MIS Quarterly

SPECIAL ISSUE: SERVICE INNOVATION IN THE DIGITAL AGE

BRIDGING THE SERVICE DIVIDE THROUGH DIGITALLY ENABLED SERVICE INNOVATIONS: EVIDENCE FROM INDIAN HEALTHCARE SERVICE PROVIDERS

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Appendix A

List of Acronyms

Acronym	Full Form
AECS	Aravind Eye Care Systems
AHF	Asia Heart Foundation
BOP	Bottom of the Pyramid
CIC	Community Information Center
ECG	Electrocardiogram
EMR	Electronic Medical Records
G-D	Goods Dominant
GIS	Geographical Information System
ICT	Information and Communication Technology
INR	Indian Rupees
ITU	Intensive Therapy Unit
KIDROP	Karnataka Internet Assisted Diagnosis of Retinopathy of Prematurity
MOH	Ministry of Health
NH	Narayana Hrudayalaya
NHAI	National Health Accounts of India
NICU	Neonatal Intensive Care Unit
NN	Narayana Nethralaya
PACS	Picture-Archiving Communication System
RetCam	Retina Camera
ROP	Retinopathy of Prematurity
S-D	Service Dominant
SMS	Short Message Service

Acronym	Full Form
TT-ECG	Trans-telephonic Electrocardiogram
TVC	Tripura Vision Center
UK	United Kingdom
USA	United States of America
VC	Vision Center
V-SAT	Very Small Aperture Terminal

Appendix B

Differences Between Goods- and Service-Centric Perspectives on the Digital Divide

	Goods-Centric Digital Divide (Traditional)	Service-Centric Digital Divide (New)
Definition	Haves and have-nots of digital goods and capabilities	Haves and have-nots of digitally enabled services
Focal actor	Provider of digital goods (producer-centric)	User of digitally enabled services (user-centric)
Bridging strategy	Divide is bridged by provision of digital goods and capabilities	Divide is bridged by providing access to digitally enabled services
Bridging resources	Digital goods and capabilities	Orchestration of digital and other resources for service provision
Role of agencies	Provision of digital goods and capabilities	Leveraging of digital and other resources to provide services

Appendix C

Research Interview Details (AECS and NN/NH)

Sl No.	Interviewees	Number of Interviews Face-to-face/Telephonic	Total Duration* (Hours)
Aravind Eye Care System (AECS)			
1	Executive Director	1/0	0.75
2	Senior Manager, Systems & IT	1/6	6.00
3	Senior Manager, Community Outreach	1/0	1.00
4	Project Manager, Vision Centres, Lions Aravind Institute of Community Ophthalmology (LAICO)	0/7	3.50
5	Vision Center (VC), Coordinator	1/0	0.50
	VC Technician	1/0	0.50
7	VC Field Staff	1/0	0.50
8	Patients	3/0	0.50
Narayana Hrudayalya (NH) and Narayana Nethralaya (NN)			
1	Chairman, NH Group	6/0	5.00
2	Vice Chairman, NN	2/0	1.00
3	Medical Superintendent, NN	2/0	1.00
4	Chief Administrative Officer, NH	2/2	3.00
5	COO(Marketing) & Administrator	1/0	1.00
6	Doctor Head of Department of Pediatric Retina, NN	2/6	3.50
7	Technician	1/0	0.50
8	Project Manager, Telemedicine	2/2	3.00
9	Chief Operating Officer, Peripheral Centers	2/1	1.50
10	Patients (at Mandya Government Hospital)	16/0	4.00
	Total	45/24	36.75

*Including telephonic interviews

Appendix D

Guidelines for Research Interview Protocol at AECS and NN/NH

1. What are the various innovative ways in which ICT is being used by your organization for serving the customers in a more efficient way?
2. Please give a brief description and technical details of these initiatives.
3. How has ICT been used by your organization for
   a. increasing service access and delivery to patients?
   b. decreasing cost of service delivery to the patients?
4. Please describe in detail the telemedicine/tele-ophthalmology initiative. How has this initiative grown over the years? What is the impact of this initiative on patients?
5. What were some of the key challenges experienced during the implementation of service innovations like the telemedicine initiative? How did you overcome them?
6. What role is ICT expected to play in future new service innovations for patients?

Appendix E

Site Visit Details

S No.	Site	Time spent	Facilities Seen / Observations
1	Aravind Eye Hospital, Madurai (part of AECS) • Lions Aravind Institute of Community Ophthalmology (LAICO) • Alanganallur Vision Care Center, Tamil Nadu	6 hours 2 hours	Observed ophthalmic technician performing slit lamp examination and refraction tests on 3 patients. Also observed consultation with the ophthalmologist at Aravind Eye Hospital, Madurai through WiFi video conferencing facility for diagnosis and prescription for medication and spectacles.
2	Narayana Nethralaya Postgraduate Institute of Ophthalmology – NN1 at Rajajinagar, Bangalore	3 hours	Observed a demo of the RetCam and patients being counseled by the ROP specialist
3	Narayana Nethralaya Postgraduate Institute of Ophthalmology – NN2 at Narayana Health City, Bangalore	1 hour	Meeting with COO (Marketing) and interactions with researchers at the Ocular Stem Cell Research Lab
4	Narayana Hrudayalaya	2 hours	Telemedicine Center including facilities for teleconferencing and managing the TT ECG network
5	Government Hospital, Mandya	4 hours	Screening of babies through RetCam

Appendix F

List of Secondary Data Sources

Aravind Eye Care System (AECS)

1. AECS Activity Report 2006-07, http://www.aravind.org/downloads/reports/annual_report_2006.pdf (last accessed: January 31, 2011).
2. AECS Activity Report 2007-08, http://www.aravind.org/annualreport08/displayreport.aspx (last accessed: January 31, 2011).
3. AECS Activity Report 2008-09, http://www.aravind.org/annualreport09/displayreport.aspx (last accessed: January 31, 2011).
4. AECS Activity Report 2009-10, http://www.aravind.org/downloads/reports/AnnualReport910.pdf (last accessed: January 31, 2011).
5. AECS Activity Report 2010-11, http://www.aravind.org/downloads/reports/AnnualReport2010_2011.pdf (last accessed: February 27, 2012).
6. AECS Activity Report 2011-12, http://www.aravind.org/downloads/reports/ActivityReport201112Final.pdf (last accessed: December 4, 2012).
7. Aravind Eye Care System (AECS), http://www.aravind.org/aboutus/index.asp (last accessed: January 31, 2011).
8. Aravind Tele-Ophthalmology, http://www.aravind.org/Telemedicine/index.htm (last accessed: January 31, 2011).
9. Kumar, N. and Rogers, B. 2003. "Aravind Eye Hospital 2000: Still in Service for Sight," Harvard Business School Case Study No. IMD098-PDF-ENG.
10. Rangan, V. K. 2009. "Aravind Eye Hospital, Madurai, India: In Service for Sight," Harvard Business School Publishing Case Study, Product No. 593098-PDF-ENG.
11. Vijayakumar, V. 2012."Primary Eye Care Services through IT enabled Vision Centres," *AECS Illumination* (12:2), pp. 12-15.
12. Video: *How Low Cost Eye Care Can Be World Class*, http://www.aravind.org/ted.html (last accessed: January 31, 2011).
13. Video: *Infinite Vision—Dr. Govindappa Venkataswamy*, http://www.aravind.org/ivision/homepage1000.htm (last accessed: January 31, 2011).
14. Miller, S. 2006. "McSurgery: A Man Who Saved 2.4 Million Eyes," *The Wall Street Journal Online*, August 5, p. A6.
15. Aravind.http://www.aravind.org/tribute/A%20Man%20Who%20Saved%202.4%20Million%20Eyes.pdf (last accessed: January 31, 2011).
16. YouTube video clips pertaining to AECS.

Narayana Hrudayalaya (NH)/Narayana Nethralaya (NN)

1. Anand, G. 2009. "The Henry Ford of Heart Surgery," *The Wall Street Journal*, November 21, http://www.narayanahospitals.com/images/Wall_Street%20Journal.pdf (last accessed: January 31, 2011).
2. Govindarajan, V. 2010. "A Telemedicine Innovation for the Poor That Should Open Eyes," *HBR Blogs*, November 9, http://blogs.hbr.org/govindarajan/2010/11/a-telemedicine-innovation-for-the-poor-that-should-open-eyes.html (last accessed: January 31, 2011).
3. Khanna, T., and Rangan V. K. 2006. "Narayana Hrudayalaya Heart Hospital: Cardiac Care for the Poor," Harvard Business School Case Study No. 505078-PDF-ENG.
4. Vinekar, A. 2011. "IT-Enabled Innovation to Prevent Infant Blindness in Rural India: The KIDROP Experience," *Journal of Indian Business Research* (3:2), pp. 98-101.
5. Narayana Hrudayalaya, http://www.narayanahospitals.com/
6. Narayana Nethralaya, http://www.narayananethralaya.org/
7. KIDROP, http://www.narayananethralaya.org/kidrop.html (last accessed: February 28, 2012).
8. Narayana Nethralaya: A Precious Gift to a Premature Child, http://www.narayananethralaya.org/pdf_files/iim_ahmedabad_ case_study_n_kidrop.pdf (last accessed: February 28, 2012).
9. YouTube video clips pertaining to Narayana Hrudayalaya.

Appendix G

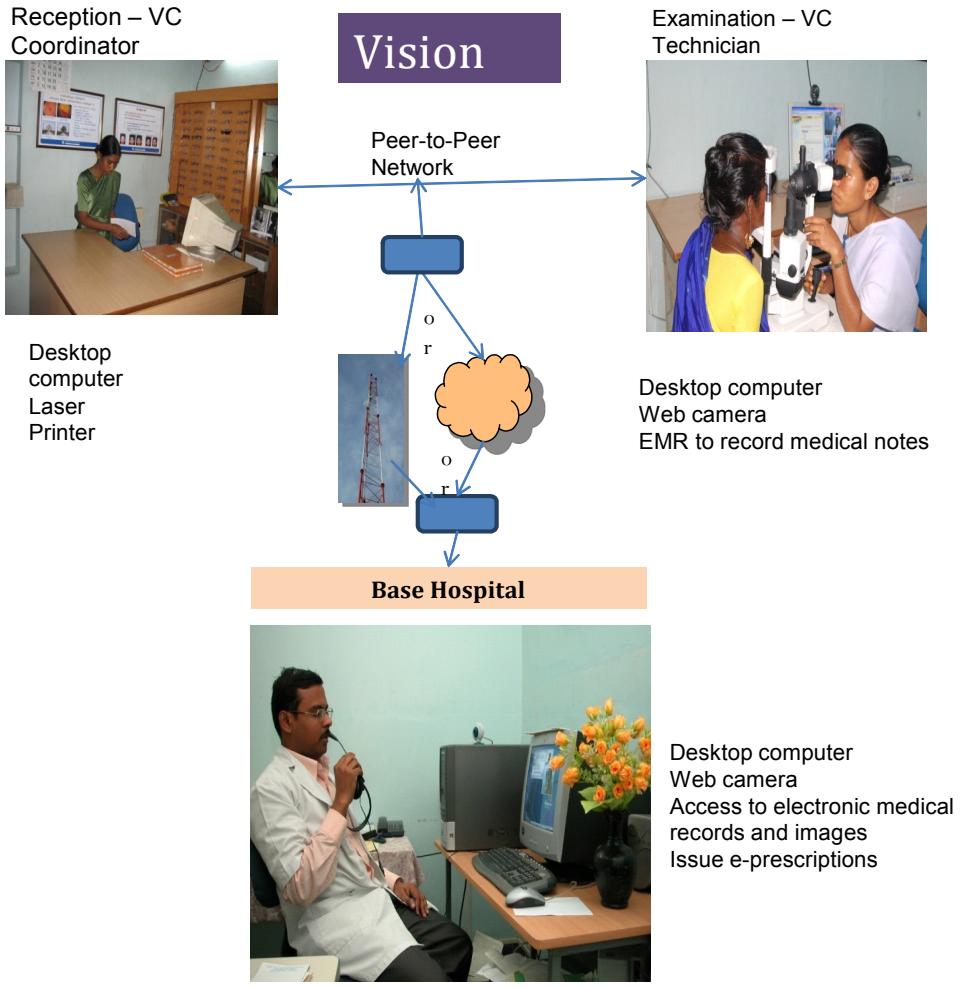
Free and Paying Beds in AECS

S No.	Location	Year of Commencement	No. of Beds		Total Beds	Percent Free Beds
			Free	Paying		
1	Madurai	1976	920	321	1241	74%
2	Theni	1985	123	40	163	75%
3	Thirunelveli	1988	480	150	630	76%
4	Coimbatore	1997	600	177	777	77%
5	Pondicherry	2003	465	137	602	77%
6	Dindigal	2010	-	-	10	-
7	Tirupur	2010	-	-	23	-
8	Salem	2011	-	-	50	-
		Total	2588	825	3496	74%

Based on data from AECS Activity Reports of 2009–10 and 2010–11.

Appendix H

Working of Vision Center and Tele-ophthalmology Consultation at AECS[redacted]



Pictures provided by AECS. Used with permission.

Appendix I

Estimated Cost Savings for Patients: AECS**

		Transport (INR)	Other Expenses (INR)	Lost Wages (INR)	Total (INR)
Scenario # 1	When the patient visits the base hospital				
Patient	1	25.00	50.00	100.00	175.00
Patient attendant	1	25.00	50.00	100.00	175.00
Total		50.00	100.00	200.00	**350.00**
Scenario # 2	**When the patient visits the vision center**				
Patient	1	10.00	20.00	50.00	80.00
Patient attendant	N/A				
Total		10.00	20.00	50.00	**80.00**
	Cost savings per patient = INR 270.00 (US$ 5.40)				
	Total savings for 143670* patients in 2009-2010 = INR 38.80 million (US $ 0.78 m)				

*90% of patients are treated at the vision care centers and do not need to travel to the base hospital.
US$ 1 = ~50 INR (Indian Rupees) in February 2012
**Based on data provided by AECS.

Appendix J

AECS Vision Center (VC): Estimated Investment

#	Item	2007 In INR	2011 In INR
1	Ophthalmic Equipment*	203,953	275,000
2	Other Clinical Equipment	11,264	11,500
3	Optical Grinding & Edging	15,000	19,000
4	Computer and Other Hardware (2 units)**	70,000	60,000
5	Digital Camera	15,000	12,000
6	VC Setup Cost: renovation, generator, furniture, publicity, boards, & incidental expenses	114,000	152,000
7	Information, Education and Counseling (IEC) Material	25,000	10,000
	Total (INR)	**435,217**	**539,500**
	Total (US$)	**8,704**	**10,790**

*Due to a 30% increase in the price for some of the ophthalmic equipment (e.g., slit lamp).
**Brand-new equipment provided to minimize chances of breakdown in remote locations where it is difficult to obtain maintenance services.
US $1 = ~ 50 INR (Indian Rupees) in February 2012.
Based on data provided by AECS.

Appendix K

Income and Expenses (April 2009–March 2010) Vision Centers Under Madurai Hospital, AECS

	Vision Centers	Net Income (INR)	Cost Recovery (Percentage)
1	Alanganallur	-104,010.00	92.28
2	Gandhigaram	218,676.00	115.81
3	Manamadurai	-43,783.00	92.04
4	Natham	-68,929.00	91.88
5	Rameshwaram	110,911.00	108.00
6	Sholavanthan	12,703.00	101.33
7	Tirupuvanam	-145,805.00	86.95
8	Usilampatti	49,305.00	111.07
9	Singampunari	-16,007.00	46.72
10	Sattur	-15,778.00	57.09
	Total	**-2,717.00**	**99.96**

Note: Net income is the difference between revenue and expenses. Cost recovery is the ratio of revenue to expenses. Singampunari and Sattur were set up in March 2010. As they were operational for less than a month during the financial year, the cost recovery of these VCs is comparatively lower.
1US$ = ~ 50 INR (Indian Rupees) in March 2010.
Based on data provided by AECS

Appendix L

Growth in Use of TT-ECG Over the Years: NH

Year	TT-ECG Centers	Cases Handled (Opinions)
2004	24	6185
2005	51	12855
2006	46	16310
2007	86	24651
2008	33	24272
2009	28	36386
2010	44	49454
Total	**312**	**170113**

Based on data provided by NN.

Appendix M

Sample Weekly Schedule for Visits to Rural Areas: NN

Day	District	Total Distance Traveled from NN Hospital Bangalore (km)
Monday	Mandya, Mysore, Chamrajnagar	320
Tuesday	Bangalore BBMP	50
Wednesday	Tumkur, Bangalore Rural	220
Wednesday	Hosur (Tamil Nadu)	80
Thursday	Kolar	152
Friday	Tumkur, Pavagada	141
Saturday	Bangalore Urban	68

Based on data provided by NN.

Appendix N

ROP Screening: Red and Green Cards Used at NN

Scanned picture of cards used by NN.

Appendix O

Estimated Cost Savings for ROP Screening Patients: NN* [redacted]

		Transport (INR)	Other Expenses (INR)	Lost Wages (INR)	Total (INR)
Scenario # 1	**When the patient visits the main hospital (Bangalore)**				
Patient + Mother	1+1	65.00	100.00	100.00	265.00
Attendant	1	65.00	100.00	200.00	365.00
Total		130.00	200.00	300.00	**630.00**
Scenario # 2	**When the patient visits the local Hospital (Mandya ~ 100 km from Bangalore)**				
Patient + Mother	1+1	10.00	0.00	50.00	60.00
Attendant	1	10.00	0.00	100.00	110.00
Total		20.00	0.00	150.00	**170.00**

Cost savings per patient per visit = INR 460.00 (~ US $ 9.2) .
US $1 = ~ 50 INR (Indian Rupees) in February 2012.
*Based on survey of patients' attendants.

Appendix P

Evolution of Vision Center Service Innovation Initiative and Value-Creating Mechanisms: Aravind Eye Care Systems (AECS)

Value-Creating Instance	Year/Month	Description of Value-Creating Mechanisms	Value-Creating Interactional Resources	Value Creation	Number of VCs	Stage of Evolution	Enablers for Value Creation
1	2000-2003	Utilization studies show that AECS eye camps (held once or twice a year at each location) reach out to only 7% of the potential patients who need eye care, so AECS begins to search for more permanent solutions for providing continuous access to eye care services in rural areas. Because doctors are located in urban areas, technology is seen as an option for connecting rural patients to urban doctors.	Knowledge improves geographical access	K→G	2	Idea	• Obsessive customer empathy • Continuous recursive learning
2	2003-2004	AECS partners with n-Logue Communications Ltd, Telecommunications and Computer Networks (TeNeT) Group, and Indian Institute of Technology, Madras, to provide low-cost, PC-based kiosks for access to eye care in rural areas.	Knowledge, technology, and institutions reduce cost	KTI→C		Idea	• Obsessive customer empathy • Belief in the transformational power of ICT
3	2004 Apr	AECS tests n-Logue-s network of wireless Internet kiosks in villages. The backbone of the network is based on corDECT, a point-to-multipoint radio frequency wireless local loop (WLL) technology that can provide 35 to 70 kbps simultaneous voice and data channels for subscribers within a 10 km radius of its broadcast location. AECS determined that the n-Logue kiosks would not work out, as eye care requires a more specialized setup than the basic PC and digital camera installed in the kiosks, as well as a trained technician.	Knowledge, technology, and institutions reduce cost	KTI→C		Launch 1 - Failed	• Obsessive customer empathy • Belief in the transformattional power of ICT
4	2004	Two vision care centers (Vcs) are set up at Ambasamudram and Andipetti, both connected to Aravind Eye Hospital. WiFi-802.11 B, developed by the University of California, Berkeley, is used for wireless transfer of images, and two-way audio-video communication is used for consultation between the patient in the rural VC and the doctor in one of Aravind's urban eye hospitals. Thi saves patients the cost of commuting to the city and prevents loss of wages/earnings of patient/attendant incurred by travel to the city.	Knowledge, technology, and institutions reduce cost	KTI→C		Launch 2	• Continuous recursive learning
5	2004	A geographical information system (GIS) is used to identify VC locations that can serve rural populations of approximately 50 to 60 thousand spread over 5 or 6 villages within a radius of 5 to 10 km of the VC, thus saving commuting time and associated patient costs.	Technology reduces cost	T→C		Infancy	• Belief in the transformational power of ICT
6	2004	Fieldworkers conduct door-to-door campaigns to create awareness about eye care and ailments such as diabetic retinopathy, glaucoma, and cataracts, and also to provide vision tests. The awareness facilitates early detection of potential ailments and saves costs for patients and society. The patient consultation is available at a nominal cost of INR 20 (~ US 4¢).	Knowledge reduces cost	K→C		Infancy	• Obsessive customer empathy
7	2004	An initial screening by the VC technicians saves time for the doctor in the hospital who can also consult with more patients in the seven to nine Vcs telelinked to the hospital. An awareness program facilitates early detection of potential ailments and saves costs for patients and society.	Knowledge reduces cost	K→C		Infancy	• Obsessive customer empathy
8	2004	AECS forms partnerships with educational and other institutions: local schools and colleges, University of California, Berkeley, nongovernment organizations (NGOs), local businessmen, World Health Organization (WHO), Lions Club, etc., who complement AECS's efforts to provide free or subsidized treatment to the majority of its patients.	Institutions reduce cost	I→C		Infancy	• Efficient network orchestration

Value-Creating Instance	Year/Month	Description of Value-Creating Mechanisms	Value-Creating Interactional Resources	Value Creation	Number of VCs	Stage of Evolution	Enablers for Value Creation
9	2004	VC staff help develop strong linkages with the local rural community, schools, colleges, and *panchayats* (local governments). People trust the service provided by VC staff, who are usually locals. More patients begin visiting the VC for ailments and problems they would have ignored earlier. This leads to a change in the local population's health-seeking behavior. Now patients expect and are willing to pay a nominal amount for consultation compared to the free treatment provided at the eye camps. The increase in patient visits helps increase each VC's revenues, and most Vcs are able to cover their operational costs in the first year.	Knowledge and institutions reduce costs	KI→C		Infancy	• Efficient network orchestration
10	2004	Technicians who have been trained at AECS for at least two years conduct refraction tests, examine patients using the slit lamp, screen patients, prepare reports, and describe conditions to the doctor at Aravind Hospital. The doctor accesses records, diagnoses patients after seeing the VC reports, and recommends treatment (e.g., prescribes medicine or glasses). Thus, the trained technicians replace the more expensive and scarce expertise of the ophthalmologist in the initial stages of consultation and screening.	Knowledge and technology reduce cost	KT→C		Infancy	• Continuous recursive learning
11	2004	The locations of Vcs are chosen to serve rural populations of approximately 50,000 to 60,000 within a travel radius of 5 to 10 km. Only approximately 10% of the patients who visit VCs need to travel to the base hospital for further treatment. This saves travel and associated costs for the remaining 90% of the patients and their attendants.	Improved geographical access reduces cost	G→C		Infancy	• Obsessive customer empathy
12	2004	All technologies for tele-ophthalmology—WiFi, broadband, very small aperture terminals (V-SAT), mobile refraction units—are partnerships with community organizations, NGOs, local businessmen, schools, colleges, and local government make the service available to underserved rural populations.	Technology and institutions improve geographical access	TI→G		Infancy	• Efficient network orchestration
13	2004	The VC employees, including the coordinators, technicians, and fieldworkers, are usually locals and well connected to the community through their role in the VC. Their credibility and personal relationships help persuade many patients who need follow-up treatment at the hospital to make the trip.	Knowledge and institutions improve geographical access	KI→G		Infancy	• Obsessive customer empathy
14	2005	An SMS service reminds patients about medication review visits and sends eye care awareness messages, thereby reducing the costs of monitoring/follow-up and patient attrition.	Technology reduces cost	T→C		Infancy	• Belief in the transformational power of ICT
15	2005	Awareness programs in the villages and door-to-door visits by the fieldworker have improved health-seeking behavior in the community.	Knowledge improves geographical access	K→G	1	Infancy	• Obsessive customer empathy
16	2005	Permanent VC setup in rural areas enables the prevention and continuous monitoring of ailments such as glaucoma and diabetic retinopathy (DR) and the rehabilitation of low-vision patients through periodic check-ups every six months. The VC coordinator and staff provide individualized attention to patients using electronic medical records (EMRs) and transmit reminders about medication and follow-up meetings through SMS, mobile phones, and even personal visits. Health outcomes are improved in the communities served by Vcs, where prevention is the focus. Glaucoma and DR patients can be treated with simple medication on a regular basis, without needing to travel to the hospital in the city.	Knowledge and technology improve geographical access	KT→G		Infancy	• Obsessive customer empathy
17	2006	A digital camera based system developed in-house to replace the expensive fundus camera facilities transferring images from the VC to the base hospital.	Technology reduces cost	T→C	2	Infancy	• Belief in the transformational power of ICT

Value-Creating Instance	Year/Month	Description of Value-Creating Mechanisms	Value-Creating Interactional Resources	Value Creation	Number of VCs	Stage of Evolution	Enablers for Value Creation
18	2006	Special training programs enable school teachers to detect refractive errors (a major cause of vision impairment in India) in children. A mobile refraction unit and Vcs facilitate refraction services.	Knowledge, technology, and institutions improve geographical access	KTI→G	Total: 5 in Tamil Nadu (TN)	Infancy	• Obsessive customer empathy
19	2007 Apr	AECS partners with the government of Tripura and India to initiate the Tripura Vision Center (TVC), a tele-opthamology project aimed at providing quality eye care for rural populations. AECS has trasined paramedical ophthalmic assistants in all Vcs in the state. Vcs are set up on the premises of community information centers (CICs) under the National e-Government Plan (NeGP). These leverage the existing infrastructure at the CICs and the Tripura State Wide Area Network (TSWAN) connectivity to locals who visit CICs for a host of citizen-centric services. Planning commences for a total of 40 Vcs in Tripura by 2012, one in each block of the state.	Knowledge, technology, and institutions improve geographical access	KTI→G	Total: 5 (TN) + 15 (Tripura)	Early Growth	• Continuous recursive learning • Efficient network orchestration
20	2007 Jul	Broaband replaces WiFi, which has a range of 60 kms and requires that antennas be in the line of sight. The new broadband technology increases geographical access to specialist doctors, with VCs being set up as far as 90 kms from the base hospitals.	Technology improves geographical access	T→G	New: 10 (TN)	Early Growth	• Continuous recursive learning
21	2007	AECS partners with Marratech to customize its Manager edition software for teleconsultation based on H.263 audio and video standards for smooth transmission of audio and video data along with case sheets and images. A hub-and-spoke model enables all Vcs to interact with the ophthalmologist at the base hospital, thereby increasing geographical access.	Technology and institutions improve geographical access	TI→G		Early Growth	• Continuous recursive learning • Efficient network orchestration
22	2007-2008	Broadband connectivity facilitates wireless image transfer and two-way audio-video communication for consultation between the patient in the VC in the village and the doctor in one of the Aravind Eye Hospitals in the city.	Technology reduces cost	T→C	New: 23 (TN)	Early Growth	• Belief in the transformational power of IT
23	2007-2008	The introduction of low-cost broadband services helps accelerate the growth of VCs by reducing the capital expenditure associated with setting up WiFi towers. The largest annual number of new VCs (13) appeared in 2008, when Bharat Sanchar Nigam Limited (BSNL) introduced broadband in rural areas, increasing the total number of VCs to 28.	Technology reduces cost	T→C	Total: 28 (TN) + 15 (Tripura)	Early Growth	• Belief in the transformational power of ICT
24	2009	After the rapid expansion, AECS's project team turns to stabilizing the 28 VCs. Processes are standardized through documentation, and in-house IT development produces MIS systems for managing and monitoring the VCs, thus enhancing the reach of AECS services.	Knowledge and technology improve geographical access	KT→G	New: 1; Total: 29 (TN)	Late Growth	• Continuous recursive learning • Belief in the transformational power of ICT

Value-Creating Instance	Year/Month	Description of Value-Creating Mechanisms	Value-Creating Interactional Resources	Value Creation	Number of VCs	Stage of Evolution	Enablers for Value Creation
25	2010-2011	Information in the EMR system is used for planning and improving patient care, thus reducing service delivery costs for patients.	Knowledge and technology reduce cost	KT→C	New: 11 (TN) + 25 (Tripura)	Late Growth	• Continuous recursive learning
26	2010-2011	AECS partners with Forus Health to develop the 3Nthre, a low-cost fundus camera used as an intelligent prescreening ophthalmology device to automatically identify symptoms of common eye disease and generate printed reports.	Technology and institutions reduce cost	TI→C		Late Growth	• Continuous recursive learning
27	2011	AECS launches "Aurosiksha," a web-based hybrid learning platform with built-in pedagogical methods that promote effective adult learning and make time-tested lessons available to individuals and teachers to boost the development of high-quality human eye care resources, especially in areas with a dearth of quality training options, such as the remote rural areas where VCs are situated.	Knowledge and technology improve geographical access	KT→C		Late Growth	• Continuous recursive learning
28	2011	AECS partners with Forus Health, Bangalore, for image technology to reduce costs.	Technology and institutions reduce cost	TI→C		Late Growth	• Continuous recursive learning
29	2012 Aug	The AECS-supported Tripura Vision Centre (TVC) in the northeastern state of Tripura has 40 operational VCs. Tripura's VCs have treated 128,000 patients between April 2007 and July 2011.	Knowledge, technology, and institutions improve geographical access	KTI→G	Total: 40 (TN) + 40 (Tripura)	Late Growth	• Efficient network orchestration

Appendix Q

Evolution of ROP RetCam Service Innovation Initiative and Value-Creating Mechanisms: Narayana Nethralaya (NN)

Value-Creating Instance	Year/Month	Description of Value-Creating Mechanisms	Value-Creating Interactional Resources	Value Creation	Number of Partner Participants	Stage of Evolution	Enablers for Value Creation
1	2007 Feb-Sep	The project is conceived by Dr. Anand Vinekar (AV) during a fellowship at Royal Oak (Michigan, USA), where he observes the use of wide-field digital imaging in the ROP RetCam. Dr. AV joins NN and proposes the idea of outreach by transporting a RetCam Shuttle to many centers.	Knowledge improves geographical access	K→G		Idea	• Obsessive customer empathy • Belief in the transformational power of ICT
2	2007 Feb-Sep	Peripherally located ophthalmologists are trained, and talks/seminars with pediatricians and gynecologists at the National Neonatology Foundation (NNF) and pediatric societies help disseminate awareness and knowledge to health care providers in rural areas, thereby improving geographical access.	Knowledge and institutions improve geographical access	KI→G		Idea	• Efficient network orchestration
3	2007 Sep-Dec	Peripherally located ophthalmologists are trained to upgrade their skills for appropriate screening and treatment of ROP. Discussions are held with peripherally located pediatricians, neonatologists, and gynecologists who can counsel mothers and family members about ROP screening. This reduces time spent by the ROP specialist, thus reducing cost.	Knowledge and institutions reduce cost	KI→C		Idea	• Efficient network orchestration
4	2008 Jan	The first RetCam Shuttle is acquired and begins a 3-month use at NN. A project manager is appointed.	Knowledge and institutions reduce cost	T→G		Launch	• Obsessive customer empathy • Belief in the transformational power of ICT
5	2009 Jan-Mar	The first 1,007 infants are examined by the ROP expert using the "gold standard" of binocular indirect ophthalmoscopy (IDO), and the findings are recorded, masked, and compared with the findings of technicians who have been trained to identify cases requiring a doctor's attention. This comparison validates the technicians' case identifications. After validation, the technicians independently screen and record images that are uploaded for the remote expert's viewing and opinion. The decision to carry out treatment (whenever required) is then based on the ROP expert's findings. This reduces time spent by the ROPspecialist, thus reducing cost.	Knowledge and technology reduce cost	KT→C		Infancy	• Continuous recursive learning
6	2008	The KIDROP team transports the RetCam Shuttle to neonatal centers in rural and semi-urban hospitals for daily screening. Most hospitals cannot afford the RetCam Shuttle, which costs approximately US $110,000. Transportation of a single RetCam Shuttle unit to several neonatal centers within one zone increases the utilization of this capital-intensive equipment, thus reducing cost.	Technology reduces cost	T→C		Infancy	• Obsessive customer empathy • Belief in the transformational power of ICT
7	2008 Apr	The RetCam Shuttle is taken to neonatal ICUs (NICUs) at partner hospitals for screenings and images are sent to the base hospital as e-mail attachments. The number of patients is initially small and can therefore be manage in this way. This saves travel costs and potentially lost earnings for the patient's family.	Technology and institutions reduce cost	TI→C		Infancy	• Belief in the transformational power of ICT • Efficient network orchestration
8	2008 Apr	Nurses give red cards to mothers who should bring their infants to partner hospital centers for screening, and they maintain a "Red ROP" register. Outreach begins in six hospitals, initially medical college hospitals and government hospitals, and is later extended to private hospitals. A major benefit of the proximity that partner hospitals provide for patients is a reduction in follow-up attrition and hence a reduced risk of blindness, while saving the patient travel costs and potentially lost earnings.	Technology and institutions reduce cost	TI→C		Infancy	• Efficient network orchestration

Value-Creating Instance	Year/Month	Description of Value-Creating Mechanisms	Value-Creating Interactional Resources	Value Creation	Number of Partner Participants	Stage of Evolution	Enablers for Value Creation
9	2008 Apr	Mobile phones are used to send SMS reminders and to call mothers the day before their infant's scheduled visit at the NICU for follow-up by the KIDROP team. This saves costs for the patients and reduces follow-up attrition.	Technology and institutions reduce cost	TI→C	6	Infancy	• Continuous recursive learning
10	2008 Apr	NN partners with i2i Telesolutions to develop an Internet-based picture-archiving communication system (PACS). Development begins by using an existing PACS as the platform for tele-PACS where multiple specialists simultaneously view and report on a single-image system. The older PACS used e-mail attachments, which was slow and did not solve security or storage issues. The tele-PACS saves the ROP specialists time, resulting in cost savings for the patient.	Knowledge technology and institutions reduce cost	KTI→C		Infancy	• Efficient network orchestration • Belief in the transformational power of ICT
11	2008 Apr	The project manager transfers images in bmp and jpeg formats from the RetCam laptop to another laptop and then simultaneously uploads them to a specially hosted server via a broadband data card. This improves patients' geographical access to services.	Technology improves geographical access	T→G		Infancy	• Belief in the transformational power of ICT
12	2008	Travel time and costs, along with lost wages due to the travel, are reduced when the screenings are conducted at hospitals closer to home. Also, increased geographical access improves the RetCam utilization, thereby reducing cost.	Improved geographical access reduces cost	G→C		Infancy	• Obsessive customer empathy
13	2008 Apr	Nurses at the NICUs are trained to maintain ROP registers with details about infants (e.g., birth weight) and their parents' mobile contact numbers, and to give red or green ROP cards to the parents. Red ROP cards signify at-risk babies and are given to the parents of premature and underweight (< 2 kg birth weight) infants. Others receive green cards (to indicate that no ROP follow-up is needed). This simple mode of screening reduces costs.	Knowledge and institutions reduce cost	KI→C		Infancy	• Efficient network orchestration
14	2008	A technician who has been extensively trained through in-house and on-site sessions replaces the ROP expert in screening infants for ROP and uploading images. The technician analyzes the images using a three-response triage format: RED, ORANGE, GREEN. The cost of the ROP specialist is reduced by this initial screening of noncritical cases.	Knowledge, technology, and institutions reduce cost	KTI→C		Infancy	• Continuous recursive learning
15	2008 Apr-Dec	Training of peripherally located ophthalmologists and discussions with pediatricians, neonatologists, and gynecologists continue, with a focus on the latter two groups to reach out to more patients.	Knowledge and institutions improve geographical access	K→G	Total: 13	Infancy	• Efficient network orchestration
16	2008 Dec	NN partners with i2i Telesolutions to develop a system that enables images to be uploaded using mobile connections to a customized Tele-PACSserver and then read in real time by remote experts (doctors) on their PCs, iPhones, and iPads. Doctors then transmit their reports to the secure data server, complete with a digital signature, using a cell phone or a PC, and these are accessed by the technician in the rural hospitals before a child is handed over to the mother. This saves the infant's parents another trip to the partner hospital for the report, thus improving geographical access. KIDROP team experts and locally trained ophthalmologists also provide treatment at the rural center.	Technology and institutions improve geographical access	TI→G	New: 6; Total: 19	Early Growth	• Efficient network orchestration • Belief in the transformational power of ICT
17	2009 Jan-Jun	Mobile phone reminders personalized reports, progress cards (yellow ROP cards), phone calls sharing the baby's daily systemic report with the mother, and meticulous data collection improve mothers' follow-up rates and treatment outcomes.	Knowledge and technology improve geographical access	KT→C		Early Growth	• Obsessive customer empathy • Continuous recursive learning
18	2009 Jan-Jun	Another six hospitals join the network, for a total of 19 in the South Zone of Karnataka State. The increased patient volume and equipment utilization further reduce cost.	Institutions reduce cost	I→C		Early Growth	• Efficient network orchestration

Value-Creating Instance	Year/Month	Description of Value-Creating Mechanisms	Value-Creating Interactional Resources	Value Creation	Number of Partner Participants	Stage of Evolution	Enablers for Value Creation
19	2009 Sep	KDIDROP enters into a public-private partnership with the National Rural Health Mission (NRHM) in Karnataka's Ministry of Health and Family Welfare, expanding the project to include 12 additional districts and 36 additional neonatal care centers. All treatment under this initiative is provided free of charge at government and private centers. KIDROP will provide free training to ophthalmologists and ophthalmic technicians in the 12 districts and become operational in January 2011. Under this INR 23 million (~ US $500,000) initiative, NN will contribute free training, image reading, and treatment, and the government will provide for the equipment, its maintenance, and team salaries.	Institutions reduce cost	I→C	Total: 19	Late Growth	• Efficient network orchestration
20	2009 Nov	An Apple iPhone application released by i2i with a complete Tele-ROP solution enables live reading and reporting. The ROP specialist does not have to travel to remote locations but can read the images in real time for diagnosis and reporting. This saves the ROP specialist's time, thereby saving costs for the patient.	Knowledge and technology reduce cost	KT→G		Late Growth	• Belief in the transformational power of ICT
21	2009 Nov	The iPhone application allows images to be viewed similarly to how they were viewed on the PC and even allows comparisons with previous visits. The expert can record findings and create a report using a customized template that is submitted to the server using the GPRS cellular network. This reduces dependence on the variable speeds of the Internet and allows the expert to view and report "on the go," thereby improving geographical access to the expert.	Technology improves geographical access	T→G		Late Growth	• Belief in the transformational power of ICT
22	2010 Feb	3G mobile services offered by BSNL at low costs enhance the speed of image transfers both from and to the rural centers. This allows KIDROP to screen more than 3,500 infants in over 20 neonatal care centers spread across six districts of Karnataka, covering a radius upward of 150 km. More than 400 infants receive laser and other treatments in rural centers, without having to travel to Bangalore. 68% of the patients receive free treatment (at government hospitals) and an additional 15% receive treatment at a subsidized rate (at hospitals run by religious trusts), while patients at private hospitals are charged INR 200 (US $4). Fees collected from those who can afford to pay help cover operational costs, allowing the program to break even. On an average, approximately 550 screenings are conducted each month. Thus, KIDROP leverages technology innovatively in partnership with several institutions to provide quality eye care at low cost to vulnerable rural infants.	Technology and institutions reduce cost	TI→C	New: 5; Total: 24	Late Growth	• Efficient network orchestration • Belief in the transformational power of ICT
23	2010 Oct	NN partners with medical colleges, government hospitals, and private hospitals, utilizing their medical personnel and facilities such as NICUs and screening rooms to reduce operational costs. KIDROP, which had started in April 2008 with 6 partner centers, has now expanded to include 24 partner hospitals in South Karnataka. The increased patient volumes further decrease costs.	Institutions reduce cost	I→C		Late Growth	• Efficient network orchestration
24	2010	Five hospitals are added in 2010, for a total of 24 partner hospitals across 6 districts in south Karnataka. Additional hospitals in the same zone further reduce travel distance, thereby improving geographical access.	Institutions improve geographical access	I→G		Late Growth	• Efficient network orchestration
25	2010	The low cost realized through economies of scale and scope further helps enroll additional partner centers and hospitals. Differential pricing for poor patients further increases numbers and geographical access. The project leader also has the discretion to waive a patient's fee, which helps provide access for many more patients.	Reduced cost increases geographical access	C→G	Total: 24	Late Growth	• Efficient network orchestration
26	2010 Dec	The state government acquires a RetCam Shuttle and other equipment for North Karnataka, which increases geographical access.	Institutions improve geographical access	I→G		Late Growth	• Efficient network orchestration

Value-Creating Instance	Year/Month	Description of Value-Creating Mechanisms	Value-Creating Interactional Resources	Value Creation	Number of Partner Participants	Stage of Evolution	Enablers for Value Creation
27	2010 Dec	Training for the KIDROP–NRHM project begins in 2010. 14 teams are trained: one pair of personnel from each partner hospital in North Karnataka. Free training by NN increases the number of trained personnel, thereby increasing geographical access.	Institutions improve geographical access	I→G	New: 14 in North Karnataka	Late Growth	• Efficient network orchestration
28	2008-2010	Choice of medical colleges with hospitals and district hospitals as initial partners reaches out to patients in remote areas.	Institutions improve geographical access	I→G		Early/Late Growth	• Efficient network orchestration
29	2007-2010	Initial awareness is spread through NNF (National Neonatology Foundation) and pediatric societies. At a later stage, partnership with the Karnataka state government through the National Rural Health Mission (NHRM) helps expand the program to the underserved districts of North Karnataka. Recent initiatives have expanded further in North and Central Karnataka.	Knowledge and institutions improve geographical access	KI→G		Early/Late Growth	• Efficient network orchestration
30	2011 Feb	Partnering with the government has been a learning experience for the team, including how to follow government procedures, particularly when working with several government departments, operationalizing the project (e.g., driver recruitment took three months), correctly managing accounts and performing data entry, and overcoming logistical difficulties in moving the team and mobilizing babies from the sub-district level. However, all of this has provided geographical access to more parts of Karnataka.	Institutions improve geographical access	I→G	Total: 40	Late Growth	• Continuous recursive learning • Efficient network orchestration
31	2011 Feb	Team A is deployed at North Karnataka (16 centers) and Team B is mobilized under a public–private partnership (PPP) with the government of Karnataka funded through NRHM, resulting in further expansion and scaling up.	Institutions improve geographical access	I→G	Total: 40	Late Growth	• Efficient network orchestration
32	2011 Dec	Tele-ROP version 2.0 is explored, to include image enhancement tools, vascular analysis, multitasking, integrated videoconferencing with image analysis, a tablet platform, and more. This helps improve both the quality of service and geographical access.	Technology improves geo-grahical access	T→G	Total: 72	Late Growth	• Efficient network orchestration • Continuous recursive learning • Belief in the transforma-tional power of ICT
33	2011 Dec	An additional 13 hospitals join the network, expanding the reach to 36 hospitals in South Karnataka, and the PPP under NRHM expands to include another 36 hospitals in North and Central Karnataka. Alliance with institutions helps increase geographical reach.	Institutions improve geographical access	I→G		Late Growth	• Efficient network orchestration
34	2011 Jan-Dec	states: government (Rajasthan), private (Maharashtra, Assam, Kerala), NGO (Gujarat).The Centre of Innovation in Public Systems, the Administrative Staff College of India, and NRHM collaborate to produce a film about KIDROP to facilitate expansion of the program at the national level. Other workshop partners include Philips Innovations, Bangalore, Samsung Advanced Institute of Technology, and several district-level local pediatric societies.	Institutions improve geographical access	I→G		Late Growth	• Efficient network orchestration
35	2009-2011	Higher utilization of equipment, increased partnerships, and conse-quently the ability to screen more infants at every hospital have reduced the distance that patients must travel, and lower costs ensure that service is affordable to larger segments of the population in rural areas.	Reduced cost improves geo-graphical access	C→G		Late Growth	• Obsessive customer empathy • Efficient network orchestration
36	2012 Nov	The KIDROP–NRHM PPP wins the “Innovation in Health Care through PPP” Popular Choice Award at the e-India Awards in Hyderabad. Several agencies are motivated to initiate similar efforts in other Indian states, which will facilitate future expansion of the service.	Institutions improve geographical access	I→G		Late Growth	• Efficient network orchestration

Appendix R

Identifying Value Propositions for Service Innovations in Developing Countries

Table R1 compares the disparities across two developed and two developing countries in their rural (and thus urban) population percentages, GDPs (gross domestic product) per capita corrected to purchasing power parity (PPP), and Gini coefficients.[1]

We observe that the rural–urban disparity is higher in developing countries compared to the developed world, indicating an observable geographic divide. Further, GDP per capita (PPP) in developed countries is substantially higher than in the developing countries, indicating a systemic economic divide between the developed and developing nations. Moreover, we also observe a significant inequality in the distribution of wealth within the developing countries as indicated by the Gini coefficients. Although many developed countries also have a huge economic disparity within the country, those governments have better resources for the provision of basic services to citizens, and the average GDP is much higher. Hence, the acuity of the economic divide is generally less in developed countries compared to that in developing countries. The value propositions that service innovations could offer for providing basic services such as healthcare in developing countries are *improving geographical access* and *reducing service delivery cost*.

Table R1. Comparing Geographical and Economic Divides in Developing and Developed Countries

	Country	Rural Population (Percent)	GDP per Capita (PPP)	Gini Coefficient
Developing	India	71	3,200	36.8
	China	57	6,700	41.5
Developed	USA	18	46,000	46.0
	Norway	23	57,600	25.0

Source: CIA, The World Factbook (2010). Available at https://www.cia.gov/library/publications/the-world-factbook/

[1]The Gini coefficient is a variability measure employed by policymakers, economists, and academics globally to calculate a nation's consumption or income inequality. The Gini coefficient has values from 0 to 100, with lower coefficients indicating more equal distribution of consumption or income: 0 denotes perfect equality and 100 perfect inequality.