Eyes in the sky: Considerations for a tele-ophthalmology service in South Sudan

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ABSTRACT

Telehealth services employ telecommunication technology to provide scarce specialist care to the multitude across the geographical divided and hard to reach areas. The Aravind Eye Care System in India has a successful tele-ophthalmology model that services poor households and could be adopted in impoverished settings such as South Sudan. Evolving technological changes in South Sudan, including provisional approval of Starlink, improve the feasibility of telehealth services. However, realizing intended benefits at minimal cost require careful consideration of multiple factors across demography, infrastructure, and governance. This article reflects on a previous evaluation project aimed at extending this model to other settings and makes recommendations for South Sudan.

Keywords: telehealth, eyecare, healthcare innovation, digital health, South Sudan

Introduction

Wholesale adoption of healthcare models is uncommon. Yet, nascent health systems like South Sudan's could benefit from proven models. The Aravind Eye Care System's (AECS) tele-ophthalmology model helped curb blindness in India [1,2] and could help other poor settings. In South Sudan, 1.5%[3] to 7.7%[4] of the population is blind or visually impaired, mainly due to cataract (30-50%), trachoma (35.3-58.1%), onchocerciasis (35%), and refractive errors.[3-5] These are exacerbated by poor socioeconomic conditions[5] and poor access to eyecare.[3]

South Sudan's strategy for self-sufficiency in eyecare is constrained by infrastructure and workforce.[3] It could benefit from Aravind's innovations, including the use of Wi-Fi technology, cheap intraocular lenses, a paraprofessional workforce, standard management systems and processes, and outreach programmes.[6] These approaches circumvent constraints. However, wholesale domestication has yet to be explored.

Evolving technological changes, including approval of Starlink in South Sudan,[7] improve feasibility of telehealth services. Telehealth avails scarce specialist care to many across geographical divide. However, reproducing outcomes from proven models requires contextual considerations.

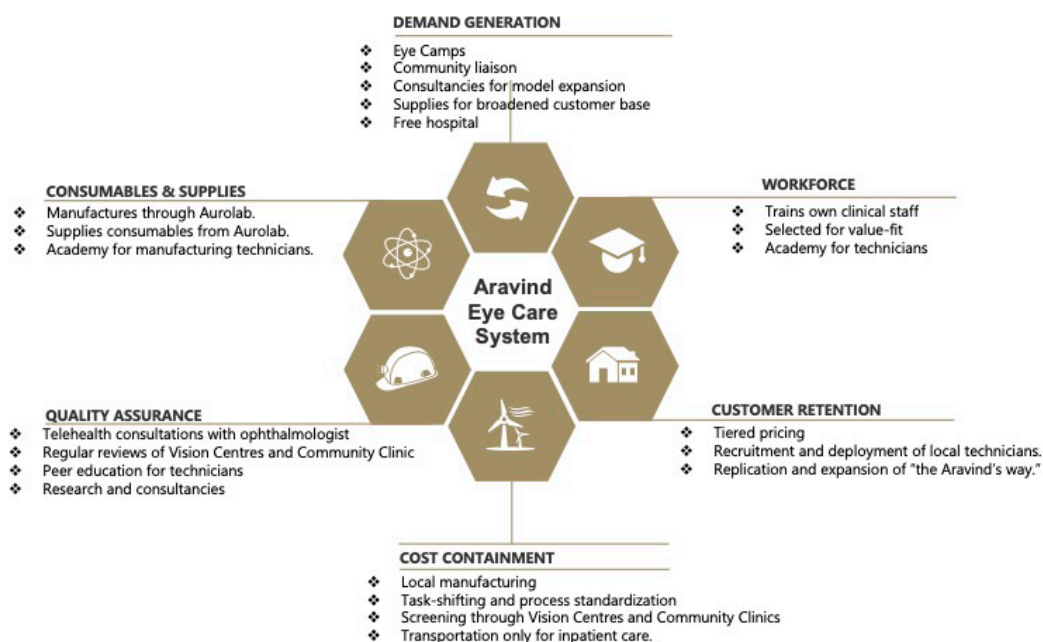This article reflects on an evaluation project completed at Lions Aravind

Figure 1. The Aravind Eye Care System's business model

Institute of Community Ophthalmology (LAICO) in Madurai, India, between 2017 and 2018. The project examined the effectiveness of Aravind's eyecare model with a view to scaling it. The article uses insights from fieldwork and administrative data to demonstrate key elements of the model and inform considerations for South Sudan. First, it delineates Aravind's approach to the global scourge of needless blindness and expounds on its elements of sustainability and quality assurance. Second, it considers constraints and opportunities for scaling the model to South Sudan. The article then concludes with recommendations.

The Aravind Eye Care System

The AECS is a primary eyecare service that operates across over 100 sites that are digitally connected to a base hospital in Madurai. Its critical elements include training of clinical staff, acquiring staff, eye camps, vision centres (VCs) and community clinics (CCs), telehealth specialist reviews, standardized and high-throughput surgical care processes, and tiered pricing for equitable access (Diagram 1). VCs are community-based eyecare units staffed with skilled eyecare service providers. These offer comprehensive eye examinations, refraction, blood sugar test, blood pressure monitoring, a teleconsultation with an ophthalmologist, eye health education, and glasses and medicines dispensing services.[2]

Although VCs are low-cost and critical to the Aravind's model, they incur set-up costs and overheads, basic necessary investments, and recurring expenditure (Table 1).

The AECS uses high-throughput surgery with a large volume of patients to generate sufficient revenue to offset operating and establishment costs at VCs and community clinics (Table 2).

The AECS's sustainability and brand recognition hinge on multiple approaches, encompassing a business model which is tailored to the poor, standardized processes for cost containment and quality assurance, volume-driven growth, emphasizing organizational culture when recruiting, and locally-embedded management practices and technological innovation (Table 3).

Considerations for South Sudan

Resistance to innovation

Healthcare innovation is fraught with risk-aversion: the health sector prizes evidence over logical argumentation, which results in a long lead time for translation.[8]

Technology transfer often induces the fear of change and threat to vested interests.[9] Factors which are critical to technology transfer include favourable governance and business conditions, supportive financial ecosystem and technological literacy.[10] Nonetheless, even after the adoption, many innovations in healthcare fail for reasons including organizational, technological, and political complexities.[11]

The Aravind's model has been externally inspired but locally championed.[2] Leadership is essential for demystifying innovation and its mainstreaming.[9] Regulatory hurdles and competition against existing products are potential barriers that require experienced entrepreneurs to scout innovations and invest for production.[12,13]

Table 1. Investments per vision centre

CAPITAL COST	USD	INR
Ophthalmic equipment	6,100	400,000
Computer accessories	2,000	132,000
Instruments (including sphygmomanometer, needle sterilizer.)	75	5000
Eye glass dispensing unit	350	23,100
Set up cost (promotion, furniture, invertor)	3,300	217,800
Overhead/ Incidental	600	40,000
Total investment cost	12,425	820,050
Recurring expenditure per month (workers, rent, maintenance, etc.)	600	40,000

Politics of metrics

The burden of eye diseases should be a political priority. Policy designers need to translate epidemiological evidence into political priorities. For India, 'Vision 2020: The Right to Sight' helped to target funding to eye health services.[6,14,15]

Eye health metrics also need to track quality of care. In Aravind's practice, this includes supply chain management, evaluation of care processes, and clinical outcomes. This also evaluates satisfaction rates and assesses care effectiveness.

Governance

Governance is an important factor in scaling social impact.[16] Autonomous decision-making is essential for low-resourced contexts, and governance determines organizational values which are difficult to replicate. Moreover, taxation, trade, and technology policies impact technology transfer.[17] While the requisite set of policies are contested,[18,19] technology policies are often considered within other priorities, including implications for national security, economic benefits, and rarely, health implications. Aravind's eyecare model thrives on cheap technology which resulted from favourable governance frameworks. These include the decision to despatch and repatriate engineers after training in USA, the choice of procured technology and its indigenization, subsidies which make technology affordable, establishment of local training institutes for a tailored skilled workforce, development of factories for consumables, and promotion of customised adoption of existing technologies. Similarly,

Table 2. Economic profile of vision centre and community clinic

	VISION CENTRE	COMMUNITY CLINIC (with transportation)	COMMUNITY CLINIC (without transportation)
	n=5	n=4	n=4
Break Even Visits/Day	8.85	20.82	13.29
Break Even Visits/Year	2,717.82	6,392.14	4,080.68
Fixed Cost/Visit	47.65 INR	58.44 INR	37.41 INR
Full Cost/Visit	52.37 INR	62.91 INR	41.27 INR
Full Cost/Cataract Surgery	1,425.89 INR	1,979.44 INR	1,297.84 INR
Full Cost/Spectacle Sold	337.64 INR	419.19 INR	274.84 INR
Total Fixed Cost	343,490.17 INR	1,211,427.76 INR	775,163.88 INR
Full Cost	377,148.17 INR	1,303,458.26 INR	854,624.38 INR

Table 3. Key tenets of the Aravind Eye Care System (AECS)

SOCIAL ENTERPRISE	PROCESS STANDARDIZATION	ORGANIZATIONAL CULTURE	SUPPLY-DRIVEN DEMAND	MANAGEMENT & TECHNOLOGY
• Leverages large consumer base, product and process innovation, and tiered pricing to service the low-income population.	• Site selection based on population and distance from the transport network.	• Recruitment with the aim of community ownership.	• Enlarges volume of service through community outreach, including eye camps, door-to-door visits, and school screening programme.	• Embedded management systems contain costs and inform technology transfer, including local manufacturing, which reduced the cost of intraocular lens (IOL) from $200 to $10.
• Creates jobs for the community, including high school graduates, and offers training and integration into the workforce.	• Standard infrastructure, layout, workforce, and operations.	• Recruits with emphasis on organization culture over clinical competency, because it could teach the latter.	• Improves access through service availability for 6 days per week.	• Aurolab, AECS's manufacturing arm, reduces the cost of consumables and positions AECS as net exporter of IOLs.
• Redistributes wealth and tackles child marriage by recruiting young women with limited education opportunities and employing them after a cadetship as eyecare technicians or manufacturing staff.	• Eyecare technicians used for task-shifting. • Reproducible management and control structures in teleconsultation and referrals. • Managerial support and quarterly reviews for supplies and quality assurance. • Standardized training facilities, electronic medical records, and teleconsultation systems.	• Instils the "Aravind way" in the training programme, thereby enhancing community acceptance and branding itself for competition on quality and compatibility. • Eye health fieldworkers build community relations, disseminate information, and support referrals and community-based follow-up.	• Referrals and follow-up at base hospital supports volume expansion by improving trust in primary care centres and reduce shunting to alternatives. • Health education and eye health promotion generate demand while enhancing brand recognition.	• Managerial reviews informed investment in Wi-Fi technology, which supports teleconsultations. • Consultancy through LAICO supports the Aravind model's adopters and extends Aurolab's market.

its domestication of manufacturing capabilities benefited from trade, taxation, and technology policies within India's overarching foreign policy.

In addition, India's populous jurisdictions are consequential for the economies of scale realized at Aravind. Success elsewhere would depend on governance frameworks which pool a critical mass under a policy jurisdiction. By contrast, decentralization may limit economies of scale where jurisdictions are small and the adopting organization is compelled to engage policymakers across multiple jurisdictions. Calls for federalism in South Sudan are requests for further devolution, despite current incapacitation.[20] While this could promote innovation, it may deprive volume-dependent services of requisite scale.

Furthermore, the financial ecosystem and government capabilities are consequential. Restricted fiscal space

necessitates public-private partnerships as the most viable vehicle for technology transfer. In this respect, government guarantees for private investors are instrumental for de-risking innovation. Preservation of public value in such partnerships also depends on capabilities in government and these are relevant for healthcare technology.

Technology

Cheap and accessible technology is essential for telehealth. The AECS uses Wi-Fi across its network,[1,6] which enables real-time specialist input. This inspires confidence in quality of service while also acting as force-multiplier. The increasing affordability of Internet, computers, and mobile phone-supported fundoscopy, improve global feasibility of telehealth services. Nonetheless, local policies will be consequential. Policies aimed at cybersecurity or social moderation over the Internet, for instance, may constrain telehealth.

Furthermore, managerial practices and operations need to be adapted to local realities. The AECS invests in feedback systems, learns from its operations, and manufactures such as to contain costs and customise technology. Tailored approaches are pertinent, because technologies built for rich economies increasingly adopt razor-and-blade model. These target consumers with high purchasing power and aim to profit from consumables or the 'blades,' rather than the often-donated implement or the 'razor.' So, their maintenance costs are often prohibitive, requiring consumables which are either expensive or difficult to procure.

Ethics

Optimization of operations at the AECS resolves backlog in outpatient reviews, minimizes unnecessary transfers, lowers labour cost, and minimizes downtime for surgeons and operating theatres. The latter involves task-shifting, with paraprofessional staff assessing patients and supporting perioperative care, including preparing the next patient on adjacent operating table while the surgeon is operating. This allows the surgeon to simply rotate around the operating microscope and minimise time between cases.[21] Although the AECS monitors and witnesses high quality outcomes and low complication rates, replicating its theatre processes would be subject to standards in other jurisdictions and cultures.

Conclusion

The AECS is a successful social enterprise. It operates a high-volume telehealth model which could be adopted for other impoverished settings. However, it is important that critical aspects of its operation are understood such as the associated benefits to be achieved at minimal cost. The foregoing analysis underscores the significance of systemic analysis when scaling care models. It demonstrates that factors particular to settings, including population, infrastructure and governance frameworks, are consequential. Tele-ophthalmology models such as Aravind's could improve eye health in South Sudan. But wholesale adoption requires all the foregoing considerations.

Declarations

References

1. Ravilla T, Ramaswamy D. Efficient high-volume cataract services: the Aravind model. Community Eye Health. 2014;27(85):7-8. https://pmc.ncbi.nlm.nih.gov/articles/PMC4069777/.

2. Mehta PK, Shenoy S. Infinite vision: how Aravind became the world's greatest business case for compassion. 2013, India: HarperCollins.

3. Mena W. Tackling the high burden of blindness. SSMJ. 2016 Feb;9(1):3. https://www.southsudanmedicaljournal.com/archive/february-2016/tackling-the-high-burden-of-blindness.html.

4. Ngondi J, Ole-Sempele F, Onsarigo A, Matende I, Baba S, Reacher M, Matthews F, Brayne C, Emerson PM. Prevalence and causes of blindness

and low vision in southern Sudan. PLoS Med. 2006 Dec;3(12):e477. DOI: https://doi.org/10.1371/journal.pmed.0030477.

5. Tizazu T, Mburu FM. Prevalence and causes of vision loss in Southern Sudan. Soc Sci Med. 1983;17(22):1785-8. DOI: https://doi.org/10.1016/0277-9536(83)90392-1.

6. Bhandari A, Dratler S, Raube K, Thulasiraj RD. Specialty care systems: a pioneering vision for global health. Health Affairs. 2008; 27(4): 964 – 76. DOI: https://doi.org/10.1377/hlthaff.27.4.964.

7. Ninrew C. South Sudan inks satellite internet deal with Elon Musk's Starlink. Updated 27 July 2024, Juba: Eye Radio. https://www.eyeradio.org/south-sudan-inks-satellite-internet-deal-with-elon-musks-starlink/.

8. Kelly CJ, Young AJ. Promoting innovation in healthcare. Future Healthcare Journal. 2017; 4 (2): 121-5. DOI: https://doi.org/10.7861/futurehosp.4-2-121.

9. Juma C. Innovation and its enemies: why people resist new technologies. 2016, Oxford, England: Oxford University Press.

10. World Bank. Global economic prospects 2008: technology diffusion in the developing world. 2008, Washington DC: USA. https://openknowledge.worldbank.org/bitstream/handle/10986/6335/Global-Economic-Prospects-2008-Technology-diffusion-in-the-developing-world.pdf?sequence=5&isAllowed=y (viewed Jan 27, 2021).

11. Greenhalgh T, Wherton J, Papoutsi C, Lynch J, Hughes G, A'Court C, Hinder S, Fahy N, Procter R, Shaw S. Beyond adoption: a new framework for theorizing and evaluating nonadoption, abandonment, and challenges to the scale-up, spread, and sustainability of health and care technologies. J Med Internet Res. 2017; 19 (11): e367. http://www.jmir.org/2017/11/e367/.

12. Mas J-P, Hsueh B. An investor perspective on forming and funding medical device start-up. Tech Vasc Interventional Rad. 2017; 20: 101-8. DOI: https://doi.org/10.1053/j.tvir.2017.04.003.

13. Le Roy F, Robert M, Lasch F. Choosing the best partner for product innovation: talking to the enemy or to a friend? International Studies of Management & Organization. 2016; 46: 136-58. DOI: https://www.tandfonline.com/doi/abs/10.1080/00208825.2016.1112148.

14. Finger RP, Kupitz DG, Fenwick E, Balasubramaniam B, Ramani RV, Holz FG, Gilbert CE. The impact of successful cataract surgery on quality of life, household income and social status in South Asia. PLoS One. 2012; 7 (8): e44268. DOI: https://doi.org/10.1371/journal.pone.0044268.

15. Murthy G, Gupta SK, John N, Vashist P. Current status of cataract blindness and Vision 2020: the Right to Sight initiative in India. Indian J Ophthalmol. 2008; 56(6): 489-94. DOI: https://pmc.ncbi.nlm.nih.gov/articles/PMC2612994/.

16. Lehmann T. Scaling social impact: the case of Aravind Eye Hospitals. Master thesis, Business Faculty. 2009, Witten, Germany: Herdecke University.

17. Mazzucato M. The entrepreneurial state: debunking public vs private sector myths. 2013, London, England: Anthem Press.

18. Bartokas A, Teubal M. A framework for policy oriented innovation studies in industrial countries. Economics of Innov New Techn. 2002; 11(4-5): 477-496. DOI: https://doi.org/10.1080/10438590200000009.

19. Chang H-J, Cheema A, Mises L. Conditions for successful technology policy in developing countries – learning rents, state structures, and institutions. Economics of Innov New Techn. 2002;11(4-5): 369-398. DOI: https://doi.org/10.1080/10438590200000005.

20. Johnson DH. Federalism in the history of South Sudanese political thought. 2014, London, UK: Rift Valley Institute (RVI). DOI: https://riftvalley.net/publication/federalism-history-south-sudanese-political-thought/.

21. Le H-G, Ehrlich JR, Venkatesh R, Srinivasan A, Kolli A, Haripriya A, Ravindra RD, Thulasiraj RD. A sustainable model for delivering high-quality, efficient cataract surgery in southern India. Health Affairs. 2016;10:1783-90. DOI: https://doi.org/10.1377/hlthaff.2016.0562.