷¹. One of the greatest opportunities for foreign companies to contribute to the frugal innovation ecosystem is through their larger investment in bringing human and financial resources to raise national technology standards.

Summary:

Similarities	Differences
<ul style="list-style-type: none">• Both GE and Embrace dealt with a fragmented private market and the challenge of gaining government adoption• Not much empirical evidence on effectiveness• Focus on design aesthetics (“do not look cheap”)• Need to find grassroots partners and empathize with end user• Efforts to protect IP (no open-source innovation)	<ul style="list-style-type: none">• Design drawbacks: GE offers bulkier and more traditional radiant warmer; Embrace Warmer is not sophisticated enough for all newborns• GE started with extensive R&D investment and distribution network; Embrace leveraged social capital and prestigious background of founders• MNCs, like GE, have the capacity to strengthen ecosystem through investment

National Innovation Foundation: From Field to Market

Product/Process Innovation

The National Innovation Foundation India is part of the Government of India's Department of Science and Technology. The NIF has helped file over 650 patents, catalyze grassroots technological innovations across all sectors, and preserve traditional cultural knowledge. In collaboration with the Honeybee Network, a knowledge-sharing network, the NIF has compiled a catalogue of 200,000 innovations from 555 districts in India. The NIF consists of six divisions: Scouting and Documentation; Value Addition and Research & Development; Business Development and Micro Venture Innovation Fund; Intellectual Property Management; Dissemination & Social Diffusion; and Information Technology. In the scouting phase, the NIF undertakes two exploratory journeys to find creative talent and participates in agricultural fairs and exhibitions. The NIF also hosts a biennial competition and involves business and engineering students in processes such as collecting market inputs, conducting background research, and creating a business plan for grassroots innovators.

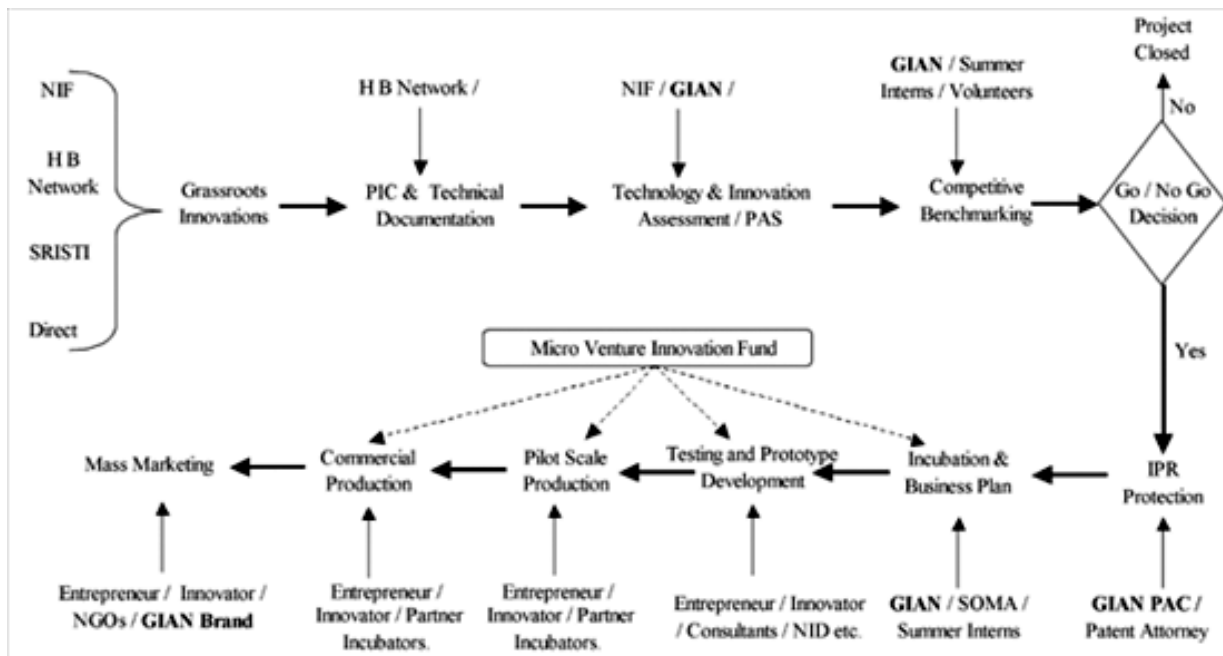
The Rs 4 cr Micro Ventures Innovation Fund, supported by the Small Industries Development Bank of India, has sourced initial capital for nearly 200 small-scale projects and helped commercialize select projects internationally, charging lower interest (12.5%) than local banks and collecting no collateral. The commercialization process happens by both licensing innovative technologies to entrepreneurs and helping the innovators become entrepreneurs.

Partners:

- Since 1993, **Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI)**, has served to link formal and informal science. It supports the Honeybee Network, coordinating a traditional food festival, recipe competition, and biodiversity competition.
- Founded in the late 1980s with the vision of cross-pollinating ideas, the **Honeybee Network** works all across India bridging people in academia, research, agriculture, and technical professions. It is trying to bring innovative practices to over 75 countries through similar networks and idea databases.

- Emerging in 1997 from discussions at the first International Conference on Creativity and Innovations at (for/from/with) Grassroots, **the Grassroots Innovation Augmentation Network (GIAN)** is a technology incubator in Jaipur and Ahmedabad that supports untrained and uneducated innovators in the creation of market-ready products. The Grassroots Technological Innovation Acquisition Fund pays innovators to acquire the patent rights to their products and practices, so that ideas can be easily disseminated, pooled, and licensed to local entrepreneurs. So far, 85 technologies have been licensed to 79 small and medium enterprises, which hear about opportunities on the SRISTI website or through exhibitions and mutual connections.

Exhibit J: SRISTI Value Added Chain



Source: SRISTI Website

Mahesh Patel, Chief Innovation Officer of the NIF, explained that the NIF is the only program devoted to grassroots innovators. He cited the “lack of incubators, finance, product development facilitation, networks, and mentoring” as ecosystem barriers to this type of innovation. Patel continued, “Many innovators need smaller amounts of finance than are offered by typical funds. [Moreover], all other incubators are in academic institutions and support high-

tech innovations by students. We evaluate innovations on novelty, efficiency, affordability, and simplicity in design” (Personal interview. January 10, 2015).

Patel added that few innovations are successfully commercialized, with the highest success rates in the agricultural and engineering sectors and with projects that are at a more advanced stage of development. Anil Gupta, founder of the NIF and professor at IIM-Ahmedabad, agreed that the success for entrepreneurs is dependent on their willingness to take risks, so young people are often the source of the most intuitive and imaginative solutions to common problems (Personal interview. January 9, 2015). The NIF tries to give grassroots innovators the opportunity to participate in mentoring meetings, seminars, and workshops with both NIF employees and outside experts. To foster creativity, the NIF collects ideas from children and runs an annual secondary school contest resulting in the IGNITE awards, which provide grants of up to Rs 500,000 for the best project proposals.

SRISTI:

SRISTI is a laboratory for testing the scientific principles of agricultural, microbial diversity, veterinary, and human practices. SRISTI has collected 40,000 practices by taking week-long treks (shodhyatras) of around 250 km into remote villages throughout India to understand local problems and identify new methods of “of crop protection, cattle rearing and improved implements developed by the villagers.”⁷²

Nirmal Sahay, Chief Coordinator at the SRISTI laboratory, explained, “These are crude innovations, so we face challenges in licensing the design, testing the prototype, implementing it on a large scale, and competing with recent innovations in the market. Not many innovators are interested in becoming entrepreneurs; most of them prefer agricultural or mechanical fields” (Personal interview. January 10, 2015).

Sahay added that technology can be for mass application or for only local niches. He said, “The local models are more difficult to commercialize because companies want to make a profit. To complete the filing for a patent, you need a lot of data. Of the 500 claims we have made, ~50 are through; all the others are in different stages of evaluation” (Personal interview. January 10, 2015).

SRISTI has a Techpedia website with over 189,000 engineering projects undertaken by university students and faculty mentors. Examples of projects include decomposition strategies

for agricultural waste, the analysis and design of a pressure-powered pump, and an automated customer billing system. In addition to enjoying an open-source innovation platform, companies and individuals can post their problems in hopes of receiving outside feedback.

Analysis:

Although the NIF has not commercialized many innovations, the organization started with a different mission and vision than traditional incubators or accelerators, which is to harness the ingenuity of disadvantaged groups of people. NIF innovations probably fall the closest to the traditional meaning of *jugaad*, overcoming limited means through resourcefulness and collective community action. For example, to improve school retention of female students, one village teacher collected the birth date of all 300 children and sent postcards with birthday greetings to the parents. When the parents came to ask why they had received the letter, he was able to remind them of the value of school enrollment. Here are other innovators supported by SRISTI:

- Harbhajan Singh, farmer from Haryana, lowered pest control and irrigation expenses by planting crops in alternate rows⁷³.
- Mr. Savalya improved the thermal efficiency of an iron cooking plate by substituting an aluminum hot plate with grooves and ridges on the bottom.
- Chandrakant V. Pathak from Pune made bullock carts safer by introducing a “flat belt brake system” to regulate the cart speed and stop the cart on downward slopes without injuring the bullock.

Gupta seeks to dispel the correlation between scale and sustainability, proposing that innovations vital in a particular community should not be disregarded for their lack of wide-scale applicability. He opposes both the viewpoint that the poor serve as beneficiaries of public assistance and Prahalad’s proposition that the poor are exclusively consumers of low-cost products manufactured by large corporations⁷⁴. Instead, Gupta advocates including the poor in the process of innovation transmission, building on their existing technical competencies and linking them with university students who offer engineering and consulting services and companies which help with funding, commercialization, and diffusion. The Honeybee Network in particular focuses on documenting innovations in a way that acknowledges and rewards the provider of knowledge, recognizing that inclusive innovation is an initial step to ending the knowledge asymmetry that maintains the current balance of powers.

Summary of Findings: *An Envisioned Future*

As demonstrated by the case studies of Narayana Health, Aravind, Embrace, GE, and the National Innovation Foundation, Indian innovation stems from many different sources: multinationals, grassroots communities, universities, and entrepreneurs skilled in a particular craft or industry. When examining the scalability and replicability of these innovations, the following can be observed:

1. The commonly cited cases of Aravind, NH, Jaipur Foot, and Mitticool are exceptions, not the rule, and are guided by exceptionally visionary founders.

Although these models can be scaled by the organizations themselves, they are difficult to replicate by people who do not share their vision. Although these types of innovations may bear commercialization potential, Aravind and NH are India's version of the Bill Gates, Steve Jobs or Mark Zuckerberg story and do not account for the many uncommercialized or unfunded innovations in the field.

2. Frugal innovation is more of a necessity in India than a revolutionary business strategy.

Since the Indian consumer has lower disposable income, any viable business must lower costs to a level that the consumer can afford. Although many businesses reduce their cost-to-performance ratio, the organizations that employ truly innovative operational models are, again, the exception.

As part of its SMART (Simple, Maintenance-friendly, Affordable, Reliable, and Timely-to-market) portfolio, Siemens adapted the Fetal Heart Monitor for the Indian market by substituting cost-effective microphone technology for ultrasound technology. Similarly, Biocon's Insugen brand for diabetics and Shantha's hepatitis vaccine are 40% cheaper than alternatives⁷⁵. Without these price adjustments, the companies would suffer a decline in sales that would render market entry in India unprofitable.

3. Emerging trends for innovation in India are in the tech industry, social sector, and on a more grassroots level

I see several distinct trends emerging in India: grassroots innovations identified by the NIF, which spread traditional knowledge among agricultural and tribal communities disconnected from other sources of information, socially driven innovations like Aravind and

NH that seek to provide all Indians with a basic level of services, and companies such as Redbus and Myntra that leverage technology to bring modern conveniences to India's growing middle class. Efforts to catalyze frugal innovation are often more effective when streamlined into a specific sector, because each subset of innovators has very different needs and resources. For example, innovators in the tech sector are more likely to be highly educated and looking to enter VC or accelerator programs, whereas grassroots innovators need commercial partners and community-based mentoring.

Prof. Anil Gupta offers specific recommendations for fostering grassroots innovations: increasing microventure finance funds, equipping communities with fabrication workshops that provide machinery and tools, rewarding innovators through competitions culminating in awards and community recognition, and linking formal and informal science and technology by establishing decentralized R & D facilities in impoverished regions. These policies are very different from those needed to accelerate tech entrepreneurs: increased enforcement of contracts, improved logistics and transportation networks, the creation of technology transfer offices and a patent management system, and support for increased broadband and credit card penetration.

Current State of Frugal and Copycat Innovation:

To understand the rise of frugal innovation, we must consider India's current stage of development. Since basic services are not available to the majority of the Indian population, particularly those in remote or rural locations, the lowest hanging fruit involves reducing service disparities through social innovation. As long as this inequality persists, it is possible to yield positive or break-even returns by targeting the BOP market.

Although India has experienced international expansion with IT service providers, such as Infosys, TCS, HCL, Cognizant, and Wipro, successful entrepreneurs targeting middle-class consumers are still largely applying basic business models that have worked in the US market, with adjustments for the Indian consumer (e.g. Flipkart is analogous to Amazon, Zoomcar to Zipcar, Makemytrip.com to Expedia, Snapdeal to eBay, etc.). It will take a long time for India to resolve its infrastructural and institutional barriers to innovation and transition to a lead market for tech innovation.

There is thus an interim period before tech innovation takes off, during which frugal innovation prevails as the leading business model.

As mentioned previously, frugal innovation is not only about products, but also about organizational design and human capital management. Here are a few examples of the process innovation in which India excels:

- **Innovation in pricing structure:** Proctor & Gamble started selling Pantene, a premium shampoo, in single-serve sachets to accommodate Indian customers who could not afford advance bulk purchases.
- **Innovation in technology integration:** Upon realizing that the auctioning system in government markets limited farmers' bargaining power, ITC started e-Choupal, an IT system that has allowed four million farmers in 40,000 villages across 10 Indian states to make decisions based on real-time data on market demand and prices, weather conditions, and scientific agricultural practices.
- **Innovation in marketing strategy:** Hindustan Lever Limited founded Project Shakti, which used a direct-to-consumer approach to gain market share by hiring rural villagers to sell hygiene products within their communities.
- **Innovation in service delivery:** VisionSpring partnered with American startup Warby Parker to deliver eyeglasses by operating a small number of optical shops with trained optometrists and deploying "Vision Entrepreneurs" into local communities to provide screenings and sell glasses, referring people with more severe eye problems to the central shop for treatment.

Truly innovative engineering requires not only the removal of unnecessary features, but also leverages technological progress and involves extensive remodeling. For example, the Tata Nano implemented "a new engine management system, lightweight steering shafts, and engine cooling module⁷⁶." Tata did not incorporate any components from previous car models. It drew on the input and expertise of a 500-person team and kept its base price low by simultaneously selling deluxe models with air conditioning, electric windows, and other upgraded features⁷⁷.

Tata also catalyzed the engineering ingenuity of partner suppliers, such as Rane Group and GKN Driveline India. These suppliers strived to innovate within their own core competencies of building the rack and pinion steering system and driveshaft, respectively, continuing to reiterate the design and bringing in external consultants to cut costs.

As demonstrated by the Tata Nano example and the healthcare case studies, every scalable frugal innovation requires the input somewhere along the value chain of resources that

are not frugal. For every success story of the rural farmer pioneering a radical invention like Mitticool, there are many more innovations produced by large multinational or highly specialized technology companies or individuals with exceptional human capital, in the form of raw ability, training, and connections.

Reaching a State of True Innovation:

Analyses of India's innovation potential commonly cite the barriers of bureaucracy and weak infrastructure.

In *Jugaad to Systematic Innovation: The Challenge for India*, Rishiksha T. Krishnan investigates why India has not experienced sustained industrial innovation despite its highly skilled labor force and *jugaad* culture⁷⁸. He proposes that India enhance the technological capacity of existing micro, small, and medium enterprises (MSMEs), promote innovation in large private companies that can serve as role models and strengthen entrepreneurial ecosystem networks (à la Silicon Valley), create a new incentive system for universities to compensate faculty according to research output and quality, continue the reform of public research organizations to retain talent and improve intellectual property management, and change the corporate culture. Although the *jugaad* mentality stems from the Indian culture, Krishnan writes that “barriers to innovation also have their origin in Indian society, such as poor teamwork, the enduring importance of upward hierarchical progression, a brahminical attitude that gives brainwork a superior position over physical work, a weak systems and strategic orientation, low tolerance for failure, a lack of confidence in innovation capabilities coupled with a failure to positively reinforce innovation efforts, and a strong need for control that comes in the way of joint working with other organizations⁷⁶.”

According to *India Inside: The Emerging Innovation Challenge to the West* and the 2013 Science, Technology, and Innovation Report, collaborating with international research centers and universities, investing in venture capital and private equity, and creating hubs for science-based entrepreneurship are other initial steps toward enhancing the existing ecosystem for innovation⁷⁹⁸⁰.

India's capacity as a lead market for frugal innovation will most likely continue unless government priorities shift substantially and other investments become more profitable. It is

probable that heavily engineered frugal innovations like GE's ECG will continue to provide a competitive advantage for India, as Indian customers are price-sensitive by nature.

As the entrepreneurial ecosystem strengthens, India will most likely follow in the direction of current VC funds and incubators that are supporting high-tech innovations, which compete not only in price leadership, but also on the product differentiation dimension. While innovations targeted at the lower-end segment will still need to reduce costs, growing consumer markets for Indian upper and middle class citizens and new export markets to developed countries will not suffer price constraints. Once India achieves a certain level of basic services, Indian tech entrepreneurs can focus on creating novel business ideas for global scale, while social entrepreneurs, supported by impact investing funds like Ashoka, Acumen Fund, Omidyar Network, Aavishkaar, and Elevar Equity, will bear a primary responsibility for addressing persisting social, environmental, and economic inequities.⁸¹

Short-Term Recommendations:

To bridge the gap between the current and future state, I would recommend:

- **Creating microventure funds for grassroots innovators**

The National Innovation Foundation encourages grassroots or underresourced entrepreneurs to partner with larger companies, but it is difficult to incentivize corporations to take on the risk of adopting an untested innovation. Microventure capital is an alternative to venture capital funds, which only invest in scalable, high-return projects, and banks, which charge high interest rates and normally require a credit history. Through microventure finance, corporations can also take a vested interest in selecting and growing the innovations in which they invest, just as private equity investors and venture capitalists typically serve as mentors to portfolio companies. Since the NIF's microventure fund has only yielded a 70% return on investment, it is still a largely social investment, but the success rate is expected to rise as resources for training and mentoring improve.⁸²

- **Encouraging students to pursue entrepreneurial paths**

Ann Koppuzha, JD candidate at UC Berkeley School of Law, has conducted extensive research on the role of culture on India's entrepreneurial environment. During a presentation at IIM-Bangalore, she explained that contrary to Americans, Indians do not have a fail-fast mentality. Family risk aversion prevents people from pursuing unstable career paths (80% of parents prefer

that their children work for established companies), and 40% of established companies do not want to undertake the risk of buying a startup⁸³. In order to shift this perspective, the Indian education system needs to foster imaginative thinking, liberal arts exploration, experiential learning, and empathetic design that brings students closer to societal problems.

- **Establishing more funds, accelerators, and incubators to support startup growth**

Many frugal innovations within India, such as SELCO, a social enterprise that produces solar lights for the poor, and Forus Health, a provider of ophthalmic digital imaging solutions, originate from the Indian startup ecosystem. According to the National Association of Software and Services Companies (NASSCOM), India is the fastest-growing startup market, with 3,100 startups as of 2014 and over 800 newly established each year⁸⁴. In the last five years, 70 venture capital and private equity funds have invested \$2 billion domestically, and 80 incubator and accelerator programs have emerged to offer seed funding, including programs run by tech giants like Google and Microsoft and IIT and IIM academic institutions. 60% of entrepreneurs surveyed in India expect to stay with their company in the long term, which contrasts favorably with the focus on profitable exits in the US⁸¹. The Indian government should continue to create attractive incentive programs and tax breaks for startups, so that the country can build up a critical mass of success stories to attract new entrants.

- **Rewarding creativity within larger corporations**

GE, Siemens, Unilever, Proctor and Gamble, Danone, and Nokia are among the multinationals that have successfully innovated for emerging markets within cost and design constraints. In order for other companies to follow in their lead, corporate leaders need to establish policies that facilitate brainstorming, reward interdisciplinary collaboration, and embrace failure. As an example of a leader in internal innovation, Google allows engineers to devote 20% of their time to projects outside of their core assignment, hosts tech talks and company-wide meetings during which anyone from an intern to a senior executive can pose questions or present ideas, and promotes open-office plans that allow employees to sit in different arrangements to mingle with new people.

Frugal Innovation Outside of India?

Christiansen and Raynor suggest that markets are suited to disruptive frugal innovation if customers would purchase a product with less (but sufficient) performance at a lower price point,

if segments of the market have been traditionally precluded from services, and if the product(s) in question simplify everyday tasks.

Many countries have developed names for *jugaad* innovation: *jeitinho* (Brazil), *zizhu changxin* (China), and *jua kali* (Kenya). Examples abound of foreign companies that have adopted a strategy of achieving more with less:

- In 1984, **Haier**, a home appliances company in China, pioneered the Mini Magical Child, a compact, highly efficient washing machine, which retails for less than 20% the cost of typical branded washing machines. Chinese customers embraced the Mini Magical Child for its ability to handle smaller loads⁸⁵. Haier also sold a wine cooler in the US at around half the price of the market leader at the time, capturing 60% market share⁸⁶.
- In 2004, **Renault** developed Logan, a sedan that requires half the number of parts of traditional Renault cars and sells for ~\$6000 USD. The engineers “designed symmetrical rear-view mirrors that could be used on either side of the car, a flatter-than-usual windshield to cut down on the cost and the possibility of defects, and a dashboard that could be produced out of a single injection-molded piece⁸⁷.” Originally targeted at the Middle East and Eastern Europe, the car also found a niche among Western European customers who were recovering from an economic crisis⁸⁷.
- In 2011, Filipino entrepreneur Illac Diaz started the **Liter of Light** project, which creates solar bottle bulbs out of recycled one-liter plastic bottles treated with bleach. Around one million homes in the Philippines use these bulbs, which cost less than \$2 USD.

Although India is the most commonly cited environment for frugal innovation, other emerging economies with service disparities and rising standards of living, such as Brazil and China, may also be viable hubs for low-cost, high-performance innovations. China is perhaps at an even further stage of development today, as it is transitioning from copycat models like the bazaar giant Alibaba and the Tencent messaging service to innovating in the fields of big data, cloud computing, and mobile apps⁸⁸.

Many countries in Africa and South America have not seen similar innovations emerge because of political corruption, civil unrest or poor knowledge transfer. Although invention is definitely occurring at a grassroots level in these countries, public institutions like the NIF and media organizations are necessary to identify, document, and publicize innovations.

In response to the initial questions, frugal innovation presents an incredible current and future opportunity for India because of the country's juxtaposition of high need and high growth; however, the innovations that scale globally are process and product innovations from environments with high intellectual or financial capital, not grassroots innovations that conform to the traditional definitions of jugaad and frugality. In order for these innovations to transfer to other environments, a central hub, like GE or Embrace, needs to enter foreign markets and work with local partners to introduce products or services, while adapting the design to conform to the new culture. As proven by LAICO at Aravind, providing open-source innovation or consulting services improves efficiency only when leaders in other ecosystems share in the social vision of the founding organization and are able to motivate their employees to do the same. India's rise as an economic superpower is unlikely to displace frugal innovation, but will see the emergence of new business models, particularly in the fields of disruptive technologies and social entrepreneurship.

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