

## Healthcare Innovation and Entrepreneurship: A Review of the Dynamics and Success Factors in Select Indian Cases

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### Introduction

The aspect of healthcare innovation facilitates to identify new or improved policy frameworks, systems, technologies, products, services or delivery methods that help to create improvement in person's health and well being (W.H.O).

Venkataraman ( 2000) proposed in his seminal work that the field of research in entrepreneurship relates to exploring how problem needs of people in society and field challenges are identified as opportunities, evaluated and implemented with commitment for useable and commercially viable future goods and services ( Shane et. al., 2000).

Now coming to the aspect of motivation for studying healthcare innovation and entrepreneurship, it is two folds. The first motivation is, that though major progress has been made to improve the lives of millions of people in the world, increasing life expectancy, reducing maternal and child mortality, tackling major communicable diseases, but in a developing economy like ours, we are still falling behind in taking care of the 2030 U.N. Sustainable Development Goals in healthcare. These goals pertain to tackling infectious diseases, non-communicable diseases, maternal and neo-natal/ child health, road accident injuries and health system cost and funding. The second aspect of academic motivation stems from the fact that Morel et. al., (2005) in his pioneering work, emphasized that there is great unmet need of health technologies to address the diseases of poor in developing countries. There is fast growing capability of health innovation in developing countries as evident from increasing patents and health research publications, more investments in health technology by public and private players, and more number of health technology

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companies. The innovation capability provides untapped opportunities to augment the entrepreneurial capacity for development of new products, services, inclusive policies and strategies for the disease of poor and to take on economic growth keeping in view of the national priorities. Clear & Nembhard (2017) found the creative ideas and innovation is positively associated with better patient care experiences and collaborative care coordination.

### **Objectives**

- Explore the literature, reports and news items for different factors and dimensions for available healthcare innovations and link them to healthcare entrepreneurs and try to understand the linkage and gap between the two.
- Conduct a review of select healthcare start-ups with product/ process innovations and entrepreneurship from literature, reports and news reports.
- Understand the strategies and dynamics of entrepreneurial ventures and the challenges they are facing and how they are leveraging the innovations to mitigate the challenges as opportunities for entrepreneurship to make quality healthcare products/ services accessible and affordable to the needs of the common masses in our country, the last-mile healthcare services in tier II and tier III small towns and deeper rural areas through use of technology.
- Analyze the success factors of the select Indian ventures and evaluate their outcomes.

### **Literature Review**

According to Global Burden of Disease Study (GBD) 2015 published in a well known medical journal Lancet, India ranks very low at 154 th position among 195 countries in the healthcare index , HAQ index (healthcare access and quality) with a score of 44.8 out of 100. The HAQ index is based on death rates due to 32 diseases that can be avoided or treated effectively with proper medical care and the progress made by each nation on its performance compared to that in benchmark year of 1990 (Bakshi, 2017; Ajaikumar, 2018).

This also highlights the greater requirement for a robust healthcare infrastructure, which is still elusive and distressing. The doctor-patient ratio in India is 1: 1,674. This implies that only one doctor is available for 1,674 people in India against the World Health Organization's norm of one doctor per thousand. (Ajaikumar, 2018).

The doctor to patient ratio becomes even lower as 1:60,000 when we move to rural areas in India. The number of oncologists is around 1500 for more than 1.3 billion population in India, whereas U.S has 20,000 oncologists for a smaller population. India has 0.7 hospital beds per 1000 people compared to global average of 2.9 beds. The nurses and mid wives for 1000 people is about 1.7, this ratio is again low given the large section of population they have to cater to. There is absence of

any central regulatory authority for healthcare services as most of the people do not have medical insurance. According to a CRISIL report, by 2026, India's population is going to be over 1.4 billion, and half of the population then would be 60 years old or older compared to the currently that being 40 percent. (Keerthana, 2017). Therefore, there would be greater demand for healthcare infrastructure including hospital beds, medical staff and nursing/ paramedical staff to name a few compared to the present supply of these resources.

An entrepreneur would approach this gap between healthcare infrastructure and requirement as an opportunity to make impact in society and economy, though the situation and figures may appear insurmountable. The innovation and entrepreneurship can unlock the hidden potential in the Indian Healthcare sector (Ajaikumar, 2018). The healthcare sector market revenue in India is expected to reach around USD 372 billion by 2022, driven by rising income, increased health awareness, increasing lifestyle diseases and more access to medical insurance. It has become one of India's largest sectors in terms of revenue and employment. The number of doctors increased to 1,154,686 in 2018 from 827,006 in 2010 (IBEF, 2020).

As **Morel et. al, (2005)** indicated that healthcare technologies have not yet adequately mitigated the unmet needs of health technologies to address the disease of the poor people in developing countries; but at the same time those countries, have shown rapidly growing capabilities for doing health innovation, named as Innovative Developing countries- IDCs including India, China, Brazil, South Africa, Thailand, Argentina, Malaysia, Mexico and Indonesia. The term health innovation may include new drugs, vaccines and diagnostics, new techniques in process engineering/ manufacturing, new design applications in leveraging digital space/ IT to address the healthcare delivery system for better doctor-patient interaction outcomes and new approaches/ policies for health systems and services.

The IDCs can develop, manufacture, ensure safety and market new health innovation products/ services. The growing strength in health innovation is demonstrated by increased patenting and published research works; more investment in innovation by both public and private sector companies; growing number of health technology companies and ability of health systems to evaluate and adopt new practices and technologies (Morel et. al., 2005). They can also introduce new health policies or strategies like Ayushman Bharat launched in India for the masses in September, 2018, the world's largest government funded healthcare scheme (IBEF, 2020).

**Mashelkar (2003)** had proposed a 2x2 matrix table to divide the different countries into four quadrants based along two axis from origin, Y-axis on relative economic strength (low to high) and the other X-axis on indigenous science & technology capacity (low to high). Morel et. al., (2005) used Mashelkar's vision into a quantitative framework into innovation rankings by measuring the number of patents granted in United States by each country (with at least one inventor from that country)

as a measure of innovative capacity correlated to relative economic strength of the country based on economic and demographic criteria. They defined a new indicator (number of patents normalized per GDP per capita for each country). These findings became the basis of development of the concept of Innovative Developing countries (IDCs) that highlighted the defining of new categories of countries into upper income, middle- upper income, middle income and lower income countries and their science and technology capacity relevance to health innovation.

**Vasconcellos et. al., (2018)** revisited the idea of IDCs , thirteen years later to investigate, that in healthcare, how important is research, development and innovation infrastructure built over the years by the IDCs is used to address the neglected areas of tropical diseases and for mobilizing resources to address specific epidemic situations like Ebola, Zika and now Corona virus outbreak in the world, including in India in 2019-20. India has made pioneering efforts in innovation and development of diagnostic kits and trial development of vaccines and drugs for Covid- 19 pandemic for large scale manufacturing in the interest of humanity and healthcare sustenance.

However, in a given study, authors Bradley et. al., ( 2012) have expressed the views that capital is necessary for firms but it is insufficient for business development, since discovery and creativity based views of innovations drives firms performance more competitively and thereby increases people's income in society through entrepreneurship, including that of poor people too. They conducted a survey among 201 small business owners in an African city of Nairobi in Kenya under microcredit programme and concluded that innovation was an important intervening variable for social, business and individual capital to augment the outcomes for business owners.

Since in this article we are discussing about innovation and entrepreneurship in select cases in small and medium enterprises (SME), innovation capacity is a major issue for their survival in the dynamic and competitive environment. It allows firms to develop and coordinate innovation process and uses innovative inputs to produce innovation outputs. (The construct of innovation capacity in SME context consists of the following dimensions: owner/manager characteristics, user/customer integration, network integration, innovation strategy and planning, culture and structure, innovation process management, learning process, institutional support, innovation-dedicated resources and processes revaluation. The innovation capacity is largely influenced by the owner or entrepreneur of the SME organization (Pierre, 2018).

The innovation process management, continuous improvement and learning process leads to organizational learning. In the context of healthcare organization the organizational learning helps to improve the quality of care while simultaneously help reduce the cost. It requires implementing best practices and improve collaborations across multiple entities of improving healthcare delivery, including patients. The organizational learning experiences help in overcoming challenges of how to work together in a radically different and new ways (Nembhard et al., 2018).

The implementation of creative ideas from the staff helps in great improvement of patient care experience. The healthcare professionals can be rich source of creative ideas. The creative ideas and strategies facilitates process improvement, patient management; provide holistic care and making changes stick by integrating patient centric innovation ideas into the organization (AHRQ, 201x).

Three forms of innovations are necessary to improve access to essential products and services including that in healthcare; technological solutions (new drugs, devices, applications , diagnostics and vaccines) that are most cost effective than existing interventions, and social and adaptive solutions (new process to organize human resources, information and decision making in health systems) to ensure distribution of goods and services involving both provider and communities (Gardner et al., 2007).

Entrepreneurship is important for developing countries because market matters where economic development involves change. The entrepreneur becomes the best agent for this change. There is a link between entrepreneurship and economic growth. With emerging recognition to entrepreneurs and the necessity of markets for the entrepreneur, policy makers in the countries are working to remove the barriers to entrepreneurship and facilitate them with positive externalities like knowledge, network and others issues (Zoltan et al., 2009).

In rural and hinterland areas of India, traditionally, the government has been the major provider and source of healthcare services for the poor, complimented by charitable trusts and NGOs. The private sector is mainly focused on providing healthcare services in the urban areas like Tier I and Tier II cities. However, recently, it has started to explore and address the large market potential in smaller towns with a population of around one lakh to expand into Tier III towns and beyond. The private players including entrepreneurs are developing innovations to address the challenges of health care inequities, improving healthcare access with quality care at affordable price.

With not so good health indicators, a globalized economy, government's willingness to work with private sector, as well as in public- private partnership, and considering poor as clients rather than only beneficiaries has led to emergence of inclusive business models (IBM) of healthcare in the Indian economy. These are enterprises which help to expand reach to goods, services to those at the rural areas in a commercially viable and scalable way at affordable price. These are both profit and not for profit organizations that have emerged in India, both in urban and rural areas (IFC, 2017).

In order to understand the dynamic challenges faced and strategies used by them, the inclusive business models are classified into following categories and sub-categories (IFC, 2017):

- Business to consumer (B2C) models that mainly serve end consumers or patients directly. This consist of (i) primary care delivery and outreach (located close to patients, front contact care providers, focusing on preventive care, health education and basic curative care) and (ii) secondary and tertiary care hospitals (hospital chains focusing on in-patient care in tier III towns, provide diagnostic tests and treatment, provide surgical care in multiple specialties in tier II cities and tier III towns at affordable price and innovative quality care process, deploying local qualified doctors and staff and provide for their further training).
- Business to business (B2B) models that supply institutions or organizations that further serve end consumers or patients. This consists of (i) standalone devices and consumables (frugal innovations and healthcare products, innovative low cost diagnostics and therapeutic devices not dependent on technology/ information networks or skilled caregivers or infrastructure and (ii) networked devices and technologies (they include technology enabled integrated medical devices to conduct diagnostics, even at remote locations like telemedicine and digital dispensary; use communication networks to provide extended patient care; information system, software and digital application solutions to hospitals, clinics and laboratory etc.).

### **Approach and Methodology**

The approach is mostly based on secondary data analysis and review of challenges, dynamics and success factors of innovation capacity (product, process or business innovation) of the entrepreneurial firms, thought process of the entrepreneurs gathered from published media interviews and news items for these cases; they, have been acknowledged in references from different reports, articles, news items, published in-depth interviews on various websites and links accessed.

The methodology of this paper for healthcare innovation and entrepreneurship for select entrepreneurial firms dwells on case study and qualitative critical incident techniques (CIT) and content analysis. The different critical incidents that led the founders to establish the start-ups and other incidents of importance that have helped to form their strategy , solved their challenges into innovative opportunities , the dynamics that guided their journey to success and continuous improvements through innovative ideas to solve unmet needs of consumers and patients at large, have been noted from published interviews. The contents from reports and published details have been extracted based on factors and dimensions understood from research publications and literature on innovations, entrepreneurship and small firms. Most of them adopt non-traditional operational and business models to reach last-mile healthcare services.

The guidelines for the factors and dimensions/ variables and their linkages for the select firms for study are drawn from literature review keeping in view of the proposed objectives. These factors are disease burden, health indicators, healthcare infrastructure gaps between demand and supply in terms of doctor to patient ratio, hospital beds to patient ratio, nurses to patient ratio, unmet needs of population, quality of healthcare, health technologies, creativity based innovations, innovation in healthcare process and products, healthcare innovations for affordable and accessible healthcare for tier II and tier III town population, rural areas, innovatively developing countries, innovation capacity, indicators for innovation capacity, economic strength, science and technology capacity, entrepreneurial mindset and characteristics, innovation in SMEs, resource allocation and capabilities in the firms for innovation, continuous improvements, investment in firms, technological and social innovations, business model innovations for inclusive business models, primary healthcare and delivery outreach, secondary and tertiary hospitals, standalone innovative devices and consumables, frugal innovations, networked devices and technologies, telemedicine, digital dispensary, mobile applications over communication networks and cloud computing.

### **Select Cases and Discussion**

#### **Primary Care Delivery and Outreach**

- **Arogya Parivar (Novartis)**

The Novartis, the pharmaceutical MNC started Aarogya Parivar (“Healthy Family” in Hindi) in 2007 as an innovative social venture for rural people in India with low income to make the healthcare accessible and affordable to them in even remote villages. The Health educators, usually women are recruited locally as ASHA workers who conduct health education program at grassroots level to raise awareness about diseases prevalent in rural India among adults from tuberculosis and diabetes to cold and pain and about maternal and child health too. The sales supervisors travel to remote local pharmacies in villages to make affordable generic and over the counter medicines available there. The product portfolio caters to over 100 types of medicines through over 16,000 local pharmacies. They also have tie up with volunteering doctors to conduct health camps. They also have collaboration with Tech Mahindra to provide doctor consultation and diagnosis through teleconferencing/ videoconferencing facility where a trained nurse at remote locations would upload the vital health parameters and symptoms and other reports for doctor located far away to diagnose and prescribe medicines that are available locally in small packs to keep them affordable for the daily wage earners.

It now covers villages in 10 states in India, having covered over area inhabited by over 70 million people. It is a commercially sustainable program as for profit program that counts as providing B2C inclusive business innovation model in healthcare delivery at primary care level and outreach to patients in rural areas. It also provides jobs, income and skill enhancements to local population through recruited health educators and health supervisors who work for the program.

- **Vaatsalya Healthcare**

About 70% of the population lives in rural India; yet only 15% of the doctors practice in rural India and only 20% of hospital beds are available in these areas. This demand supply gap for affordable quality healthcare and hospital treatment was filled by Vaatsalya Healthcare in 2004, co-founded by Ashwin Naik and Dr. Veerendra Hiremath with small savings and borrowed money from their friends and relatives at Bengaluru. As he had explained that it was an opportunity to learn at ground level to build up a socially responsible business. Vaatsalya is now one of the earliest and largest hospital and clinic network to enter India's rural and semi-urban areas with over 17 hospitals employing more than 1400 staff including nursing, paramedics staff and doctors serving in tier II and tier III towns across Karnataka and Andhra Pradesh, making primary healthcare available to over 400,000 patients as affordable medical treatment. It is a big challenge to recruit and retain talented doctors in remote and interior areas and co-founder Ashwin Naik motivates them by empowering them and offering challenging assignments to doctors, which they might not get in larger hospital chains.

Yet they still find it hard to retain medical professionals in far flung areas; they are addressing the high turnover rates by making plans for a training institute to train healthcare professionals. They have deployed innovative features in some of their remote clinics through telemedicine – videoconferencing for remote doctors to counsel at front clinic with nurse/ paramedic staff for diagnosis/ treatment and guidance for dialysis procedures. They provide diagnostic laboratory facilities also. Vaatsalya has also gone into medicine sales through its chains where margins are better than treatment. They have been able to raise funds through venture capital and private equity through strategic support by investors.

Their medical offerings are in four main areas; general medicine, general surgery, obstetrics and gynecology, and pediatrics uniform across each clinic/hospital. These four core areas meet the 70% of healthcare of the primary patients who typically earn between Rs.6000 to Rs. 20000 a month.

### **Secondary and Tertiary Care Hospitals**

- **Glocal Healthcare Systems**

On similar lines, Glocal Healthcare systems is spearheading acute care in small cities with a population of 1,00,000 through its chain of hospitals in more than 11 such cities. When a stroke or heart attack or road accident happens it is often fatal. Transporting a patient to a big city is mostly not practical and invariably too expensive. Therefore, acute care with emergency unit and ICU to save lives in case of above disease incidents became their focus areas; they have surgical and medical facilities in cardiology, neurosurgery, orthopedics, trauma, respiratory diseases and nephrology domains. People came to them when they were about to die and there was a large



demand for acute care services, when hospital had to deal with them to fix the problem and save lives. For common ailments in general medicines, pediatrics and gynecology, people prefer clinics and small nursing homes where they have old associations. But they have limitations of not able to provide such emergency oriented acute care service to patients. So Glocal Healthcare hospitals have more than 100 beds each, with large number of ICU beds, modern and well equipped machines, diagnostic facilities, pharmacy, medical staff and younger doctors; they have positioned themselves between secondary and tertiary care hospitals in small cities. The footfall is very good and business is sustainable along with providing affordable and effective healthcare in a critical domain to society where not many big hospital chains serve. The Government run hospitals for secondary care in far flung small town areas are mostly ill equipped in surgical cases, under staffed, overcrowded and inefficient, and thus ineffective in emergencies.

Dr Syed Sabahat Azim, Glocal's (which began as a social enterprise to provide basic care services at block level of 30,000 population) energetic CEO and founder, says that they have evolved into a multi specialty hospital as a provider of acute care services, where they have implemented an assembly line, process-driven, protocol-based healthcare system in delivering treatment. They believe medicine is a science and that it works. It does not hire top doctors and instead invests in an assembly line of skills of young upcoming doctors staying nearby and who can follow instructions and operating procedures. Dr. Azim explains and clarifies, "There are protocols for treating someone who has had a stroke or heart attack or been in a road accident and if you train people these protocols actually work. In acute care you are not actually bothered by why it happened but about fixing what is happening right now. You work backwards. There is a protocol for 0-2 minutes, 2-5 minutes and so on. It is very amenable to an assembly line because you have to respond quickly and by adhering to the protocol". This a great innovation they have done, where they have combined technical, social and business innovation to deal with large number of patient cases effectively and efficiently; they also run closed ICUs, in which once a patient is admitted the people inside the ICU have the responsibility and authority to do whatever is necessary. Over the past ten years, Glocal has built well-equipped hospitals and put medical teams in place at such unlikely destinations as Bhagalpur, Muzaffarpur, Behrampur, Begusarai, Amroha, Mednipur, Krishnagar and Jeypore. They are located in clusters on highways near those towns and small cities where doctors can travel and other resources and logistics can be shared and transported between the facilities easily. The geography forms an important part of their business strategy.

Glocal has also implemented digital dispensary for the primary healthcare part of its mission; it is a computerized unit at remote location, managed by a qualified nurse. It can perform 25 different tests with two drops of blood in 12 minutes; ECGs and ultrasound can be performed; the nurse can also use the electronic stethoscope

to generate the heartbeats and lings condition for the doctor to see at far away location through internet connectivity and tele-consultation/videoconferencing. The doctor can also see skin rash through a derma scope used by the nurse on the patient. The nurse feeds the data, tests report and the symptoms to the computer, which generates possible disease conditions from its database and that is shared with the doctor at far locations for advise. The doctor generates a prescription and it goes to the dispenser at the remote unit which issues the medicines in required doses for the rural patients. This is an important innovation for reaching affordable and inclusive healthcare to people in remote areas. It is an important strategy outreach for Glocal, since it links its hospitals in small cities to the rural people for the escalated cases to be dealt in hospitals. Glocal's digital dispensaries are attracting the attention of state governments. There are already 100 numbers in Rajasthan and Odisha is also in process for the implementation.

### **Standalone Devices and Consumables Embrace Innovations**

Embrace Innovations makes two versions of portable infant warmers that prevent hypothermia in premature and low-weight-newborn babies, at an affordable cost for the people in developing countries, as a substitute for infant incubator. The innovative product (stand alone medical device category) is composed of three components : an infant-sized sleeping bag or baby interface made of polymers, a pouch of phase change material (PCM), and a heater that operates on electricity. The pouch, once warmed by the heater and when placed into a compartment of the sleeping bag can maintain the temperature of 37°C as per WHO standard for 8 hours. The product was designed to complement skin-to-skin care of the mother to keep her warm and prevent hypothermia. During the design, it was kept in perspective about the infrastructure challenges of a developing country with unreliable power supply, limited skill of healthcare staff and the limited purchasing power. The infant warmer is priced at USD300 at 1% of the price of the traditional incubator. They tied up with the government and NGO in India to distribute free to the low income families and mothers in private clinics and rural hospitals.

One version of the product, Embrace Nest needs intermittent electricity for use in hospitals meant for transporting the baby in Neonatal ICU or in maternity wards. Embrace Care version works without electricity, periodically using hot water and it can be used by a healthcare worker or village mother. Co-founded in 2008 by four U.S based Stanford university graduate students (Jane Chen, Linus Liang, Naganand Murty and Rahul Panicker) where the challenge for them was to design a low cost infant incubator at extreme affordable price. Initially funded by seed fund from the university, later they got access to capital funds for scaling up. They moved to Bengaluru for more field observation before design in a developing country and

emerging market like India and the first clinical trials began in 2010. Their first product was launched in 2012 with ISO 13845 certification and meeting international regulatory standards. Along with product design, manufacturing and distribution, Embrace also began health education and awareness imparting training to mothers, families and healthcare workers on the impact of hypothermia and the use of infant warmers.

- **Axio Biosolutions**

Axiostat® is a sterile, non-absorbable haemostatic dressing made out of polymer microfiber (Chitosan medical sponges) derived from shrimp and crab shells. It is intended to control moderate to profuse bleeding within minutes of application by providing an active mechanical barrier to the wound site. It is an innovative product much better than other haemostatic agents/ granules, that is saving lives of Indian soldiers wounded in the frontline war on borders. It provides rapid blood coagulation in case of a traumatic injury caused through arterial bleeding. This Medical Tech start-up firm, Axio Biosolutions founded by a bioengineer Leo Mavley in Bengaluru has attracted huge investments by various Venture capitalists and Angel investors recently. It is the first Indian product approved by USFDA for wound dressing and it is also exported to more than 20 countries. It is in great demand and they have shipped more than 720,000 pieces so far. They have also setup Global Helpline Desk For Chronic Wound Patients and conducting training camps in India.

Leo Mavley, founder and CEO recalled that an accident stimulated him to create this life saving product. The wounds cause suffering, pain, long hospital stays, morbidity and even death. They started on the premise that most of these are preventable and demonstrated in solving this primal issue through innovative use of technology. It stops moderate to severe bleeding due to cuts, abrasions, lacerations, venous/arterial punctures, surgical bleeding and more. It is ready to use and they can be cut to suit different wound sizes; and it is also simple to apply ( by directly applying on bleeding area by palm pressure) and remove by even a non-medical first responder. It also stops bleeding faster than any available haemostat. It does not have any side effects such as viral transmission (associated with Gelatin, Collagen products) or exothermic reaction (association with Kaolin/Zeolite products).

Their other product, MaxioCel is a sterile, highly absorbent 100% chitosan microfiber dressing with pain relieving and scar improvement properties. It can be used for moderate to heavily exudating wounds of varied depths, shapes and sizes including pressure ulcers, leg ulcers, diabetic foot ulcers, malignant wounds, surgical wounds, first and second-degree burns and infected wounds. It demonstrates mild haemostatic properties and actively stimulates wound healing and also tends to hold antimicrobial properties, therefore providing complete ecosystem for advanced wound care management of wounds.

- **COVID-19 Diagnostics Test Kits**

The kit developed at Mylab Discovery is India's first corona virus testing kit indigenously designed in Pune by virologist Minal Bhosale, and her ten member team. It will cost Rs 1,200, much less the government kit. The company's co-founder Shrikant Patole said that test kits go through a lot of quality checks to improve the precision just like drug discovery. The team delivered the testing kit in a record time of six weeks by third week of March, 2020. The company has planned to ramp up the capacity at its plant in Lonavala to deliver one lakh kits a week. Other startups ventures in the country have also designed testing technologies and capabilities. These kits will also be available at a affordable cost of about Rs 900 to Rs 1,200 per patient. Some of these have also started manufacturing and scaling up.

Bengaluru based Molbio Diagnostics are manufacturing 20,000 tests per day capacity; they could increase to 50,000 per day. They have supplied to Goa, Andhra and Chattisgarh, as explained by Chandrasekhar Nair of Molbio Diagnostics. This point-of-care test can be deployed even in primary health centres. It comes equipped with its own machine that can test anywhere between 8 to 40 samples at a given point of time.

DNAXperts, based at Noida has also developed two types of test kits - the first one is similar to the currently used (RT-PCR) test kit- but the testing time is just 58 minutes as against the current 2 to 3 hours. The second one that does not require the RNA extraction part of every test process and takes about 2 hours can be bypassed. The first version was submitted to the Indian Council for Medical Research (ICMR) and the second version was submitted recently for final approvals.

Dr Ashwani Kumar Mishra, Founder, DNAXperts Pvt Ltd. confidently opined that once it is approved, the reduction in testing time will have a huge impact. It will also cost only about Rs 900.

### **Networked Devices and Technologies**

- **Remedo App**

Founded in 2017 by Harsh Bansal (Business development, marketing and e-commerce expert), Dr. Ruchir Mehra (consulting and healthcare expert) and Richeek Arya (Information technology expert, Silicon valley), Remedostarted out with a focus on solving for doctors, mostly by digitizing health records on online connectivity based mobile App..They followed the B2B approach for its service, where doctors' onboard patients to its cloud computing online networked mobile App based Care platform to stay in touch and guide the patients like those in pregnancy, suffering from diabetes, having cardiac problems or those having undergone orthopedic surgery. With the changing demographics, the patients now have more queries about what type of treatment they are getting, why they need to take certain medication etc. Particularly for the patients with chronic illness, it is very necessary to keep the patient

engaged and motivated for the better outcomes. The product apps facilitate doctor to ensure that the patient gets the right information, right solutions, right suggestions and thus better and more effective outcomes of the therapy. In case of Gynecologists and Pediatricians, we observe that doctor-patient interactions go through a lot of questions regarding the diet plan, exercise schedule, vaccination schedule and more. Harsh Bansal, Co-founder of Remedo, said, "Covid19 has brought a digital revolution that will transform the whole healthcare industry. We have introduced a platform for the Pharma companies for Remote consultancy so that they can support their doctors in such a time. The industry needs such digital solutions that focus on Healthcare Providers and Patients so as to improve the health quality of the nation".

The company, based at Noida, Uttar Pradesh made its steady and consistent beginning with a focus on women's health primarily with gynecologists and has now moved towards chronic conditions including diabetes, orthopedics and cardiology on the mobile App based Care platform. They are now present all over India with their tie ups with well known Pharma companies and their medical representatives spearheading their sale of digital products to the doctors. The benefits of using Remedo App, is that doctors' can see improved patient compliance on advice, brings them for follow-ups to the doctor as well. Therefore, as a result they do a lot of medical content development in consultation with doctors, dieticians and other health experts for patient education for the patient's condition, through the App, who can make educated decisions and judgments about what they want to do going forward.

The starting point for Remedo began with a vision to connect Healthcare - a problem that, no one is focusing on but when focused and resolved, it will impact billions of lives and make them better. It was started because of personal incidents that made Co-founders realize how disconnected healthcare was, how medical records are mismanaged, how poor treatment journey was for patients, and how patients are self-medicating themselves even in chronic conditions. To solve these problems 3 friends with a same vision come together and build Remedo

The various success factors and dynamics of facing the challenges to convert them into opportunities could be attributed to following online digital products and cloud based mobile Apps. It started with Remedo Practice – their cloud-based networked practice management software (for better data security and privacy) that helps doctors and clinics manage to digitize and make the practice more efficient. They found great acceptance and interest from doctors.

In 2019 Remedo Introduced, D.I.S.H.A- (Digital Integrated Smart Health Assistant) A smart health assistant that connects Doctors and Patients throughout their care journey to provide the special care via customized plans and follows a different approach to reach out the maximum doctors i.e., by going through pharmaceutical companies and joining the forces with them that help to bring doctors from their network onboard. After seeing the positive response of the doctors and how every doctor has

adopted the Remedo in their practice, Remedo also introduced its Integrated services with a vision to build Next Generation Digital Clinics which includes D.I.S.H.A, In-clinic Pharmacy, Diagnostics services & In Waiting Room engagement.

In 2020, Remedo Introduced Telemedicine based online product application; Remedo played a very active role even in the pandemic to help the doctors to engage with there patients via Telemedicine. Remedo as a company joined the forces with Giant Pharma companies to reach maximum doctors and acquire the market share. This result of 5x growth during the past month of Covid-19 spread. At present Remedo has reached all Tier 1, Tier 2, and Tier 3 cities and has impacted thousands of lives. Recently, the company has raised lot of funds from angel investors and venture capital firms. Dr. Ruchir Mehra, CEO of Remedo, said, "Coronavirus is a worldwide emergency and technology can play a very powerful part in helping the public to stay safe at home and get access to their doctors digitally. Reaching their doctors through online consultation is a great way to provide that".

- **MetroMedi**

The young CEO and founder, Maruthi Mediseti had explained that his company MetroMedi works on a simple model – patients share their prescriptions through WhatsApp and their staff then delivers the medication to them regularly. Their primary focus is to address the gap in the last-mile healthcare services in tier-two and tier-three cities where customers don't have multiple options like in metros; they should not be over loaded with technology at the front end itself; however, they aim to deliver health and wellness in these cities. They have developed relationships with the top three distributors of every city (as trusted partners to ward of counterfeit medicines) that we are operational in online retail pharmacy. They also make sure that their supply chain has branded medicines that are compliant with drug standards. It has been in the business of e-pharmacy for a decade and have added online health store to offer all kinds of health related devices and other products at best discounts in their e-commerce based website at the selected southern cities and nearby smaller towns of Telengana, Andhra Pradesh and Karnataka.

Since Covid- 19 pandemic, the organic demand has increased two-fold, with the majority of demand for FMCG products, hand sanitizers, masks and essential supplements. The chronic patients are now purchasing medication for 60-90 day cycles instead of 30-day cycles. During this crisis, JIT (Just-in-time) inventory is not working anymore in e-commerce model as earlier cases. The businesses that are JIT inventory system based are now forced to stock larger quantities of Stock Keeping Units (SKUs), thereby meaning that businesses will soon be facing challenges with capital. With the increase in demand, delivery timelines are stretched. With the current curfew by multiple state governments to contain the spread of the virus, fulfilling the deliveries is getting challenging. Therefore supply chain innovation and capital use has to be addressed with meticulous coordination and accountability.

They have two stores near Hyderabad; they are looking to build the first omnichannel health center cum store business focused on tier-two and tier-three cities. They plan to open a health store in every city where they have an online presence already. These health stores will be used to develop customer loyalty, educate customers and deliver more healthcare services like health check-ups through tele-consultation/ telemedicine, etc. The company has also partnered with SRL Diagnostics to offer diagnostics. Their goal is to become a one-stop solution for all healthcare and wellness needs.

They are launching their MetroMedi Doc app very soon, which is aimed at offering doctors' consultation to patients in tier-two and tier-three cities. The app will be in regional languages. This will happen over the next month. The doctors enlisted will speak the regional languages. In this way, they are not only catering to the educated or urban population but all segments of the population. They are planning to launch it via the platforms like TikTok, Twitter and Instagram by partnering with some celebrities who have a better reach to the population.

In India, people from the tier-three and tier-four cities have to travel at least on average 60 km to visit a specialist for a consultation. This becomes a challenge if one is working on daily wages because one ends up losing the wage for that day. The current primary healthcare centers do not do a great job in these cities, where every ailment is treated with some kind of antibiotics which also leads to another problem of unnecessary use of antibiotics and antibiotic resistance. So they want to address this situation by making available top doctors from the best hospitals from metros and tier-one cities for consultations via phone or video at half the costs they would otherwise incur. Their mission is to make healthcare accessible and affordable.

Since COVID-19 cases are being given the topmost priority, patients suffering from other ailments are scared to visit doctors in person and even if some are going, they are not being admitted or treated simply because there are resource constraints. The pandemic situation like this creates unique challenges to provide healthcare. Though telemedicine will not solve them all, it can be used in cases in which medical practitioners can evaluate and manage patients with chronic illnesses.

### **Conclusion**

We have discussed the different dimensions involved in healthcare innovations, innovation efforts of firms, health technologies and entrepreneurship in healthcare domain. We also understand that innovation capacity and orientation depends upon the owner of the firm and his resources available to the firm. Healthcare and medical treatment is an essential development goal every country needs to strive for its human population as per the U.N Sustainable Development Goals. It is also guided by the unmet needs among the different segments of population, particularly the common masses in Tier II and Tier III small towns, rural

areas and villages, so that quality healthcare is available at an affordable cost, apart from government run health services . These services are not sufficient and efficient. The healthcare services have evolved and increasingly become dependent on technological innovations to provide care services to large number of people efficiently at a lesser cost. The entrepreneurs have seized the gap in healthcare infrastructure as an opportunity to convert the challenges through feasible and innovative business models that provides sustainability at lower price to the end user and patients. The capacity and urge to improve process through creative ideas and innovative products and systems has facilitated that outcome. All the entrepreneurial ventures have attracted investor support for their large number of loyal customer base, revenue source model and innovative and ingenious operating models and business innovations apart from innovative products and process for healthcare service care. These firms have assured large customer life time values and earnings than their customer acquisition costs as the main success factor of their business model through technological, social and business process innovations.

We have seen that Arogya vParivar project (which is a corporate social responsibility of MNC pharmaceutical company, Novartis) and Vaatsalya Healthcare project are providing service based on direct primary healthcare and outreach model to the patients in the form of health awareness, health education, health checkups, common surgical interventions in terms of common ailments and chronic illnesses and deliver affordable generic medicines in larger quantities to the interior of small towns and villages in rural India. The number of patients covered in terms of volume of operation helps in maintaining revenue sustainability from low priced services as a part of their strategy and success factors. Arogya Parivar has won accolade and awards from various social organizations, and Vaatsalya healthcare has attracted equal attentions form venture capital firms.

Among the section of secondary and tertiary care hospital services. GLocal Healthcare systems chain of hospitals have smartly positioned themselves as a business strategy for acute care services with extensive Intensive Care Units beds in small towns where it is urgently required in cases of emergencies and absence of convenient travel facilities to big hospitals in nearby larger cities. All services are provided at very affordable rates. They have adopted innovative and carefully thought medical skills oriented assembly line process of dealing with large volume of surgical cases in acute cases and accidents as a measure of sustainable source of revenue. The skill set is based on young upcoming doctors and surgeons who are continuously updated and work as an empowered team with sharing of learning and medical skills among them. There is a cumulative learning effect outcome, and the mortality rate in their modern well equipped ICU units with many beds and more than 100 beds for recovery care, are very competitive as compared to world's best practices including that in USA and all over India. Their digital dispensary cum tele-consultation project



based on technology has been a very successful and sought after project for their outreach in interior villages to bring patients to their town hospitals in case of more serious cases. They have positioned their facilities, accessibility, capacity and rates in between secondary and tertiary care hospitals. The hospital chain has attracted large amounts in investor funds.

Among the standalone devices and consumables, the baby warmer for new born infants in place of incubators by Embrace Innovations is a very important, ingenious and frugal innovation that helps to save lives of many new born premature and under weight babies in towns and villages of under developed countries including India. It helps to prevent hypothermia in babies by substituting for skin-to-skin contact for babies by their mothers. It can work with simple components that are low cost, available and can be easily used in the extreme conditions of rural India and can be used by mothers and health workers who are not very skilled. It comes at a very low price compared to the incubator. It has two versions; one based on short period of electricity based heater that keeps it warm for 8 hours and another version based on hot water pouch to keep the polymer based sleeping bag warm. The firm has been supported by many investors.

The only USFDA approved wound dressing Axiostat and Maxiocel from Axio Biosolutions is a globally accepted product that has been designed in India by a bioengineer. It is an important innovation product based on chitosan, a microfiber derived from shrimps and shell fish. It helps in containing deep wounds to soldiers in war and patients during surgical interventions and thus is a life saving device/consumable at an affordable cost with a global quality mark. It is easy to use and manage in emergency and even by an untrained person, since the product composition has been designed accordingly for convenience and fast pain relief and stop bleeding. It is exported to 20 plus countries and they have shipped more than 720,000 units. Hence the sources of revenue have attracted many investor supports as in other cases too.

Remedo App and MetroMedi are significant examples of digital product innovation and applications as networked devices and technologies over communication networks and cloud based computing. The Remedo App platform combines doctor practice management, patient care and query handling system, patient education, telemedicine and tele-consultation under one roof for the doctor. They have a B2B approach wherein they charge the doctors and doctors in turn charge patients a marginal amount over their consultation fees for the extended assistance to patients over digital apps over mobile phones. They have made great strides in terms of large customer acquisition base of over 2000 doctors and tie-ups with big pharmaceutical companies to sell their app products along with formulation products as a combined solution to doctors with the active participation of their

medical representatives and distribution network. This is an important and innovative business strategy to minimize their customer acquisition cost of doctors. They are further planning to make inroads to tie up with diagnostic labs and pharmacies to provide more one roof comprehensive solution to doctors for their patients through their App products over mobile phone. This will help to enhance the practice of doctor for more diligent follow ups and compliance with doctor advice and prescription resulting in better health outcomes.

MetroMedi has combined their e-pharmacy model through whatsapp and e-commerce based website into a health center store for ordering various different products at a bigger discount. The simple technology model for buyers and users based on non-traditional operational model combines a well managed supply chain with trusted partners and stock keeping units for pharmacy and product distributors with lesser inventory costs, that is critical for this kind of operations. They are foraying into tele-consultations and telemedicine with their Medi doc mobile app based digital product in different regional languages with onboard specialist doctors from city hospitals who can speak the regional languages; this will uniquely facilitate greater access for medical treatment by patients from remote villages at an affordable cost.

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