Proposal Template

Name of the institute: **Independent**

Incubator: Not Assigned- **Prototype Not Yet Developed**

Faculty: Not Applicable

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Objective: **To Reach the Vaccination Programme to Every Last Corner with the Infrastructure already available**

Type of Intervention: (Choose one)

1) Proposal on Vaccination drive community engagement

2) Proposal on Cold storages and Cold chains battery or solar operated for last mile connection

3) Last stage Vaccination development

**4) Post Vaccination studies.

Details of intervention:

As important as the vaccine is predicted to be in tackling COVID 19, the most important part of the jigsaw will be to efficiently distribute the same to the last mile. The challenge here is to maintain an environment ambient for the storage of the vaccine- not too hot, not to cold, yet be handled with ease without much technical skills. The design that is proposed here, is based on the block-to- village mode of distribution, primarily a top-down approach for administering vaccines to thousands, keeping in mind that in extreme cases, major parts of the chain will be without the services of electrical power.

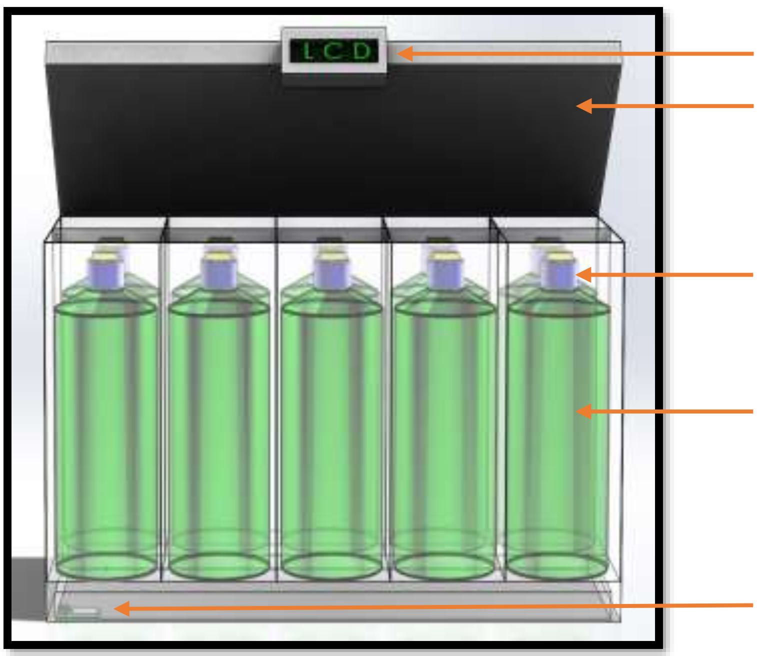
The vaccine storage cabinet is proposed to use almost zero electricity to keep vaccines at the appropriate temperatures for at least 24 hours along with frequent vaccine retrievals. The cooling system relies on single batch of ice packs/packs of cooling solutions along with multiple layers of insulation system. The design has been made compact of 160 liters effective volume and easily transportable via mini trucks, vans etc. to block level from where the individual storage units may be taken to villages, hand held in thermocol boxes for final administration. In extreme cases if temperature increases, it can be efficiently tackled with simply replacing the cooling pads in the portable section of storage. The simplicity of the design makes it easy to manufacture and easier usage for a vast community of people along with its minimum maintenance cost and temperature tracking system all the time during field use makes it an ideal, reliable vaccine storage and transportation system.

While the distribution of the individual vaccines is a difficult task unto itself, the safe=keeping and legitimate distribution of the vaccination equipment remains an equally important challenge within the foreseeable future owing to the critical scarcity of these precious items. It is therefore proposed that each of these distribution cabinets be equipped with a micro-controller-based GPS logging unit which also controls the temperature tracking sensors. This unit can then cast its true coordinates in real time to any preconfigured server/API, or alternatively, be integrated into a mapping database in order to facilitate geoscientific data management (with provision for active tamper protection if package does not reach its intended destination).

Figure 1:

Artistic rendering of vaccine cabinet

(transparency showing full layout)



LCD readout for physical and security

Digitally Locked High Security

Tamper Proof Container Seals
with display for unit condition

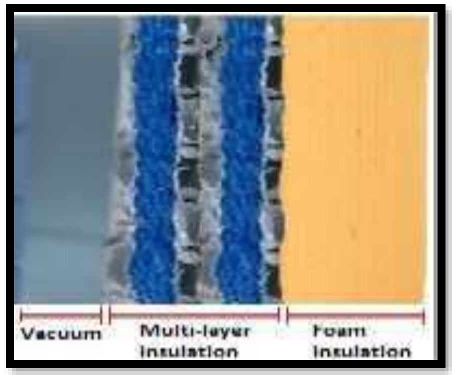
Insulated Bulk Storage Bottles

Electronics for GPS and Status monitoring

Fig 2: Detailed Layout of Proposed Design

Each of the vaccine chamber is of dimension **3.5ft x 1ft (approx.) or 1066.8mm x 304.8mm (approx.)**

The opening hatch is of radius **15 cm**. This dimension is same throughout the retrieving channel. It is big enough for a person to take out the vaccine stacks contained inside. Digital thermometer is attached with battery to monitor temperature.



An enlarged view of the insulating layers. The multilayer insulation is a comprises of alternate layers of aluminium sheets and plastic bubble wraps that together acts as a super - insulation system.

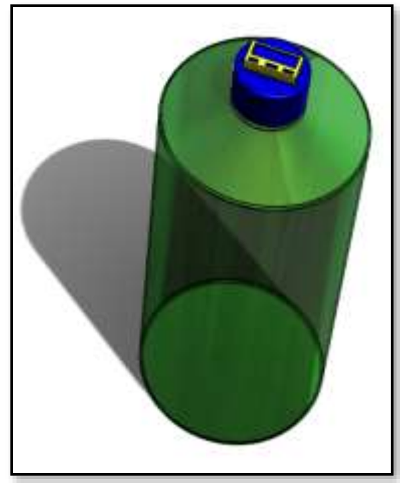
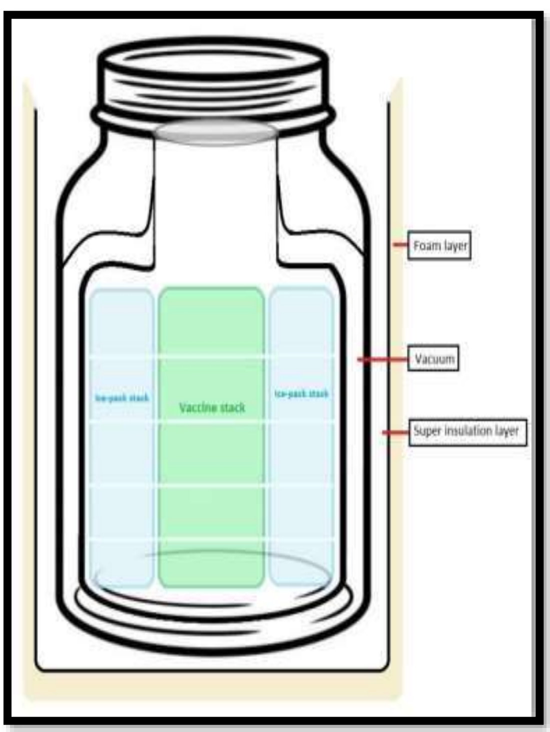


Fig 3: Detailed Layout of Proposed Design of Individual Vaccine Storage Units

This is the chamber where the vaccines are to be stored. The inner chamber is wrapped up by mainly three layers >>> a vacuum layer, a layer of super insulators, a layer of foam.

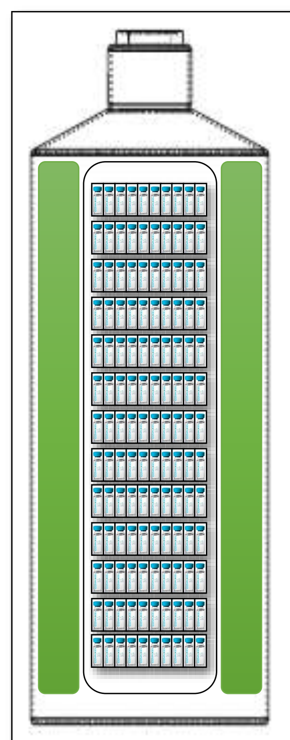
The vaccines are retrieved from the chamber through small channel at the top but it's large enough to put one's hand through it while retrieving. Each time lid is opened to retrieve vaccine, the retrieving channel enables minimum hear transfer from outside thus maintaining the cold temperature inside the

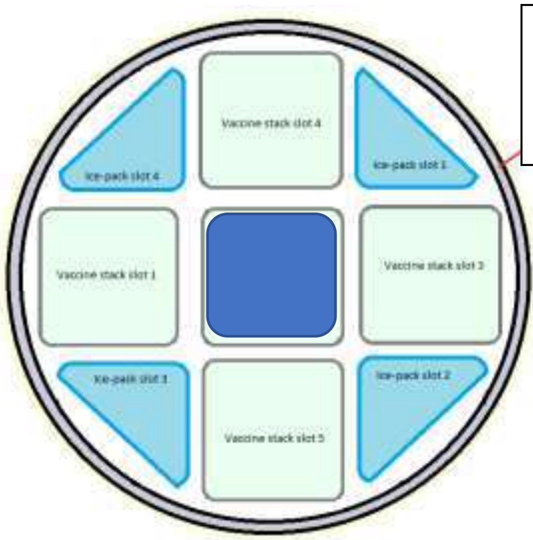
chamber. An enlarged view of the insulating layers. The multilayer insulation is a comprises of alternate layers of aluminium sheets and plastic bubble wraps that together acts as a super insulation system.



This diagram shows how the opening of the vaccine chamber is closed using a lid that completely seals the retrieving channel. This air tight locking mechanism prevents any loss of temperature thus keeping it almost constant inside of the chamber.

In the middle is the opening lid which is fitted with a foam of cylindrical shape. Its dimensions are such that it fits right into the retrieving channel.





This is the orientation in which the vaccine stacks and ice-pack stacks are to be positioned inside each of the vaccine chambers. The outer ring is the vacuum layer.

The ice packs also are made of similar quality of plastic material. They are placed in the form of stacks along with the vaccine stacks inside the vaccine chamber. Easily replaceable.

Fig 4: Orientation of Opening Lids, Vaccine Stacks and Cooling Units

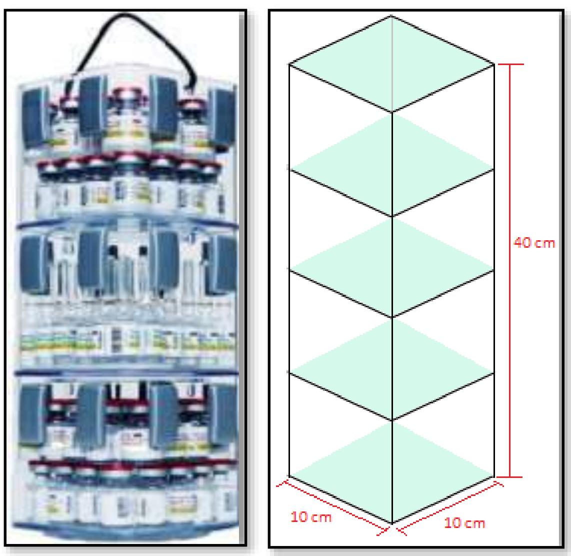


Fig 5: Vaccine Stack

This is a vaccine stack in which the vaccines are to be stored. These plastic containers

are of dimension: **400mm x 100mm x 100mm** Total volume: **4000000 mm^3** i.e., **4 liters**

per stack. There are four stacks in each chamber i.e., **16 liters** per chamber. Now ten

of these chambers forms the cabinet, that makes **160 liters** of storage volume.

The stack is made of plastic that can withstand temperature variance and few small

openings are there all over its body in order to maintain the inside humidity

- The main attraction of this design is its simplicity along with its manufacturing technique.
- The vaccine stacks and ice packs are placed compactly inside the chamber thus it prevents them from spillage.
- Optimized Temperature can easily be calibrated using number of Icepacks.
- The outside covering body of the cabinet is made up of polycarbonate stuffed with foam structure.

Approximate Projected Cost of Preparing the Prototype of One Vaccine Cabinet containing a Single Vaccine Storage Unit based on Retail Price of Materials available online:

Full Assembly of High Security Vaccination Transport Equipment						
Item	Quantity	Minimum	Maximum	Average/unit	Total	Comments
Electronics						
Digital lock	1	500	2200	1350	1350	Lower price comes with lock only, no electronics
LCD display	2	150	500	325	650	7 segment or Dot-matrix display
GPS tracker	1	1700	3400	2550	2550	Varied capability and precision of mapping commands higher cost
Temp Humidity Pressure sensor	11	250	600	425	4675	Lower priced module can sense temp and humidity only
Microcontroller module	11	220	350	285	3135	Depends on availability
Battery 500mAh	11	400	500	450	4950	Depends on quality
Buttons/Misc	50	6	10	8	400	Depends on availability
Cooling Fan	1	200	250	225	225	Depends on availability
Security Box						
Sunboard	152	55	65	60	9120	
Spray foam (insulator 1)	1	180	220	200	200	per Kg
Polystyrene (Insulator 2)	4	550	600	575	2300	per Kg whichever is lower
	152	10	15	12.5	1900	per sqft whichever is lower
Coolant						
Branded Cool Pack	10	200	220	210	2100	Depends on quality
Industrial Ice slab	10	100	120	110	1100	Depends on quality
Industrial Coolant fluid	1	330	350	340	340	Depends on quality
Large Heat exchanger	1	2700	3000	2850	2850	Varies by size
Bulk containment bottles						
Bottle body (PET)	10	700	800	750	7500	Varies by materials
Bottle cap (Silicone)	10	50	100	75	750	Varies by materials
				Grand Total	46095	Conservative estimate suggests the final manufacturing price of a prototype to be @ INR 35,000, the inflated values in this chart were retail-based estimates.

Mass properties of Security Box Assy			
Configuration: Default			
Mass = 241.48 pounds			
Volume = 7133.45 cubic inches			
Surface area = 304 square feet (approx.)			
Principal axes of inertia and principal moments of inertia: (pounds * square inches)	Ix = (1.00, 0.00, 0.00)	Px = 125075.72	
Taken at the centre of mass.	Iy = (0.00, 1.00, -0.01)	Py = 202240.30	
	Iz = (0.00, 0.01, 1.00)	Pz = 282064.09	
Moments of inertia: (pounds * square inches)	Lxx = 125076.30	Lxy = 205.19	Lxz = -66.19
Taken at the centre of mass and aligned with the output coordinate system.	Lyx = 205.19	Lyy = 202242.61	Lyz = -477.64
	Lzx = -66.19	Lzy = -477.64	Lzz = 282061.20
Moments of inertia: (pounds * square inches)	Ixx = 226311.02	Ixy = 104.07	Ixz = -178.14
Taken at the output coordinate system.	Iyx = 104.07	Iyy = 257991.00	Iyz = 49879.01
	Izx = -178.14	Izy = 49879.01	Izz = 327547.98

Implementation Strategy and Planning:

Since in our individual capacity, it is not possible to proceed to manufacturing, we have contacted a number of manufacturers and have filtered down to two main potential manufacturers which both have their individual Pros and Cons. Detailed analysis comparing both the manufacturers are mentioned below:

Category 1: Mass Producer

Material of Vaccine Storage Unit: Polyethylene Terephthalate

Mandatory Initial Investment: Approximately 20 lakhs INR for designing and manufacturing the primary die.

Capacity: 30,000 vaccine storage units per month = 3000 Vaccine Cabinet

Scalability: Each die has the capacity of producing 30,000 units. This capacity can be increased as per requirement in batches of 30,000 units by deploying extra die which would require an initial addon payment of 1 Lakh INR for each extra die.

Cost for each Vaccine Storage Unit producing at 30,000 units per month:

The first 30,000 units of vaccine Storage Unit can be supplied at a cost of approximately 38,000 INR. Therefore, considering each complete vaccine cabinet consisting of 10 vaccine storage units, by mathematical multiplication, the cost of a single unit of the Complete Vaccine Cabinet comes to

38,000 INR*10 equaling to 380,000 INR, which according to our experience can be manufactured well below the estimated cost at around 350,000 INR.

For subsequent batches of 30,000 units, a decrease in cost of up to 25% maybe possible.

If the units are produced at a capacity of 60,000 units per month, the price of each Vaccine Storage Unit is estimated to be around 32,000 INR amounting up to 320,000 INR for the entire Vaccine cabinet. For subsequent batches of 60,000 units a cost reduction of 30-35% may be expected.

Comments:

The manufacturer is the biggest PET manufacturer and supplier in Eastern India. The manufacturer has to adhere to some pre-existing technological specification while they have assured to be flexible in certain other specifications. This gives rise to a constraint in geometrical shape, requiring us to go back to the drawing board for some fundamental modifications in our design. Vacuum insulation will not be possible to be implemented but similar level of insulation can be achieved by alternative strategies. However, this modification is perfectly achievable but the volume capacity of vaccine storage in each Vaccine Storage Unit would be reduced by approximately 33%. The main drawback in this case is that the manufacturer will not be able to produce a prototype. The prototype has to be assembled by us individually by collecting spare parts from the open market. The cost of assembling and testing the prototype will range approximately to around 15,000 INR which we have calculated purely based on prices and data available online, which therefore is subject to a certain degree of variation. Therefore, the prototype is expected to suffice the basic need of testing and data analysis, it will by no means represent the final product.

Pros: <u>Easily Scalable, Price Diminished with Scale</u>

Cons: Design needed to be modified, No Vacuum Insulation, No Manufacturer Prototype

Category 2: Precision Manufacturer

Material of Vaccine Storage Unit: Medical Grade Polypropylene

Mandatory Initial Investment: Nothing as such

Capacity: 5,000 vaccine storage units per month = 500 Vaccine Cabinet

Scalability: As of immediate, 5,000 units is the maximum manufacturing capacity for 1 month. However, if the product is finalized to be manufactured, the manufacturer has promised to try his best to increase the manufacturing capacity. This is subject to further discussions at later stages of development.

Cost for each Vaccine Storage Unit:

The prototype of the Vaccine Cabinet containing a single Vaccine Storage Unit can roughly be manufactured at a very rough approximate of 38,000 INR. The exact estimate may be obtained as soon as the complete detailed manufacturing design and plan is forwarded to the manufacturer. We are engaging continuously regarding the matter.

When in the manufacturing chain, the cost may decrease slightly to around 35,000 INR, leading the complete cost of a vaccine cabinet to around 350,000 INR.

Comments:

The manufacturer is The Best plastic engineer available in the market. Earlier experience of working with the manufacturer adds an added level of confidence. The main advantage is that the unit may be manufactured accurately as planned without compromising with any structural features. Vacuum Insulation may be efficiently implemented. The production capacity is apparently somewhat limited, but we are confident, the best efforts may be made to increase the capacity of production if called for.

Pros: High Precision, Vacuum Isolation

Cons: Comparatively less Production capacity

Final Assessment of Designers:

The uniqueness of the proposed design is that the volume capacity of the vaccine cabinet can be customized without much hassle and risk of compromisation with the design.

Both the implementation strategies have their own advantages and disadvantages as discussed in detail. Upon consideration of all the facts, the designers are not to convinced with the first track of development because there exists a number of weak links, leading to disruption of the holistic stability of the design. Hence from technological point of view, it is best to proceed with the second manufacturer, even though the mass production capacity is restricted.

From the side of economic viability, the first approach appears more lucrative but the feasibility of the entire project is at stake because firstly it would be impossible to achieve the ideal insulation, without vacuum insulation. The efficacy of the entire project is at the risk of drastically reduced. It should also be taken into consideration, that upon modification, the volume capacity of each vaccine storage unit is reduced by almost 33% thereby negating the cost advantage.

As a final assessment, the designers would strongly recommend the second approach of development but are always open to further suggestions, discussions and considerations.

Approximate Development Plan (Timeline):

1. Detailed Prototype Manufacturing Design and Plan: 15 days to 30 days
2. Simulation in Computer Model: 14 days to 21 days
3. Prototype Development and Testing: 3 months
4. Modifications, Simulations and Analysis if Necessary: 1 month
5. Official Formalities
6. Mass Production

Do you have State Government connection, or will you require support from CSR – Will need support from CSR.

States that you can provide technology to – Any State

Please answer following questions depending on the intervention you choose and if applicable to you:

Can you do the Community engagement yourselves or will need help by CSR- **Help of CSR**

If you have a Market ready technology available,

- How do you plan to deploy:
- Number of unites available:

Do u wish to partner with an NGO? If yes, name the NGO and provide details on how u will partner? (item wise costing should include cost to NGO for their scope of work)

**** For this type intervention, please send a separate 1-2 pager proposal that will include abstract of the planned/proposed work, methodology, tentative budget, and estimated timeline.**

Design Proposed By:

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