

A systematic methodology for tailoring Tele-Health infrastructure to desired outcomes

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Issues: ICT intervention in Health Care delivery has attracted international initiatives with huge budgets for proliferation of timely and efficient Health care delivery in developing countries. Although Tele-Health holds great promise as an ICT mechanism for equitable care delivery, the number of successful programs worldwide is far too few relative to the spending.

Description: We categorized information exchange in Tele-Health process into basic activities and infrastructure requirements for these basic activities. We find each of these activities having multi-dimensional dependencies on the infrastructure, the phase of the disease and its treatment. For example a 32KBPS telecom link could enable remote audio counselling, while “lossless” transmission of an MRI image or a video-conference with multiple experts from an OT needs higher bandwidth. A thin-client based iconic interface can cut literacy barriers to usage while language translators can bridge patients and doctors of different regions but may need thick client technologies. A cell-phone based application can proliferate faster and wider than on a PC, but it would not be preferred to do a 3D Radiological analysis. We also find several activities can be bunched on basis of similar infrastructure requirements.

Lessons learned

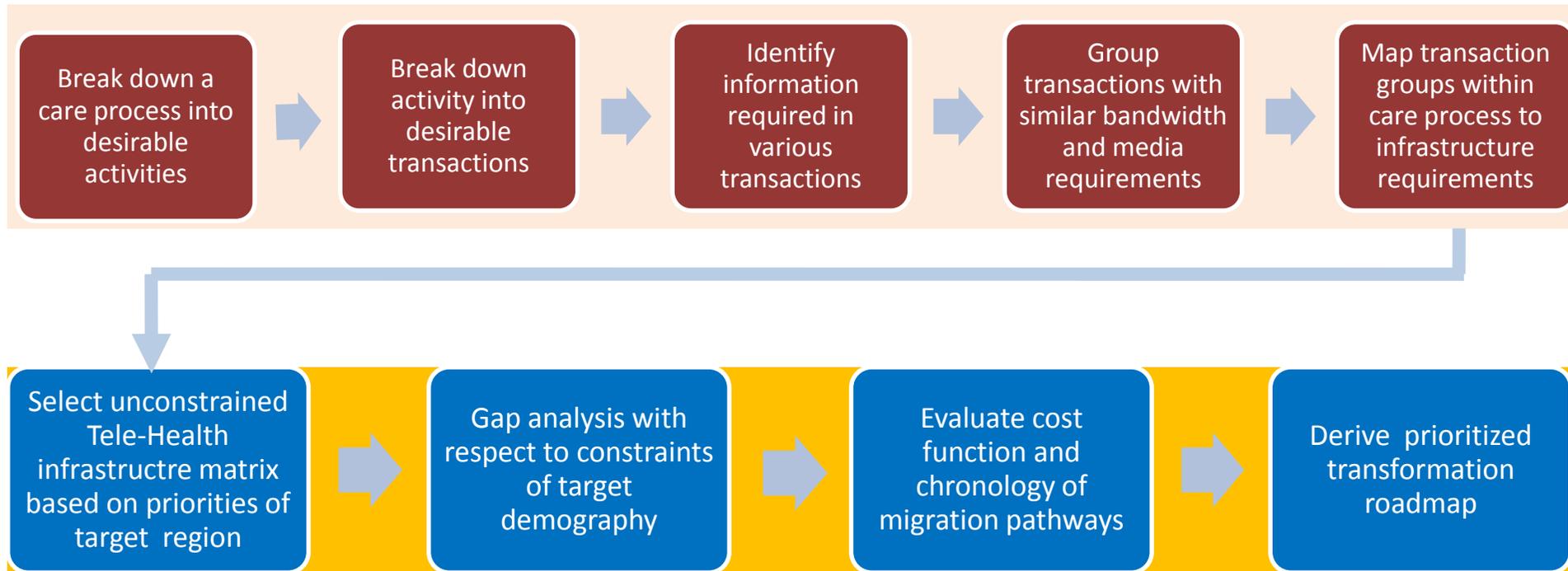
Information exchange in the care process ultimately boils down to basic activities such as measurement, storage, analysis, distribution, presentation and monitoring of relevant data in form of text/image/audio/video. A formalized ICT adoption methodology helps to separate these activities while aggregating data from several patients and distributing among disparate care-provider resources.

Way forward

A specific technology mapping approach to marry the right technology to the particular care problem at hand, while keeping in mind the specific outcomes desired, a realistic budget and an awareness of feasible work flows is a sensible and cost-effective approach to a scientifically sound deployment of Tele-Health technologies. This involves building maps that relate activities within a care process to corresponding infrastructure requirements, and using such maps to conduct gap analysis given the constraints of a target demographics and deriving infrastructure transformation pathways prioritized by corresponding cost function.

Keywords: Tele-Health; technology adoption; information communication technology

Figure 1. Workflow of suggested methodology for Tele-Health infrastructure planning



Advantages of suggested methodology:

1. Provides a Ethnographic based, health care need driven approach rather than a technology driven approach
2. Enables integration and reuse of learning and facilities of projects
3. Enables think tanks to pile up desirable infrastructure maps for various care programs while execution bodies can pick a relevant map and subject it to the constraints of the target demography to derive transformation roadmaps. This enables parallel effort in generation and utilization of associated knowledge base (shown in two different rows in figure 1).
4. Helps to reduce wastage through prioritization and optimization of spending, deliverables and milestones within such roadmaps based on ground realities
5. Provides a scalable approach to optimize investments in health ICT transformation

Step 1: Breaking down a care process into care activities encountered by the citizen

In general, a care pathway involves some basic activities shown in Figure 2. These Activities may repeat in different combinations depending on the evolution of the health condition. Some of these activities may happen at the hospital, some at the patient's home and some at the physician's clinic. Some of them require proximity of the care provider (doctor/nurse/etc), patient and biomedical devices while some activities can be done remotely. Depending on the type of diagnostic, treatment and medication needed at different phases of the care process, different personnel and infrastructure may be needed.

It is necessary to map such dependencies to identify the desirable infrastructure so as to address two objectives:

1. Understand what care activities can be enabled with existing infrastructure, without having to wait for completion of huge infrastructure projects.
2. Understand which activities can be enabled alongside infrastructure transformation roadmap, such that resource planning and mobilization can happen in tandem for continuous enhancement of services



Figure 2. Mapping activities within a care process

Step2: Breaking down activities into transactions

Each of the activities such as shown above consists of several transactions between the care provider personnel and the citizens. Many of these transactions repeat in different activities, but the infrastructure be different depending on the information content being exchanged in different activities.

For example counselling in a routine family planning awareness program may require different information content than a triage situation in a disaster management scenario.

This step helps at least two objectives:

- a. Obtaining scenario based workflow requirements
- b. Estimate resource requirement accordingly

Care activity	Transactions	Care activity	Transactions
Care program design	Demographic data capture Seasonal and sporadic trending of diseases Environment monitoring Habits and occupational hazard monitoring Genetic risk monitoring Care program management	Treatment	Therapy Surgery Follow up consulting Counselling
Screening (including specialist support)	Registration Patient history capture Screening tests Public education Counselling Prescription	Assistance	Physical assistance Financial assistance Logistics assistance Information assistance
Consultation (including specialist collaboration)	Registration Patient history study Primary examination Diagnostics(second opinion) Disease profiling Prescription Treatment plan	Monitoring	Data acquisition and generation of indicators Tracking indicators to bounds, detection of anomaly Alerting Emergency Consultation Emergency ward admission Emergency treatment records Admission/Discharge/Transfer admission Prescription
Diagnosis	Record patient data Analyze data and report patient status	Emergency management	Consultation Emergency ward admission Ambulance booking Ambulance based patient tracking First-aid management Emergency treatment records Admission/Discharge/Transfer Prescription Triage
Medication	Procure medicine Schedule medication Deliver medication Medication schedule tracking and counselling	Preventive care management	Immunization schedule and resource booking Consultation Counselling Disease vector control Local health authority training

Figure 3. Decomposing care activities into specific transactions

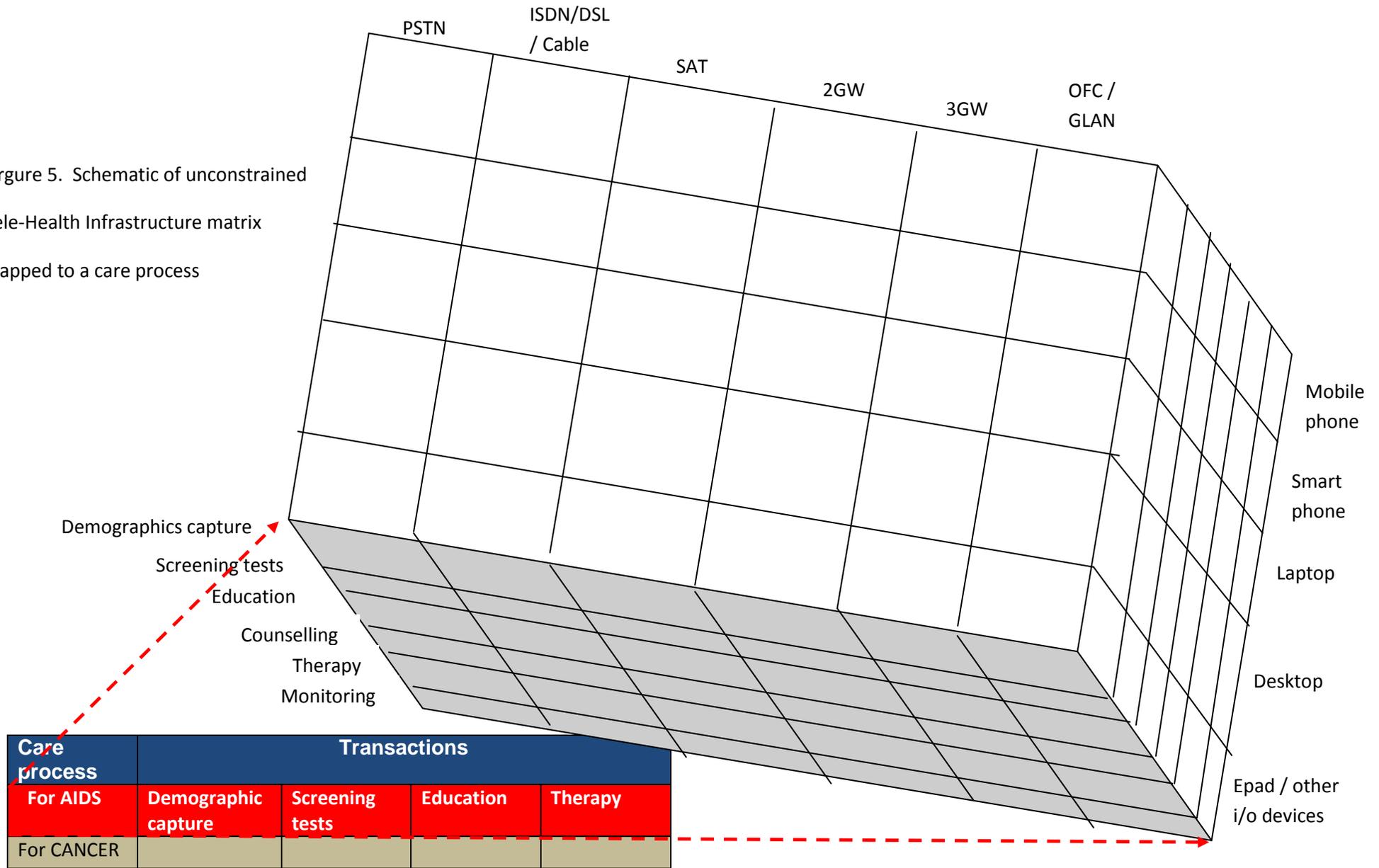
Mapping transactions to associated type of information and its presentation

Information transactions in various activities	Data type	Data Size	Transfer mode	Client platform	Client BW
Demographic data capture (family members, age, education, income level, hereditary diseases, occupation, vaccination, status, family planning awareness, harmful habits, pre-existing illnesses, etc)	TH	S	O	C	L
Trending of health issues (regional, seasonal and sporadic disease incidence distribution reports, inventory plan , etc)	TH	S	O	D	L
Environment monitoring (hygiene, pollution levels in air/water/food, industrial efflux, pests, insects, climatic change, etc.)	TH	T	O	E/C	L
Genetic risk profiling (known/unknown symptoms of genetic disorders ,ethnic predisposition, etc)	TI	SM	O	D	L
Care program management(target prioritization, planning, scheduling ,resource ordering forms, status and performance reports, etc)	T	M	O	D	M
Register patient (patient photo , biometric, other details)	IT	M	B	D/C/L	L
Screening tests (diagnostic data like pathology radiology, Electrical graphs, Character codes, Cine(Echo/Ultrasound),lab reports)	IT	ML	R	C/L/D	M
Public education (information pamphlets, guides, Lectures, health event alerts, registration and cancellation forms, etc)	TA	LV	R	D/TV/C	M
Counselling (information pamphlets, FAQ, Tele conversation/ image/video models, trends of patient response to treatment, etc)	VTAI	L	R	D/L	M
Patient history study (patient risk quantification, genetic/ familial predispositions, allergies and adverse reactions to medication, etc)	TI	SL	O	L/D	L
Diagnostic (second opinion)(ECG, PFT, EEG, Audiogram, mammogram, X-ray, CT, MRI, Ultrasound, ECHO, Angiogram, Blood, Urine, Stools reports, TMT, Etc)	IVST	MLV	OB	D	M
Analyze data and report patient status (specialist report on disease stage, assessment of complications for treatment, prognostic classification, rarity of disease condition, etc)	T	S	O	D	H
Medication scheduling and follow up (medication service order, prescription of diet and medication schedule, dosage tracking reports, Symptom and complication capture, correlation of symptom to schedule mismatch)	T	T	B	D/C	L
Therapy (patient training information, therapy progress tracking form)	TAVI	ML	R	D/C	M
Health follow-up consulting (conferencing, patient records, patient health trend reports)	ITAVH	L	B	D/L	M
Financial assistance (insurance/ subsidy claim forms, insurance/subsidy claims processing forms, claims verification database, risk profile reports, insurance/subsidy program application forms)	TAVIH	S	O	D/C	L
Monitoring health parameters and alerting (monitoring Configuration form, recording of temperature, heart and respiration rate, ECG, EEG,BP, height ,weight ,urine, stools, foetal heart rate, blood glucose, ultrasound etc)	STVT	SML	R	D/C/E	L
Emergency response (Tele-consulting, live video, real time vital signs, abnormality reports from monitoring)	AVS	ML	R	L/C	MH
Triage (disaster assessment form, disaster management protocol, resource allocation form, emergency training, counselling consulting, triage assessment form)	AVTI	L	R	L/C	MH
Emergency treatment records (emergency treatment plan, patient vital signs and other medical parameters monitor, health Insurance /subsidy information form, specialist notes)	SIT	ML	R	D/L/C	HV
Admission/Discharge/Transfer admission (bed booking, admission/ transfer form, discharge summary, legal forms)	T	SM	B	D	L
Ambulance based patient tracking (real time patient data monitoring, video conferencing, facility availability enquiry)	STVA	L	R	D/L/C	MH
First aid (primary symptoms capture, immediate care guide, counselling, screening and preventive care guide)	TAV	ML	R	C/D	L
Capture Patient history (family history, patient history, video conferencing)	TAV	S	B	D	L
Primary examination (by GPs and specialist) (general condition on examination report, BP, Height, Weight, visual inspection, temperature, specialist investigation order, etc)	T	ML	B	D/L	M
Prescribe diagnostics / medication (diagnostics prescription, Medication prescription, Treatment prescription)	T	S	B	D/L	L

Figure 4. Transaction information and infrastructure map. Note: Data type :Audio (A), Video(V), Image(I), Text(T), bio-signal(S),hand writing(H); typical data size after lossless compression per information frame [Tiny (T)<160 Bytes; Small(S) <1KB;medium (M)<100 KB; Large (L) <1MB;Very large (V)<64MB;Extremely large >64MB]; utility (real time-R, buffer and forward-B, offline transmission- O; minimum client platform (Cellphone(C), Smartpone(S),Laptop(L), Desktop(D), Equipment(E)); Bandwidth: Low(L) < 64Kbps;medium(M) <384Kbps; High(H)<10Mbps;very high(V) >100Mbps

Grouping transactions with similar requirements and map to infrastructure standards

Figure 5. Schematic of unconstrained Tele-Health Infrastructure matrix mapped to a care process



Select unconstrained Tele-Health infrastructure matrix based on community health priorities and filter through constraints of target region

Power supply	Unscheduled cuts	Shcheduled but frequent cuts	Seasonal cuts / Genset + UPS backup	Solar UPS/ GENSET back up available 24X7	Hardly any power cuts
TeleCom	None	ISDN / PSTN	Satellite / Cable	DSL/ 2G wireless	OFC/ WIMAX/ 3G
Literacy	oral skills	Oral, Reading and writing skills	ORW + electronic data entry	Data processing and reporting	Data analytics
Linguistics	Local Language only	Regional Multilingual	Regional and National	Regional, National and International	Transcription/Transliteration
Technical skill	Calculation	Operational	Servicing	Managerial skills	Organizational skills
Affordability	Rs 600	Less than 1.2K	Less than 12K	Less than 60K	1L+
Illness Cause	Hygiene and malnutrition	Habitual disorders	Infectious / vector borne / contagious	Preventable diseases	Geriatric, Lifestyle management, Global
Commerce	Barter / Material / Crude Debt	Teller Cash transactions	ATM based cash access	Cashless / TPA driven models	Insurance based automation
Automation	Basic manual records	Electronic record capture +access	Billing and Accounts Automation	HIS/RIS/PACS/LIS	PHR, Community Blogs, Tele-education / care portals, etc
Accessibility	Information center	Primary health center	Secondary health center	Tertiary care	Home care (for chronic conditions)
Staff	Health worker	Nurses/paramedic	GP's	Specialists, Surgeons, Pathologists	Departmentalized services
Funding	Self funded	Govt.	WHO, UNICEF, NGOs.	Community Insurance	Private Insurance
Disaster preparedness	Yearly Census	Monthly monitor	Seasonal monitor	Emergency management, daily monitoring	Forecasting and Multi site coordination
Transportation	Crude /self owned	Private service	Govt. transport	ambulance	Helipad ambulance
Inventory	First aid	Containment	Centralized response	Decentralized Nodal tree	Research facilities
Infrastructure	Counseling trip	Bio-chem/therapy	Radio/Cardio LABs	Multi-speciallty Hospitals	Multi-Hospital Networks

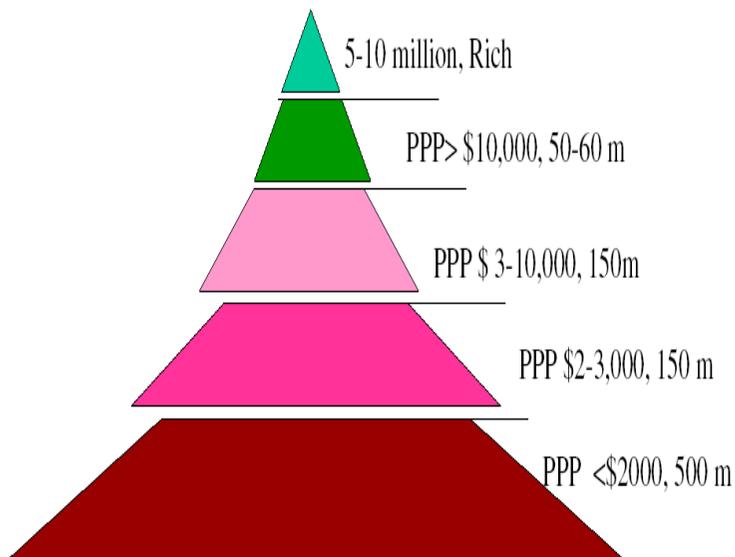
Figure 6. Schematic of constraints which can be evaluated for a given target region and applied as a filter to the unconstrained infrastructure

Based on infrastructure gap-analysis derive

- a. Services that can be enabled with current infrastructure
- b. Services which can be enabled by enhancing non-technical resources
- c. Services that can enabled with enhancements to existing infrastructure

EXPECTED IMPACT OF THIS METHODOLOGY

- Develop programs to immediately launch services utilizing current infrastructure
- Prioritize and launch programs for upgradation of non-technical resources base on cost function
- Derive prioritized infrastructure transformation roadmap for wide scale adoption
- Methodology thus adopted will lead to Reduction of wastage/redundancy
- Cost thus saved directly affects proliferation of affordable care to global majority of the population as can be seen in the affordability pyramid indicated below



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