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Evaluation of an Autonomous, Modular Primary Healthcare System Based on Prefabricated ISO High-Cube Containers in Rural Ghana

An Integrated Medical, Organisational, and Economic Systems Approach

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Abstract

Ensuring comprehensive primary healthcare coverage in the rural areas of Sub-Saharan Africa faces profound structural challenges. Due to long construction times, high investment costs, and volatile grid connections, conventional brick-and-mortar infrastructures often prove inefficient. This review paper consolidates strategic, technical, and economic data from established project designs into a scientific solution. A standardised, fully autarkic infrastructure model based on pre-equipped 40-foot ISO High-Cube containers is proposed, which is precisely tailored to the epidemiological profile of the 'Double Burden of Disease' as well as perinatal medical needs in Ghana. Embedded within a Public-Private Partnership (PPP) model with the Ghana Health Service (GHS), this concept demonstrates how a highly efficient basic coverage can be realised through targeted scaling, decentralised off-grid technology, and a hybrid material approach.

1. Introduction and Epidemiological Context: The ‘Double Burden of Disease’

1.1 Epidemiological Polarisation in Rural Ghana

Rural regions in West Africa, particularly in Ghana, are confronted with an epidemiological polarisation. Data from the World Health Organization (WHO) and the Ghana Health Service (GHS) prove that these areas are characterised by a so-called Double Burden of Disease: the persistent pressure of infectious and parasitic diseases is increasingly compounded by a drastic rise in chronic, non-communicable diseases (NCDs).

The container-based primary healthcare system is dimensioned in its medical configuration precisely to address the following primary case groups and rural healthcare requirements:

- **Malaria (uncomplicated):** Accounting for approx. 40–50% of all outpatient presentations, it constitutes the main cause for consultations
- **Acute Respiratory Infections (ARI):** Mild pneumonias and bronchitis, which show a high morbidity rate particularly among infants.
- **Diarrheal Diseases (Diarrhoea):** Due to a lack of water and sanitation infrastructure in the rural surroundings, this is a primary cause of critical dehydration.
- **Non-Communicable Diseases (NCDs):** A significant increase in field-related hypertension (high blood pressure) and type-2 diabetes requires a continuous, local screening and management system.

1.2 Focus on Perinatal Care and Maternal Health

Furthermore, a critical focus is placed on perinatal care as well as maternal and child health. The lack of protected, sterile spaces and qualified midwifery supervision leads to avoidable complications during natural births in remote areas. The evaluated system therefore integrates dedicated treatment and monitoring capacities to ensure routine antenatal care, the management of nutritional anaemias, and uncomplicated deliveries within a protected, hygienic environment.

2. The Medical-Spatial Zone Concept

In order to rigorously prevent cross-contamination whilst maintaining the intimacy and privacy indispensable in a perinatal context, the architectural structure is based on a 40-foot High-Cube ISO container. Through an integrated corridor system, the limited usable area of around 30m2 is divided into four functionally autarkic zones:

Room 1: Reception, Triage & Pharmacy

This area is used for patient registration and the initial measurement of vital parameters (blood pressure, body weight). Attached to it is the secure storage and dispensing of Essential Medicines in accordance with the official guidelines of the Ghanaian Ministry of Health (MoH). These include ACT preparations (Artemether + Lumefantrine) as well as rectal Artesunate emergency suppositories against malaria, oral antibiotics (Amoxicillin) for ARI, oral rehydration solutions (ORS) paired with zinc, antihypertensives (Amlodipin/Lisinopril) for NCDs, as well as Oxytocin for the prophylaxis of postpartum haemorrhage and Chlorhexidine (7.1% gel) for neonatal umbilical cord care.

Room 2: Laboratory & Diagnostics Cell

Equipped with fixed, disinfectable work surfaces and a separate sink. This room accommodates immediate point-of-care diagnostics using malaria rapid diagnostic tests (RDTs), urine strips, and pregnancy tests. For advanced differential diagnostics, the laboratory features a binocular microscope, a 6-place benchtop centrifuge, as well as Hb meters and glucometers for chronic disease management.

Room 3: General Consultation Room

The clinical core area for the examination and treatment of acute infections and the long-term monitoring of NCD patients. The standard equipment includes wall-mounted blood pressure monitors and medical LED examination lights.

Room 4: Isolated Delivery & Midwifery Room

Positioned at the rear end of the container to guarantee maximum visual and acoustic privacy. Along with a fully adjustable, professional delivery bed/table with sterilisable catch basins, this room contains two patient recovery beds for inpatient postpartum observation or for conducting controlled fluid therapies in cases of severe dehydration. A handheld/tablet-based digital ultrasound device secures antenatal diagnostics directly on site..

Zone	Primary Function	Key Equipment
1 — Reception / Triage / Pharmacy	Patient registration, vital signs, drug dispensing	BP monitor, scale, pharmaceutical cabinet
2 — Laboratory / Diagnostics	POC testing (malaria, glucose, Hb, urinalysis)	POC analyser, centrifuge, biosafety cabinet
3 — General Consultation	Acute infections, NCD monitoring, examination	Examination couch, ECG, diagnostic set
4 — Delivery / Midwifery	Safe supervised childbirth, obstetric emergencies	Delivery table, resuscitaire, neonatal kit

Table 1: *Medical-spatial zone concept of the 40-foot ISO High-Cube container clinic.*

3. Technical Specifications and Infrastructural Autarky (Off-Grid)

The operational validity of the overall concept stands or falls by its technological independence from local, often unreliable utility grids. The dimensioning of the technical systems is based on a restrictive inclement weather scenario during the rainy season (calculated with 4.0 Peak Sun Hours – PSH) to guarantee absolute failure safety for critical subsystems (refrigeration and sterilisation).

3.1 Solar Power and Energy System

- **Energy Requirement:** The daily gross energy requirement, including calculated system losses (20%) amounts to 24kWh/day.
- **Photovoltaic Output:** This is implemented via 12 monocrystalline solar modules of 500Wp each, which can be installed entirely on the 30m2 container roof.
- **Storage Capacity:** Two parallel-connected 48V modules are deployed, providing a sufficient capacity of 9.6kWh of which 8.1kWh are net usable at 85% Depth of Discharge – DoD). This buffers night-time operations and provides a 1-day reserve for inclement weather.
- **Inverter:** An 8kW off-grid inverter safely absorbs the transient, simultaneous start-up currents of the air conditioning units and the thermal autoclave. The cooling circuit relies on a WHO-certified SDD (Solar Direct Drive) refrigerator combined with a separate medicine refrigerator to provide redundant protection for the vaccine cold chain.

3.2 Drinking Water Purification System

- **Volume:** Generation of 600l/day ultra-pure water, sufficient for approx. 70 patients per day, system cleaning, and up to two deliveries.
- **3-Stage Filtration Cascade:**

    1. *Stage 1:* Sediment filter coupled with an activated carbon filter for particle and pollutant adsorption.
    2. *Stage 2:* Ultrafiltration membrane serving as a mechanical barrier against 99.999% of all viruses and bacteria.
    3. *Stage 3:* UV-C disinfection reactor for the final DNA inactivation of remaining pathogenic organisms.

- **Energy Consumption:** Flow rate is managed via a highly efficient 80W DC pump with a delivery capacity of 200 l/h. The system requires a daily operating time of only 3 hours, which impacts the energy balance by a mere 600Wh. A dual tank system 500l raw water tank for gravity utilisation on the roof, 500l clean water tank in the technical compartment including an internal domestic waterworks unit) ensures continuous supply.

3.3 Hybrid Material Strategy and Waste Disposal

To compensate for rural supply chain disruptions, a strict separation of materials is applied (hybrid solution): critical point-of-care items (syringes, needles, scalpel blades) are designed as single-use materials (consumables) to guarantee absolute sterility upon first use. In contrast, basic metallic instruments (scissors, clamps, wound suture and delivery sets) are systematically reprocessed in the internal vertical or benchtop autoclave (25–30 litre class, >2,000W) using steam sterilisation. This prevents a halt in treatment due to supply bottlenecks and minimises waste volume.

For the remaining medical waste, a standardised on-site disposal procedure is used: tongue depressors and used needles are immediately isolated in puncture-proof safety boxes, which are permanently sealed once they reach a 75% fill level, stored for a maximum of one week in a ventilated, restricted-access shed, and completely incinerated on a weekly basis under PPE protection in a container-allocated De-Montfort incinerator. The sterile residual ash and deformed metal remnants are transferred into the secured pipe of a 4-metre-deep ash pit.

4. Organisational Perspective and the Partnership Model

The sustainability of the health system is primarily secured by its anchorage within a clearly defined Public-Private Partnership (PPP) model. The organisational structure separates procurement, financing, and operation strictly to minimise administrative inefficiencies:

- **Thurn und Taxis Consulting AG / SEF (Social Entrepreneurship Foundation):** Manages project management, international logistics, and the provision of the quality assurance system.
- **Republic of Ghana:** Responsible for providing the total project capital and strategic budget approval.
- **Ghana Health Service (GHS):** Provides the clinical specialist staff, handles day-to-day operations, undertakes technical maintenance, and bears comprehensive clinical responsibility.

4.1 The Sourcing Lever and Refurbished Medical Equipment

A major organisational lever lies in utilising **refurbished medical equipment** from Europe, particularly Germany. Due to legally mandated modernisation cycles in the German outpatient and inpatient sectors, enormous quantities of functional diagnostic systems become available. Through partnerships with institutions such as the Stiftung Gesundheit in Hamburg, these systems can be certified, refurbished, and cost-effectively integrated into African primary healthcare. This drastically reduces initial investment costs for medical equipment by 50–80% compared to purchasing new items and simultaneously mitigates global electronic waste.

4.2 Scalability and Local Employment Effects

The organisational framework provides for structured scaling over 24 months: a four-month pilot phase (3 to 4 containers) defines binding standards, followed by a ramp-up phase with a monthly production of approx. 10 units. After 24 months, **200 operational units** enter regular service. This roll-out generates a total of **approx. 1,100 local jobs** across production, logistics, training, quality management, and clinical operations on site.

5. Economic Perspective and Macroeconomic Key Figures

The project strictly follows the economic **Pareto principle (80/20 rule):** through standardisation and a focus on basic primary care, 20% of the potential maximum infrastructure investment is directed to rural areas to simultaneously achieve 80% of basic medical coverage.

5.1 Capex Analysis of the 40-foot Container Health Centre

The total costs for a turnkey, fully autarkic 40-foot clinic range between **85,000 and 122,000 USD** (mean value approx. 100,000 USD). Due to economies of scale from doubling the volume compared to a 20-foot variant, the costs for the shell and logistics do not increase proportionally. The detailed cost breakdown is as follows:

Sector / Cost Item	Cost Range per Unit (in USD)
Base Container (40-foot High-Cube, shell incl. Polyurethane insulation)	18,000 – 24,000
Scaled Energy Technology 6.0kWp PV system, 9.6kWh Lithium storage, 8kW inverter)	24,000 – 32,000
Advanced Water Treatment & 1,000 l tank system	6,000 – 8,500
Advanced Medical Equipment (Ultrasound, lab microscope, delivery bed, recovery beds, autoclave)	22,000 – 35,000
On-Site Infrastructure (De-Montfort incinerator, 4 m ash pit, civil engineering, PPE)	3,000 – 4,500
Logistics & Foundations (Ocean freight, customs, on-site crane foundations in Ghana)	12,000 – 18,000
TOTAL INVESTMENT (Turnkey Capex)	**approx. 85,000 – 122,000 USD**

Table 2: *Capex breakdown per 40-foot container health clinic unit.*

5.2 Macroeconomic Key Figures of the Overall Programme

Extrapolating these cost structures to the overall goal of 200 containers within 24 months embedded in the strategy document yields highly efficient macroeconomic figures: a budget of approx. 3.5 million EUR is earmarked for Year 1 (84 units incl. setup). With a target reach of around 20,000 inhabitants per health point, the calculated setup budget per inhabitant stands at only approx. 1.75 EUR. The invested budget per newly created job amounts to approx. 6,400 EUR across the entire system.

6. Outlook: Modular Scaling and the Ghanaian HMO Financing Model

To secure the long-term success of the decentralised units, the system must not remain rigid at the primary level of basic care. Instead, the container-based infrastructure concept is inherently modular, meaning it can be expanded step-by-step technologically, medically, and financially.

6.1 Step-by-Step Technological and Medical Functional Expansion

The physical and digital infrastructure of the container clinics offers an ideal platform for expanding the vertical and horizontal spectrum of medical services:

- **Telemedicine Networking as a Clinical Multiplier:** Through the already integrated internet connectivity and electronic health records, rural stations can be digitally linked to regional district hospitals via a "hub-and-spoke" model. Local midwives and Technical Officers gain direct access to the expertise of specialist doctors in urban centres via real-time telemedicine (e.g. live video consultations, digital transmission of ultrasound and microscopy images). This drastically increases diagnostic safety in perinatal risk cases or ambiguous laboratory findings.
- **Integration of Specialist Services (Dentistry and Ophthalmology):** By attaching an additional, specialised container module (Type-A expansion), the clinic can be transformed into a specialist satellite centre.
    - Dentistry: Addition of a dental treatment focus for basic pain therapy, extractions, and caries prophylaxis.
    - Ophthalmology (Eye Care): Installation of basic refraction and slit-lamp systems to combat widespread rural pathologies such as cataracts and field-related eye infections.
- **Expansion of Primary Surgical Care:** The existing zone concept can be enhanced by integrating a sterile operation module for minor surgical procedures. This allows wound management for complex traumas, abscess incisions, tissue excisions, and—in advanced stages—emergency Caesarean sections (Sectio caesarea) to be conducted directly in the rural hub village, thereby eliminating time-critical transport routes.

6.2 The Ghanaian HMO Model: Adaptation to Local Conditions

To make the expanded functionalities economically viable and sustainably relieve the state budget, the implementation of an integrated HMO (Health Maintenance Organization) model is proposed. This model connects risk-pooling health insurance directly with local care delivery but must be precisely adapted to the socio-cultural and economic realities of Ghana.

Cultural and Economic Adjustment

Ghana has a strong tradition of community solidarity systems (e.g. Susu collection groups) and a high awareness of health insurance through the state-run National Health Insurance Scheme (NHIS). The proposed HMO model operates as a complementary, highly efficient **social micro-insurance cooperative** at the community level.

Since the rural economy of Ghana is heavily agrarian and marked by seasonal liquidity bottlenecks, the system breaks away from rigid monthly cash payment cycles. The adaptation occurs across three dimensions:

1. **Mobile Payments (Mobile Money Integration):** Premium collection is handled entirely via mobile money platforms omnipresent in Ghana (such as *MTN Mobile Money* or *Vodafone Cash*). This reduces administrative barriers in the informal economy to a minimum.

2. **Flexible Premium Structures and Diaspora Involvement:** Contributions are adjusted to agricultural harvest cycles (e.g. larger advance payments after the cocoa or cashew harvest). Furthermore, a direct digital interface for international remittances is created: the Ghanaian diaspora living abroad is given the opportunity to settle HMO premiums for their relatives living in rural areas directly via international mobile transfer.

3. **Family-Centred Tariffs:** Parallel to existing planning, a flat-rate premium per core family (up to 5 people) is defined. This aligns with collective family structures and provides redundant protection particularly for women in the perinatal period as well as young children.

Medical-Economic Revenue and Cost Matrix in the Ghanaian Context

The HMO model operates as a *prepaid system*. The advance payment of family contributions creates a stable capital pool, from which the advanced medical equipment and above-average salaries for medical personnel are financed.

To manage moral hazard and secure local co-financing, a Ghanaian *co-payment* system (user fees) will be established. Whilst basic services (malaria rapid tests, routine antenatal care) are entirely free for HMO members, heavily discounted co-payments are levied for advanced services:

- **Outpatient Consultations & Basic Diagnostics:** Covered by the HMO premium.
- **Specialist Services (Dentistry/Ophthalmology):** Low rural user fee to cover specific consumable items.
- **Advanced Surgical Procedures / Deliveries:** Heavily discounted flat rates that sit significantly below the costs of private urban clinics.

The continuous revenue generated from insurance premiums and moderate *out-of-pocket* co-payments remains directly at the regional level. It flows into a dedicated **Maintenance and Expansion Fund**. This fund secures the independent upkeep of critical off-grid components (solar inverters, ultrafiltration membranes) and finances the step-by-step procurement and attachment of new container modules.

6.3 Conclusion of the Expanded Systems Approach

The synthesis of accelerated physical deployment (PPP container model) and integrated financial sustainability (Ghanaian HMO cooperative) yields a future-proof overall system. It not only eliminates the risks of local construction delays but generates a self-sustaining medical infrastructure hub that dynamically evolves with the health and economic needs of the Ghanaian population.

7. Concrete Stock, Equipment, and Consumables Lists

7.1 Medication Lists by Expansion Stage

Stage 1: Basic Primary Care & Perinatal Essential Care

These medications cover the immediate Double Burden of Disease as well as uncomplicated obstetrics.

Indication / Category	Active Ingredient & Strength	Formulation / Type
Malaria Therapy	Artemether 20 mg + Lumefantrin 120 mg	Oral tablets (Adult & Paediatric)
Malaria Emergency	Artesunate 50 mg / 200 mg	Rectal suppositories (prior to district hospital transfer)
Bacterial Infections	Amoxicillin 250 mg / 500 mg	Capsules & oral suspension (syrup)
Bacterial Infections	Cotrimoxazol 240 mg / 480 mg	Tablets & suspension
Rehydration	Oral Rehydration Salts (ORS) + Zinc (20 mg)	Powder sachets & tablets
Hypertension (NCD)	Amlodipin 5 mg / 10 mg	Tablets (long-term care)
Hypertension (NCD)	Lisinopril 5 mg / 10 mg	Tablets (long-term care)
Diabetes Type 2 (NCD)	Metformin 500 mg / 850 mg	Tablets (long-term care)
Pregnancy Prophylaxis	Iron (Ferrous Sulfate) + Folic Acid	Combination tablets
Obstetrics (Emergency)	Oxytocin 10 IU/ml	Injection solution (only for postpartum haemorrhage)
Neonatal Care	Chlorhexidine digluconate (7.1% gel)	Topical gel for umbilical cord care
Analgesics / Antipyretics	Paracetamol 500 mg / Ibuprofen 400 mg	Tablets & syrups

Stage 2: Advanced Downstream Modules

Specific pharmaceutical additions for dental, ophthalmic, and advanced surgical services.

- **Dentistry (Dental Services):** Local anaesthetics (Lidocaine 2% with/without Epinephrine via injection cartridges), topical anaesthetics (Lidocaine gel/spray 10%), antiseptic mouthwashes (Chlorhexidine gluconate 0.2% solution), and specific antibiotics for odontogenic infections (Metronidazole 200 mg / 400 mg tablets).
- **Ophthalmology (Eye Services):** Diagnostic mydriatics (Tropicamide 0.5% / 1% eye drops), local anaesthetics (Oxybuprocaine or Tetracaine 0.5% eye drops), antibiotic eye drops (Ciprofloxacin 0.3% or Gentamicin 0.3% drops/ointment), and antiviral/antiallergic agents (Aciclovir eye ointment / Antazoline eye drops).
- **Advanced Rural Trauma Surgery & Emergency Section:** Analgesia/anaesthesia (Ketamine injection solution 50 mg/ml, Atropine sulfate 1 mg/ml), local anaesthesia (Bupivacaine 0.5% for spinal anaesthesia during Sectio / Lidocaine 1% for infiltration anaesthesia), intravenous perioperative antibiotic prophylaxis (Ceftriaxone 1g / 2g i.v. powder, Metronidazole 500 mg i.v. infusion), and tetanus prophylaxis (Tetanus Toxoid vaccine 0.5 ml i.m. + human Tetanus Antitoxin).

7.2 Parts and Equipment Lists by Expansion Stage

Expansion Stage 1: Basic 40-foot Clinic (Clinical Core)

- Medical Technology & Capital Goods (Refurbished Focus): 1x vertical or benchtop autoclave (25–30 l, 2,000W, 1x professional delivery table/bed, 2x patient recovery beds, 1x WHO-certified SDD refrigerator + 1x separate medicine refrigerator, 1x handheld/tablet-based digital ultrasound device, 1x binocular laboratory microscope, 1x benchtop centrifuge (6 places), 3x wall-mounted blood pressure monitors, 3x Hb meters & 3x glucometers, 2x fixed medical LED examination lights.
- Reusable Stainless Steel Instruments (for Autoclaves): 10x standard delivery sets and 10x wound suture sets (including artery forceps, needle holders, surgical scissors, and anatomical tweezers).
- Off-Grid Infrastructure Components: 12x monocrystalline PV modules of 500Wp each, 2x parallel-connected battery modules of 48V / 100Ah (9.6kWh gross), 1x 8kW off-grid inverter, 1x 3-stage water filtration unit (sediment/activated carbon filter, ultrafiltration membrane, 1x 24V-DC water pump (80W), dual 500l tank system, and 1x De-Montfort incinerator.

Expansion Stage 2: Advanced Functional Modules (Downstream Phases)

- **Dental Module:** 1x mobile, autarkic dental treatment unit (patient chair, integrated compressor, spittoon, LED operating light), 1x dental handpiece set (turbine, contra-angle, micromotor), 10x dental extraction sets (adult/paediatric, including dental forceps and elevators according to Bein/Flohr), and 1x ultrasonic scaler.

- **Ophthalmology Module:** 1x portable, battery-operated slit lamp, 1x hand ophthalmoscope and retinoscope set, 1x phoropter and visual acuity chart wall (Snellen charts via cordless LED), and 1x Schiötz tonometer or rebound tonometer for intraocular pressure measurement.
- **Advanced OR Module:** 1x mobile, hydraulic operating table (Sectio-compatible), 1x ceiling-mounted, battery-buffered LED operating light (100,000 Lux), 1x mobile high-frequency surgery unit (HF cautery, min. 100W) for haemostasis, and 4x large laparotomy and Sectio instrument sets made of stainless steel (including retractors, specula, and abdominal clamps).

7.3 Calculation of Consumables (Quantity and Local Costs in Ghana)

The calculation is based on an average rural patient throughput of **40 patients per day (approx. 1,200 patients per month)** and local market prices in Ghana (converted into Ghana Cedi [GHS] and USD, exchange rate approximation 2026).

Monthly Routine Requirements for Phase 1 (Basic Care)

Consumable Item	Specification / Unit	Quantity per Month	Cost / Unit (GHS)	Total Cost / Month (GHS)	Total Cost / Month (USD)
Malaria RDTs	Diagnostic rapid tests	600 tests	15	9,000	~600
Urine Strips & Pregnancy Tests	10-parameter strips / hCG cassettes	300 units	10	3,000	~200
Single-use Syringes & Needles	2\ 5\ 10 ml incl. needles (21G/23G)	1,000 units	2.25	2,250	~150
Peripheral Intravenous Cannulae	Cannulae (18\20\22\ G)	150 units	15	2,250	~150
Infusion Sets & Solutions	NaCl 0.9% / Ringer's Lactate (500ml)	150 bottles	30	4,500	~300
Wound Care Material	Sterile gauze, elastic bandages, surgical tape	400 sets	15	6,000	~400
Absorbable Suture Material	Vicryl / Chromic Catgut with needle	60 units	50	3,000	~200
Examination Gloves (Non-sterile)	Nitrile / Latex (Box of 100)	15 boxes	120	1,800	~120

Surgical Gloves (Sterile)	Packed in pairs	150 pairs	15	2,250	~150
Obstetric Single-use Supply	Umbilical cord clamps, underpads, aspirators	100 sets	45	4,500	~300
Hygiene & Disinfection	Hand sanitiser (l), chlorine tablets	20 units	112.5	2,250	~150
Safety Boxes	5-litre cardboard, puncture-proof	15 units	30	450	~30
TOTAL (Consumables)	**Monthly Opex Allocation Stage 1**			**41,250**	**~2,750**

Supplementary Monthly Consumable Costs for Phase 2 (Downstream Modules)

Once the specialised units are activated under the regional HMO model, specific consumable costs per container centre increase by the following calculated monthly fixed flat rates:

- **Dental Consumables:** composite fillings, cements, extraction needles, sterile drapes, suction cannulae $\rightarrow$ ~6,000 GHS / approx. 400 USD.
- **Ophthalmic Consumables:** fluorescein test strips, sterile eye wash solutions, single-use tonometer prisms, ophthalmic ointment bases $\rightarrow$ ~3,750 GHS / approx. 250 USD.
- **Surgical Consumables (Advanced OR/Sectio):** single-use scalpel blades, sterile surgical drape packs, advanced suture material (Monocryl/PDS), sterile OR gowns, and invasive disinfection solutions $\rightarrow$ ~16,500 GHS / approx. 1,100 USD.

8. Conclusion and Strategic Recommendation

The consolidation of available data validates the technological readiness and economic plausibility of the container-based primary healthcare system. By intelligently coupling robust off-grid infrastructure (solar and filtration systems) with a highly efficient sourcing model for European refurbished medical equipment, a level of care is achieved that matches the standard of traditional brick-and-mortar district hospitals in primary care, whilst entirely eliminating the risks of local construction defects.

Embedding the modular expansion stages (telemedicine, specialist modules, rural surgery) within the socio-culturally and digitally adapted Ghanaian HMO prepaid financing model ensures that the overall system can operate in an economically self-sustaining manner over the long term. Monthly income from rural family insurance contributions reliably covers operational consumable costs (OPEX of approx. 2,750 USD for Stage 1). The resulting surplus flows directly into the regional Maintenance and Expansion Fund.

Since the entire system is designed as a mobile, standardised asset and contributes directly to achieving the UN Sustainable Development Goals (specifically SDG 3: Good Health, SDG 6: Clean Water, SDG 7: Clean Energy, SDG 8: Decent Work, SDG 17: Partnerships), it is strongly recommended to establish this concept as a standard infrastructure hub for rural hub villages within the Ghanaian healthcare system and to finalise the pending MoUs with the Ministry of Health swiftly.

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Professor Bernd Glazinski PhD, M.A. (born 1967) is a psychologist, educator, and classical philologist with more than 30 years of experience in leadership and project management.

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Since 2000, he has served as a Professor of Business Psychology. From 2006 to 2015, he was a Visiting Professor at the Comenius University in Bratislava. Since 2019, he has been a Visiting Professor at the Amílcar Cabral University in Bissau. Since 2021, he has served as Rector of the European University in Bissau and Director of the German University Institute at the same institution.

He is the author of specialist books and publications in the field of people and organizations. Currently he leads the Social Entrepreneurship Foundation under Thurn und Taxis Consulting AG.

Prof. Konrad Obermann, MD, PhD

Professor Konrad Obermann MD, PhD (born 1965) is a physician and economist with more than 30 years of experience in clinical practice, research, strategic planning, and consulting.

Professor Obermann worked as a consultant with the Boston Consulting Group (BCG), headed the Health Economics Department at the IGES Institute in Berlin, and worked for the German Agency for International Cooperation (GIZ) in the Philippines.

Since 2008, he has been a Senior Lecturer at the Mannheim Center for Preventive Medicine and Digital Health (CPD) at Heidelberg University. In addition, he is a Visiting Scholar at the Pakistan Institute of Development Economics (PIDE) in Islamabad and an Overseas Member of the Royal Society of Medicine in London.

His recent publications include The German Healthcare System (3rd edition, medhochzwei Publishing, Heidelberg) and Medical Economics (Columbia University Press, New York).