ADAPTIVE, SMART, GRAVITY BASED INFUSION PUMP MONITOR

TEAM MEDIHELP
UNIVERSITY OF MORATUWA

MEDIHELP

SMART FLOW - SIMPLE CARE

INFUCARE

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WHY ?

Key Problems Identified:

Manual Flow Rates:

Deviations cause overdose/underdose risks, especially critical for chemotherapy.

No External Display:

Patients cannot monitor Flow, and staff must constantly check manually.

Patient Self-Adjustment:

Some patients dangerously self-adjust flows, particularly for chemotherapy.

Expensive Regulators:

Advanced pumps are expensive and rare in Sri Lanka, limiting access.

Our proposed solution effectively addresses these issues identified during a field visit to Apeksha Hospital in Maharagama on 12th August 2025, conducted under the guidance of Dr. Ranjith Mahilal, Medical Officer – Oncology

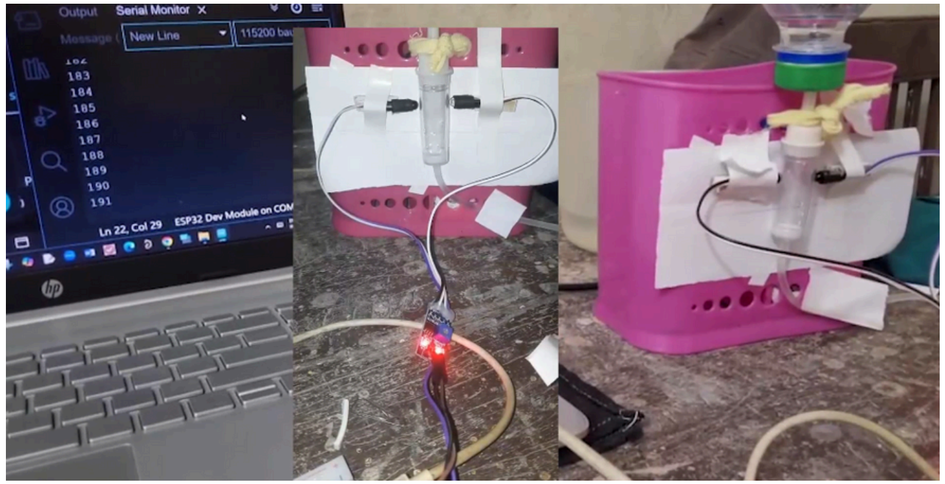
WE ADDRESS A SERIOUS ISSUE IN HEALTHCARE!

As identified during a field visit to Apeksha Hospital in Maharagama on 12th August 2025, conducted under the guidance of Dr. Ranjith Abeywardhana, Medical Officer – Oncology,

for a ward of 25 beds, only 3 advanced infusion pumps are available where other 22 beds are making use of simple gravity based infusion pumps!

Initial Concept Selection

IR Method



Capacitive Method

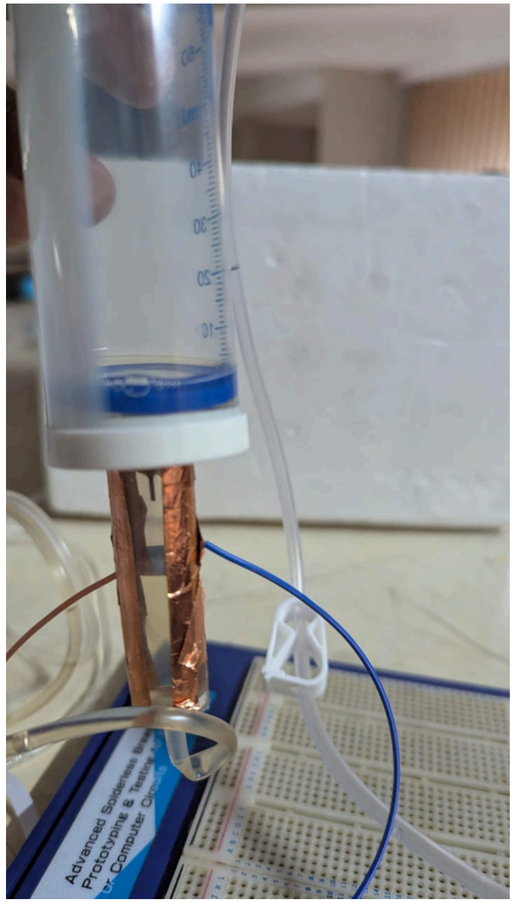
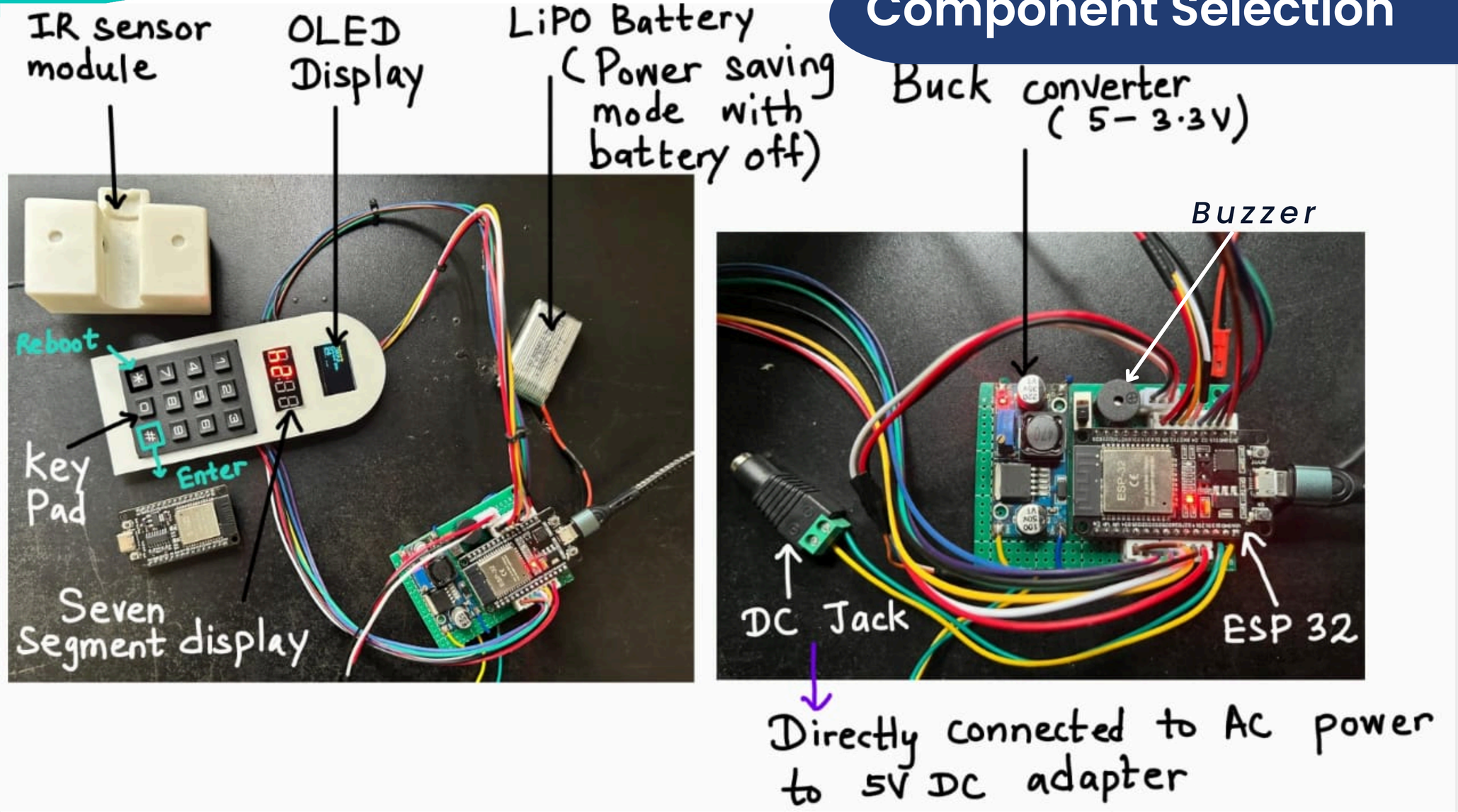


Image processing Method

Circuit Design and Product Dissection

Component Selection



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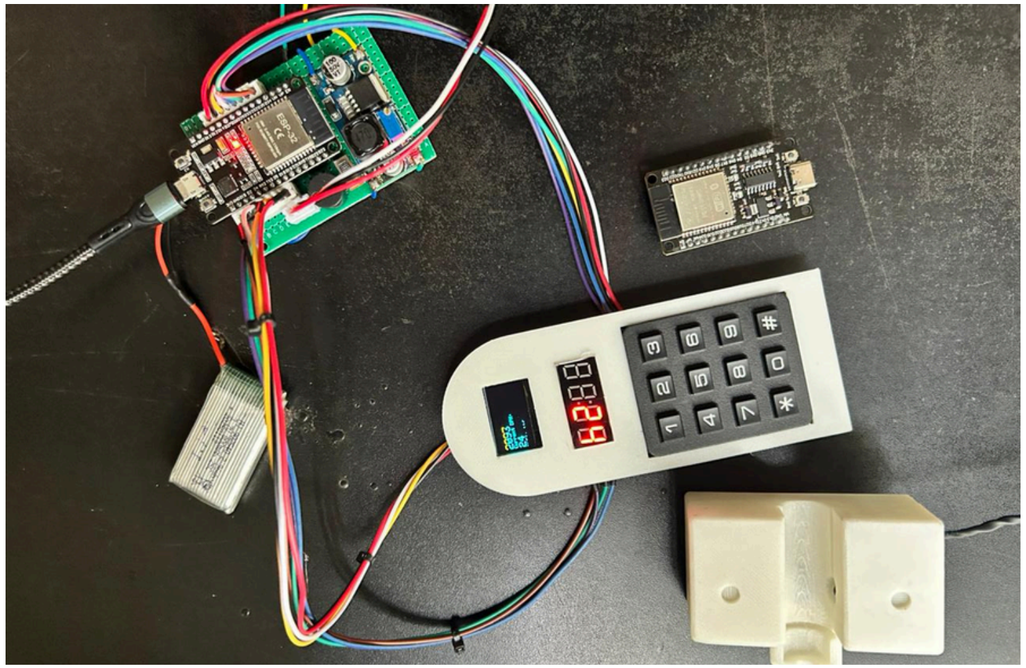
Technical Overview

Component	Role in the Product
ESP32	The brain of the system. Processes signals from the IR sensor, calculates drop rate, displays results, and connects with mobile/IoT systems.
Buzzer	Acts as an alarm. Alerts staff immediately when the drip rate deviates from the expected value.
Num Pad	Allows medical staff to input the desired drip rate (drops/min) for each patient.
Display	Shows the real-time drip rate in drops/min and mL, making it doctor-friendly and patient-friendly.
TP4056	Manages battery charging with built-in overcharge protection, ensuring safe and reliable backup power.
DC Jack	Provides AC power connection for continuous operation in the ward.
3D Printing	Creates the protective enclosure. Designed to be easily opened for sensor inspection, cleaning, and maintenance.
IR Sensor	Detects each IV fluid drop when it interrupts the light beam, enabling accurate real-time drop counting.

Tools	Platform / Service	Technologies & Protocols
ESP32 DevKit (hardware)	On-device MCU (ESP32)	Arduino
TP4056 module, Li-ion battery	Power subsystem	Battery charge/protection, AC/DC adapter input
IR emitter & receiver pair	Sensor subsystem	Photointerrupt detection, analog/digital input
OLED / LCD	Local UI	I²C/SPI display drivers
Buzzer, NumPad, Magnets, Wires, PCB	Mechanical & electrical components	GPIO, debouncing, and mechanical mounting
3D printer (Prusa/Creality)	Enclosure prototyping	Fusion
Development IDEs: PlatformIO / Arduino / ESP-IDF	Firmware dev	C/C++ with JSON serialization
Mobile app: Flutter	Mobile platform (Android/iOS)	JSON over MQTT/REST;
Testing tools: Multimeter, Oscilloscope, Postman, Android emulator	Lab & QA	Automated unit tests, integration tests
PCB fabrication: JLCPCB	Altium	Gerbers, pick-and-place files

Funcional block diagram



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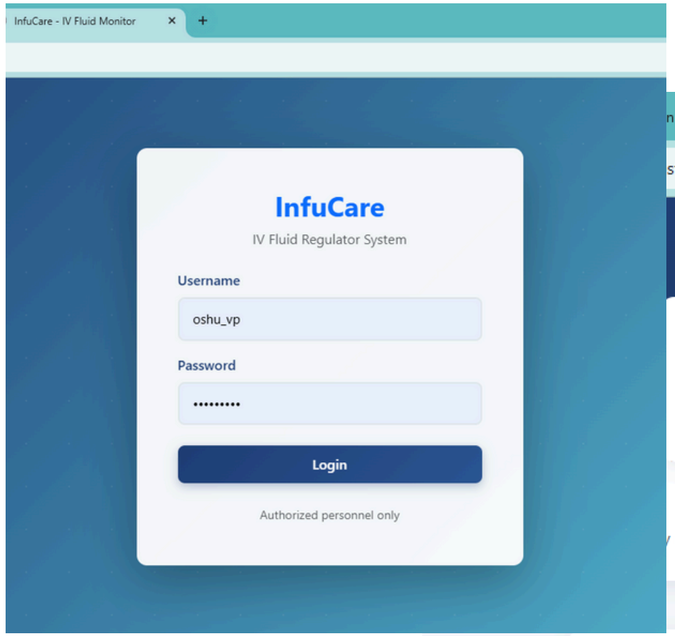
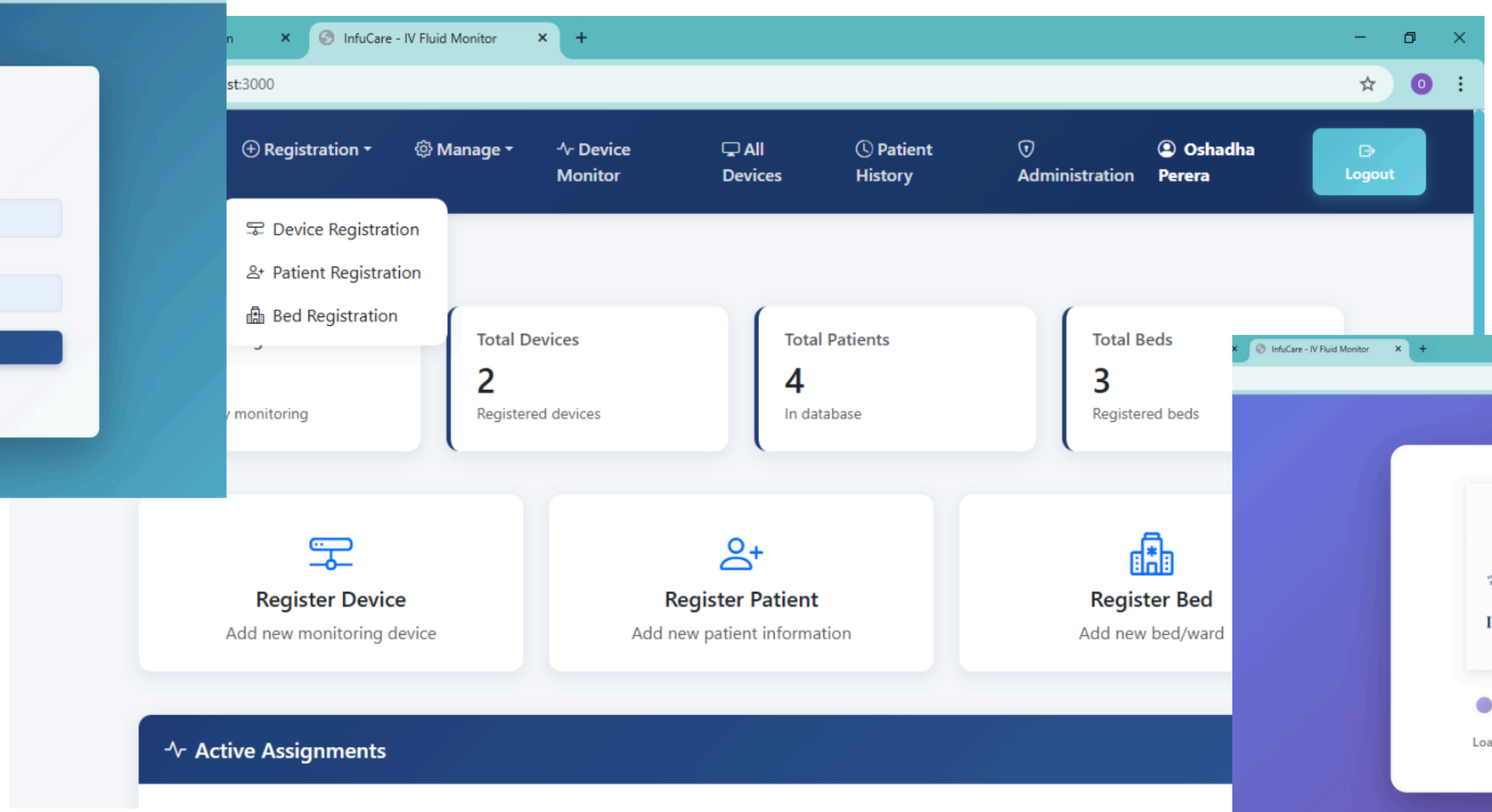
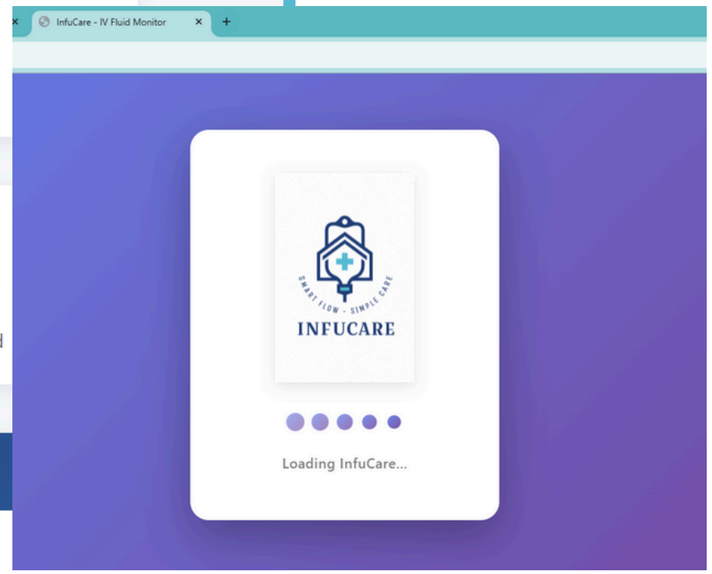
UI/UX Design and IOT Integration







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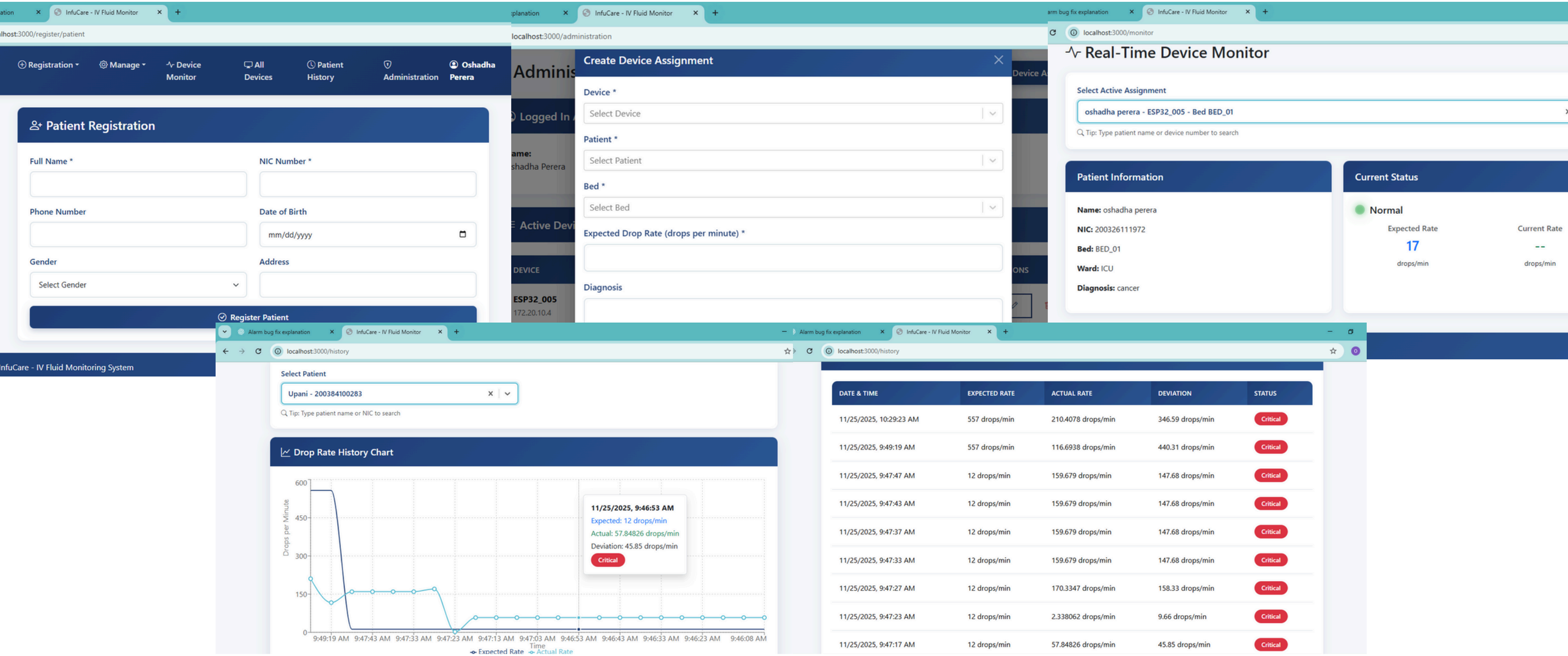
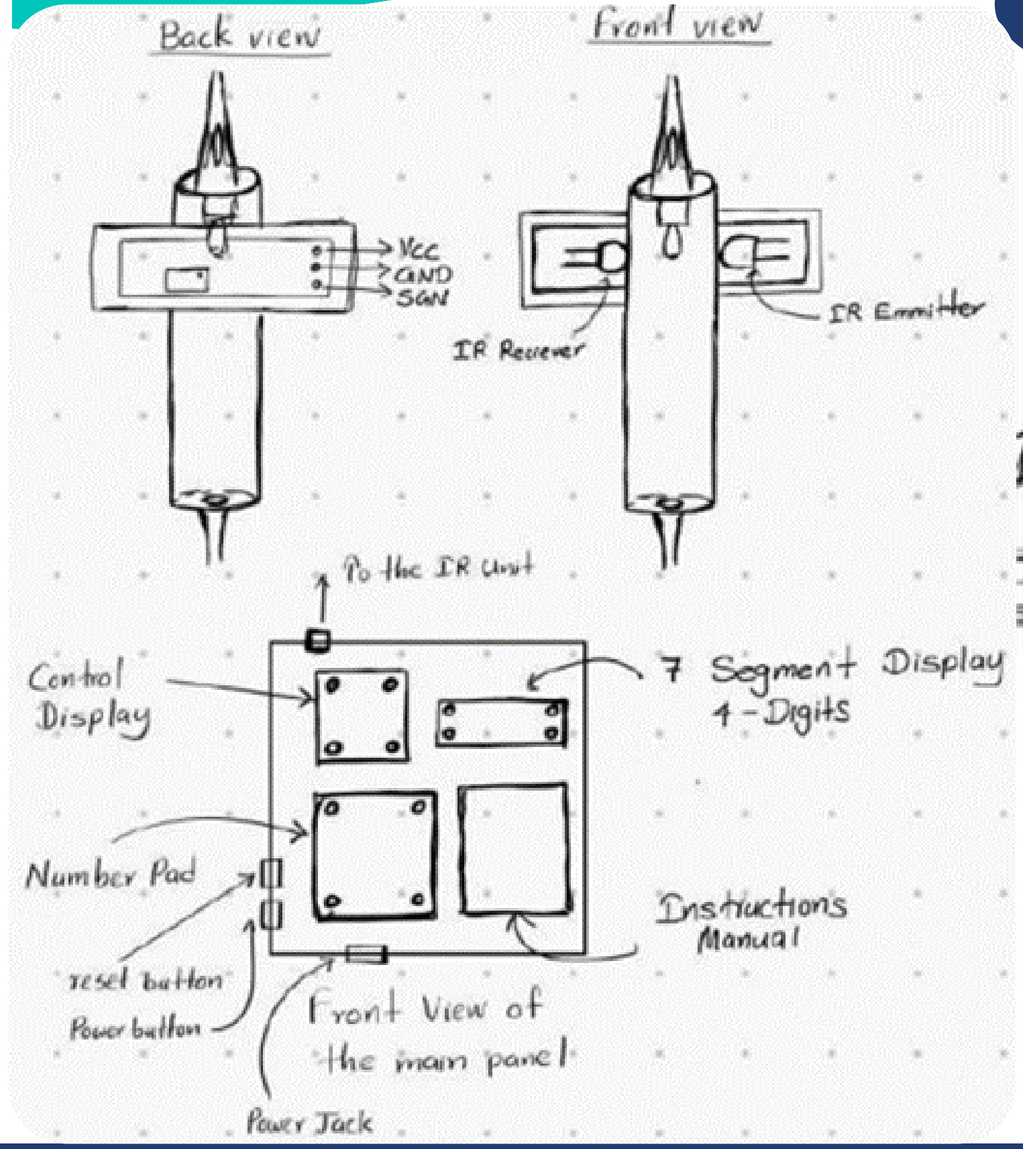
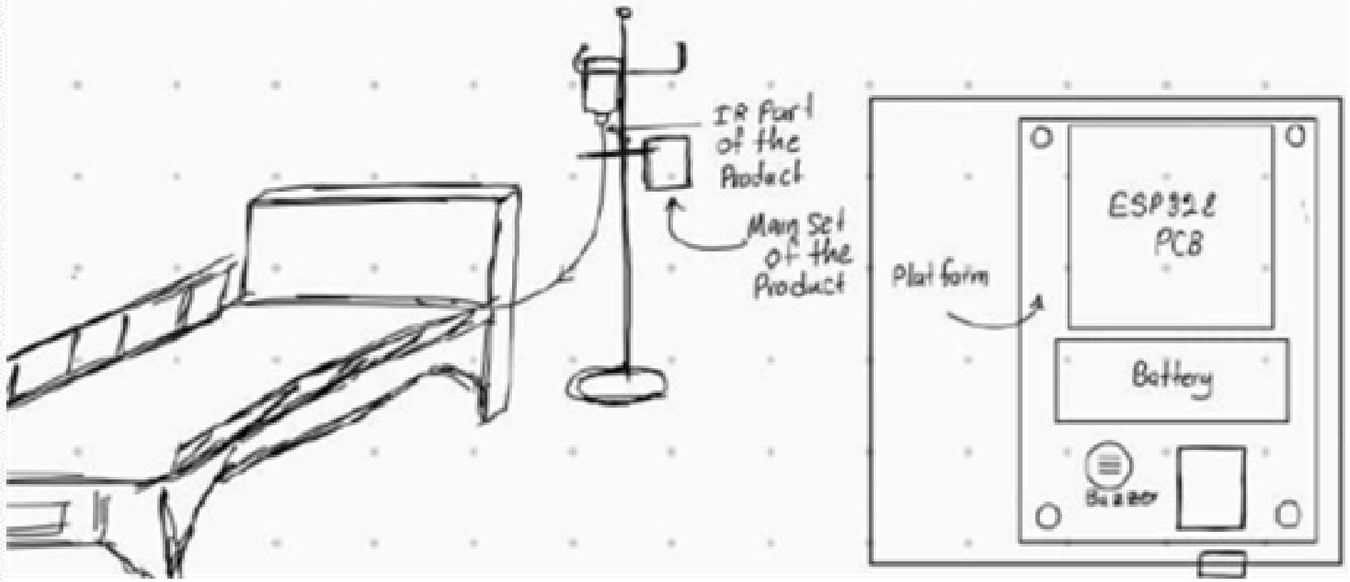
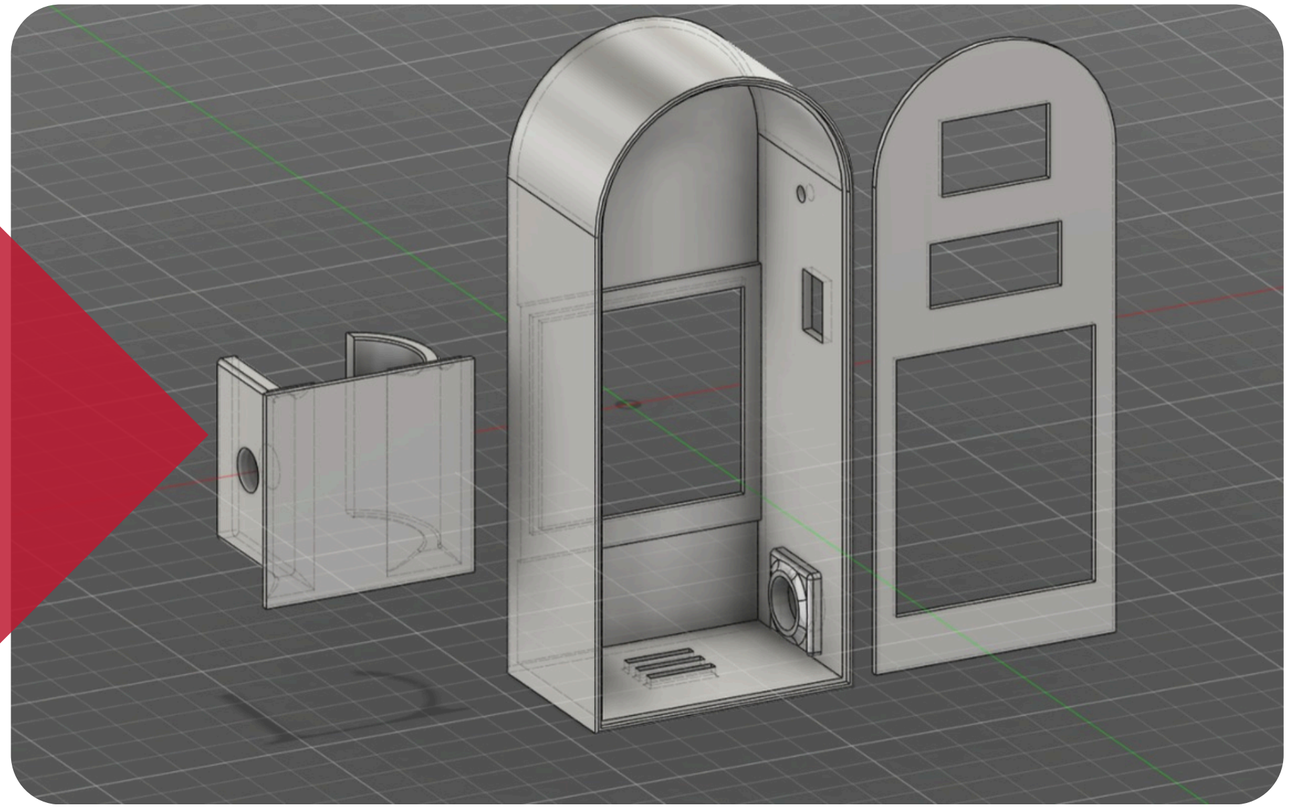


Sketch


Back view
Front view
Vcc
GND
SGN
IR Reciever
IR Emmitter
To the IR unit
Control Display
7 Segment Display 4-Digits
Number Pad
Instructions Manual
reset button
Power button
Front View of the main panel
Power Jack


IR Part of the Product
Main Set of the Product
Platform
ESP32 PCB
Battery
Buzzer

Enclosure Design



Demonstration

1. Power on the device.
2. Enter the required medicine volume.
3. Set the duration that we want to pass the medicine.
4. Adjust the IV set until the displayed drop rate (DPM) matches the required value.
   - After displaying the target DPM, the device will remain silent for 5 minutes to allow the nurse sufficient time to set the drip rate (no alarms during this period)
5. Alarm Indication Protocol:
   - If the drop rate deviates from the set value:
     - Ignore deviations for the first 5 seconds (no alarm).
     - If deviation persists beyond 5 seconds, activate an alert alarm for 3 seconds.
     - After the alert, the device waits silently to observe if the drop rate corrects itself.
     - If the deviation continues for 10 seconds, the device activates a continuous alarm until the drop rate is corrected.

UNIQUENESS OF INFUCARE MVP

Simple Gravity Based pump

External display ✗

Rate Deviation alarm ✗

Affordability ✓

Reliability ✗

IOT Monitoring ✗

Infucare (MVP)

External display ✓

Rate Deviation alarm ✓

Unit Cost < Rs.10000

Affordability ✓

Reliability ✓

IOT Monitoring ✓

Advanced Infusion Pumps

External display ✓

Rate Deviation alarm ✓

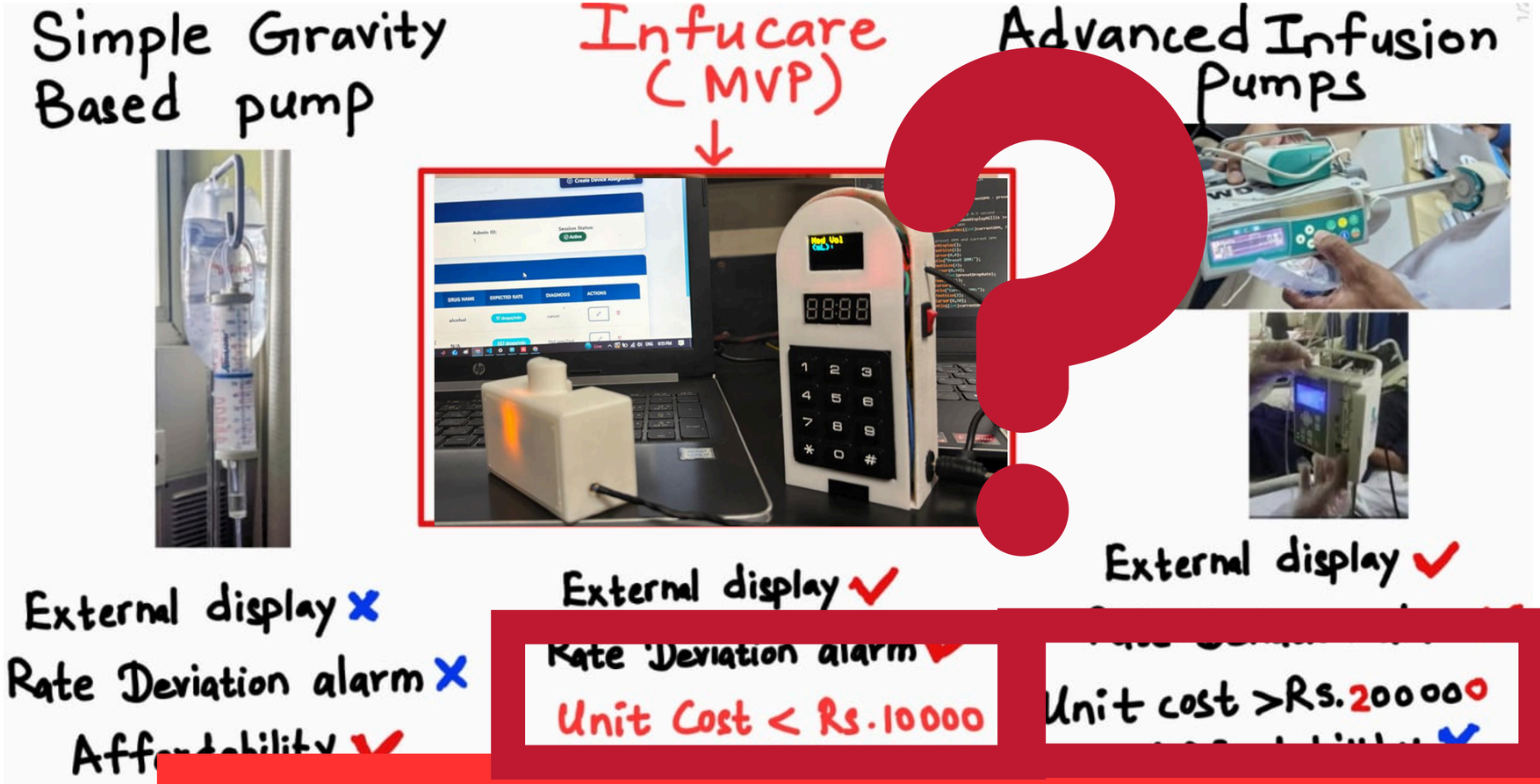
Unit cost >Rs.200000

Affordability ✗

Reliability ✓

IOT Monitoring ✗

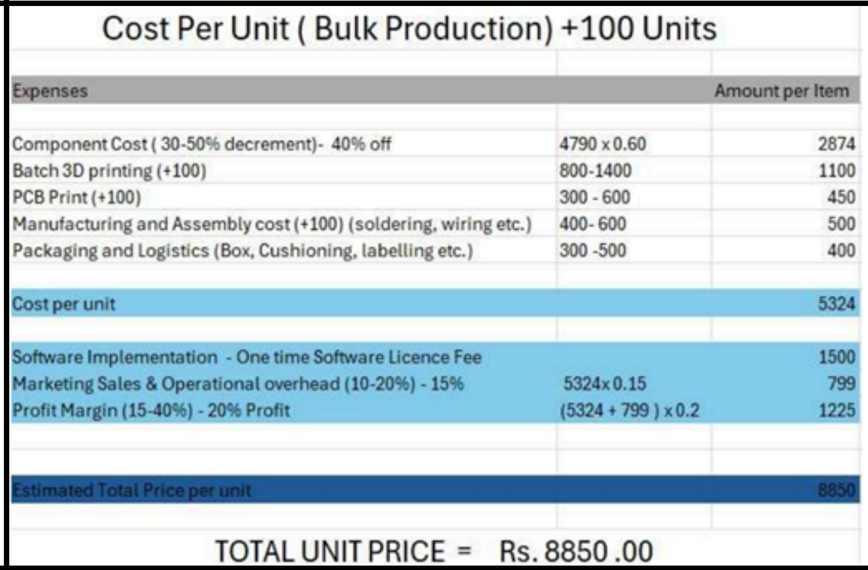
UNIQUENESS OF INFUCARE MVP



What features cause the Rs. 190 000 difference per unit?

Does low-cost reduce the efficiency of Infucare?

INFUCARE UNBEATABLE COST ADVANTAGE

	INFUCARE INFUSION PUMP	ADVANCED INFUSION PUMPS
IMPLEMENTATION COST PER UNIT	Cost Per Unit (Bulk Production) +100 Units 	Greater than Rs. 200000.00 NOT AFFORDABLE !
IMPLEMENTATION COST PER WARD OF 25 BEDS	Rs. 8850 x 25 = Rs. 221 250.00 Savings by implementing Infucare over advanced pumps: 55.75 %	Rs. 200000 x 25 = Rs. 5000000.00

Expenses		Amount per Item
Component Cost (30-50% decrement)- 40% off	4790 x 0.60	2874
Batch 3D printing (+100)	800-1400	1100
PCB Print (+100)	300 - 600	450
Manufacturing and Assembly cost (+100) (soldering, wiring etc.)	400- 600	500
Packaging and Logistics (Box, Cushioning, labelling etc.)	300 -500	400
Cost per unit		5324
Software Implementation - One time Software Licence Fee		1500
Marketing Sales & Operational overhead (10-20%) - 15%	5324x 0.15	799
Profit Margin (15-40%) - 20% Profit	(5324 + 799) x 0.2	1225
Estimated Total Price per unit		8850

TOTAL UNIT PRICE = Rs. 8850 .00

DOUBLE COST EFFICIENCY FOR INVESTORS!!

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INFUCARE GO-TO-MARKET STRATEGY

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1. Regulatory Approval Pathway

STEP 1

Submitting documents to obtain the **ethical clearance from the University Ethics Review Committee, University of Moratuwa** (https://uom.lk/uerc) **to perform initial clinical trials**.

STEP 2

Submitting documents to obtain the **clearance from the National Medicines Regulatory Authority (NMRA)**, the responsible body for the regulation and control of registration, licensing, manufacture, importation and all other aspects pertaining to medical devices in Sri Lanka **to further continue clinical trials**.

FDA Class II

non-invasive and thus require to perform as expected and will not cause injury or harm to their users

Low-moderate risk device

Classification systems for notified medical devices in India (www.icac.in)

INFUCARE GO-TO-MARKET STRATEGY

2. strategic partnerships with hospitals and local manufacturers to accelerate regulatory approval and market entry.

Landscape of the Market	Market segmentation	Target market	Nature of competitors
In Sri Lanka, IV therapy is one of the most common treatments used in hospitals. Almost every type of patient depends on IV fluids, from cancer patients to those in ICUs and after surgery. But proper IV fluid regulators are very limited. For example, at Apeksha Hospital, which is the main cancer hospital, there are only about four infusion pumps available for more than forty beds in a ward. In rural hospitals, many patients are treated only with simple gravity-based IV sets that are not accurate. This shows a big gap between the need and the available solutions. With the number of patients increasing every year due to cancer, heart disease, diabetes, and surgeries, the demand for a reliable but low-cost regulator will keep growing.	From the hospital side, there are three main levels: large national hospitals like Colombo and Kandy that handle thousands of patients, regional hospitals that serve smaller cities, and rural hospitals where facilities are very basic. From the economic side, private hospitals can afford expensive devices, but government hospitals, which treat the largest number of patients, cannot. This means that even though private hospitals are able to buy costly infusion pumps, the real need is in government and rural hospitals where patients depend only on basic IV sets.	The main target is government hospitals because they have the highest patient load and the biggest need. They struggle the most with having too few regulators and too many patients. The second target is private hospitals. The third important target is rural hospitals that do not have improved IV regulators at all. Introducing even a basic affordable system will make a big difference in safety for patients and reduce stress on staff who are already overloaded.	Advanced IV fluid regulation systems are not affordable to the local hospital system. At the moment, no one is providing a low-cost but reliable IV regulator made for the Sri Lankan context. This creates a clear space in the market that our solution can fill.

Future Improvements

In future developments, the system will be enhanced by enabling ESP32-to-ESP32 communication within each hospital ward. This will allow the creation of a **local LED indicator network connecting all infusion setups in the ward.** Each bed will have a dedicated LED indicator that reflects the current drip status — normal, deviating, or alarm — in real time.

This offline communication model will ensure that the monitoring and alert **functions remain fully operational even if internet connectivity fails, making the system highly suitable for rural hospitals and low-resource environments** where reliable internet access cannot be guaranteed.

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References

[1] O. Hoffman and O. Bacon, “Infusion Pumps,” in Making Healthcare Safer III: A Critical Analysis of Existing and Emerging Patient Safety Practices, K. K. Hall, S. Shoemaker-Hunt, L. Hoffman, et al., Eds. Rockville, MD, USA: Agency for Healthcare Research and Quality (US), Mar. 2020. [Online]. Available: https://www.ncbi.nlm.nih.gov/books/NBK555506/

[2] B. Jung, K. S. Seo, S. J. Kwon, K. Lee, S. Hong, H. Seo, G. Y. Kim, G. M. Park, J. Jeong, and S. Seo, “Efficacy evaluation of syringe pump developed for continuous drug infusion,” J. Dent. Anesth. Pain Med., vol. 16, no. 4, pp. 303–307, Dec. 2016. doi: 10.17245/jdapm.2016.16.4.303. PMID: 28879319; PMCID: PMC5564196. [Online]. Available: https://pmc.ncbi.nlm.nih.gov/articles/PMC5564196/

INFUCARE GO-TO-MARKET STRATEGY

THANK YOU
Q & A

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More Lives. Less Cost.