VICN - Vending Intelligent Control Node modular system

ID: 130809

Challenge Name	Date Added
Autonomous Contraception Dispensing Stations	19/10/2024

Creator

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Team Members

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1. Participation Type - Please select how you are participating in this Challenge:

Solver (Individual)

2. Solution Level – Please select the Technology Readiness Level (TRL) of your solution:

Ideation (TRL 1-3)

3. Partnering - Are you interested in partnering?

Yes

4. Problem & Opportunity – Please highlight the innovation in your approach to the problem, its point of difference, and the specific advantages/benefits this brings (up to 500 words)

Thinking Outside The [VENDING MACHINE] Box

How have vending machines changed significantly over the years? Yes, these days we see all kinds of vending machines. For example, some can dispense coffee and grilled sandwiches . Apart from such specialised functions, vending machines have only seen minor improvements over the years (see A4) but on the inside, newer models resemble much older models. You may also notice that in most areas you see old-looking beverage vending machines retro-fitted and modernised simply by adding a Visa/MasterCard or mobile payment terminal. Thus, by integrating modern payment systems, even decade-old vending machines can compete effectively with contemporary models, highlighting that the true innovation lies in enhancing the

command mechanisms rather than the dispensing process itself. Additionally, changing the classic vending machine as little as possible in order to leverage existing supply chains and factory tooling help keep costs low. Hence, this solution explores VICN (pronounced “vican”), standing for Vending Intelligent Control Node modular system, a module that is attached to the side of the vending machine and commands the vending machine to dispense.

Innovation in Approach

1. Modularity: A modular system is ideal because it allows us to adapt different feature sets to various areas where the vending machine can be deployed, all at a low cost. We can customise configurations at the factory without significant tooling changes. (see A3). For example, in sunny areas it might be better to add a solar panel on top and replace the hand-crank module with a second battery module to increase the battery capacity.

2. Self-Sufficiency: The system can be configured with Starlink satellite dishes to go on without wifi/cellular connection for weeks as it can connect to the Starlink network, and the QR-code Punch-cards do not need wifi to work (see A2), hence the machine can keep running till it runs out of stock. Energy required to run the machine can be generated by the user itself.

3. Integrated Health Assessment: VICN takes the user’s blood pressure and prompts the user to fill out a questionnaire on the screen. Users are then given options to buy medications they are eligible for based on their data.

4. Payments: Users can pick between paying by cash, card, local mobile payments as well as punch-cards given out by the IRC (see A2).

5. Punch-Cards: Punch-Cards given out by IRC ensure credits given out are strictly for medication purchases and ensure funds are used properly and will not be used for recreational drugs or make the punch card-holder a target of crime. Special permission punch-cards can be given to pharmacies to allow them to restock machines.

6. Privacy: Punch-card patient data is encrypted (see A2), the screen has a privacy filter that restricts the viewing angle, all medications are bagged in black and common drugs like paracetamol and loratadine are available so onlookers cannot speculate what users purchase.

5. Solution Overview – Please describe the features of your solution and how they address the SOLUTION REQUIREMENTS (add supporting data, diagrams, etc. as attachments below) (500 words).

Payments/Punch-cards (SEE A2)

Technological: Punch-cards have fraud-prevention features. VICN scans the punch-card, indicating slots to punch, then the user reinserts the punch-card to validate the transaction. It reduces moving parts, minimising production and maintenance costs.

Practical: Holographic and UV-ink QR codes allow punch-card use without wifi/cellular. Reserved punch-card stock prioritises target groups, as cash/credit/debit cards can only buy limited stock. Special QR-coded punch-cards can be emailed and printed by pharmacies for limited-time machine access for restocking. Users can easily check balance on punch-cards, while contactless cards or codes require machine access for balance/validity checks. Patient data on punch-cards expire, requiring users to retake health screenings to keep medical information current.

Behavioural: Machines log card/payee, time and drug for each purchase, applying cooldowns, preventing repeat purchases in short durations, reducing stockpiling and drug misuse.

Health-Screener

Technological: Featuring a blood-pressure monitor, screen and keypad, users wear the cuff, follow on-screen instructions, and complete a questionnaire to check medical eligibility. We avoid AI chatbots due to possible hallucinations and wrong advice. Locally-run, they are energy-intensive; cloud-based solutions need fast wifi and costly server space.

Practical: Keypads are more durable and energy-efficient than touchscreens. Post-screening, users can buy eligible medications with a screen reminder to confirm the dispensation of correct drugs. A privacy filter restricts the viewing angle of the screen.

Behavioural: Varying questions and inputs ensure quality answers, preventing impatient users from spamming ‘yes’ to rush the process e.g. some users get “Press 5 if you are pregnant” and some “Press 8 if you are pregnant”.

Vending Machine **(SEE A3)**

Technological: Chassis has no glass front. It is opaque and insulated all-round to prevent the greenhouse effect, improving temperature-regulation.

Practical: The machine's graphics display available drugs, uses, and a map of alternative vending machines, pharmacies, and feedback contacts. Light colours and glossy textures reduce heat transfer improving temperature regulation. VICN transmits weekly purchase data for stock-tracking and maintenance.

Behavioural: Opaque front hides available stock. Individuals need to interact with the machine, do the questionnaire, be serious about purchasing to check availability and even then, they only see what is in-stock, not that the machine is well-stocked. See-through materials are subconciously associated with fragility. Opacity discourages theft and reduces break-ins.

Others

Technological: Solar and Starlink panels installed in environments with strong sunlight or poor connection respectively.

Practical/Mechanical: Modularity (see A3).

Behavioural: All medications are black-bagged and available common drugs ensure onlookers cannot speculate what users purchase.

6. Solution Feasibility - Please provide supporting information and rationale, such as references and precedents, that will help the IRC evaluate and validate the feasibility of the solution (up to 500 words)

See A1 for links. Example: A1L15 denotes the 15th link.

Components

2024 Ipad air 13’’ A sample device that the user interacts with.

40.88Wh lasts 14.75 hours web-surfing hence roughly 5min = 0.230Wh

A1L1-Phonearena= 40.88Wh battery for 14h42min of web-surfing.

UB-543 Wrist BP monitor Wrist-cuffs are less accurate but easier to use than arm-cuffs and there is lesser variance in wrist circumferences in a population compared to arm circumference. 1.8 *2 = 3.6W for 180 readings = 0.02W per reading.

A1L2-Mayoclinic = Less accurate than arm-cuffs.

A1L3-A&D = 2 AAA-batteries lasts 3 months for 2 readings per day.

A1L4-Microbattery = alkaline 1200mAh, 1.5V AAA-battery, 1.8W.

Refrigerated vending machine: R-290 refrigerant, 30.5 ft^3 refrigerated volume, 800 vending capacity, no-glass front consuming 2.67kWh/day = 1.854Wh/minute. 5 min would require 1.854 * 5 = 9.271Wh

A1L5-Energystar.gov = 2.67kWh/day

Commercial fridge: R-290 refrigerant, 31.91 ft^3 capacity uses 2.03 kWh/day = 1.410Wh/minute. 5 minutes need1.410 * 5 = 7.049Wh.

A1L10-Energystar.gov = 2.03kWh/day

Starlink Gen 3 Standard model. For starlink to upload statistics weekly, we need to upload a file of size less than 5Mb which should take 1s at 5mb/s, the lowest range of estimated speeds. But to account for worst-case-scenarios we assume a 3-minute upload time. Assuming 87.5W average, 3 minutes usage = 87.5 * (3 / 60) = 4.375Wh

A1L6-StarlinkHardware = 75W-100W power use

A1L7-Starlink = 5-10mb/s speeds

400W Hand-crank generator - Going above 400W requires a pedal-bike, suggesting its too difficult to rotate by-hand.

A1L8-HandCrankGenerator/ElectricPedals/Amazon = 400W max, realistically 50W

Solar panels - 1m^2 of solar panels can generate 200W in peak sunlight. Conservatively, we assume 175W generation for 5 hours a day, and a poor-weather buffer of 2 days a week. Mean-generation/day = 175 * 5 * (5/7) = 625Wh/day

A1L9-UtilitySmarts: 200W generation

Doomsday-Scenario: No-sunlight, no cellular-connection, 1 daily-user, 5-minute usage-sessions.

Power per session

= (Vending machine) + (Health questionnaire) + (BP-measurement) **-** (Refrigerator)

= 9.271Wh + 0.230Wh + 0.02W -7.049Wh = 2.472Wh

Hand-crank time per session

= (energy required in Watt-hours) / (power supplied in Watts)

2.472Wh / 50W = 0.04944 hours = 178 seconds

Hand-crank-time-per-day for starlink

= 4.375 / (50 / (60 * 60)) / 7 = 45 seconds

Assuming 1 in 5 people are disabled and cannot use the hand-crank, we increase generator-time for non-disabled by 20%.

Worst-case-scenario (1 daily-user)

= (178) * (1 + 0.20) + 45 = 259 seconds/user

Pessimistic-Scenario: Good weather 5 days/week, wifi available once/week.

Ipad web-surfing power calculations account for wifi/cellular power usage.

On solar power, VICN can service 625 / 2.472 = 252 users.

Conclusion: This suggests user experience of 259s crank-time in dire conditions which is permissible. With solar, VICN can serve 252 users without hand-crank usage or 178s crank-time per-user without solar.

7. Do you have further relevant information you could disclose, consisting of IP rights you would only grant the Seeker subject to an acceptable award offer? If yes, you will be asked to capture the IRC's interest (up to 500 words).

Unfortunately, no.

8. Experience – Please describe expertise, use cases, and skills you or your organization may have in relation to your proposed solution, and state your interest in potential partnership (up to 500 words)

I am a pre-university student who is enthusiastic about technology and interested in current affairs and more widely, global issues. I read widely and keep up with technological advancements and their applications. Although I do not have hands-on experience, I am highly interested in studying and analysing problems and solutions and feel like I bring a unique perspective. I have also completed multiple courses in computer programming and technological entrepreneurship. I am also an incoming student that will be joining a QS world top 15 ranking university to pursue a degree in computer engineering in Singapore.

9. Solution Risks – Please describe any risks you see with your solution and how you would plan for this (up to 500 words)

1. Modular machines require skilled labour to switch modules and make changes on-site, hence we must research key factors like WiFi/cellular reliability, sunlight availability and intensity and target market prevalence before deployment into an area to reduce the need to make changes to already deployed machines.

2. Due to possible language barriers, poor literacy it may be intimidating for users to learn how to operate the machine. Hence, a marketing exercise must be carried out where punch-cards are distributed by volunteers and on social media. In the short term, placing these responsibilities on volunteers is demanding but progressively, information may spread through word-of-mouth amongst communities.

3. Restocking would be a challenge especially in remote areas. IRC can work with localpharmacies or other third-parties and email them special permission punch-cards to print out. These punch-cards would not require all the normal security features since they are single-use, redeemable on specific machines. When inserted, the machine unlocks and the punch-card gets blacklisted by the machine to prevent reuse.

4. The elderly and people with disabilities may find it difficult to use the hand-crank to power the machine. Since these groups likely make up a small subset of the population, we can give them permission via punch-card QR to be exempt from using the hand crank. The machine would run entirely on battery but increased the required power generated by other users so maybe the required turns for each medication increases from 12 to 20. For weaker users to use the generator, we can make the crank-wheel's radius larger to reduce force required.

5. Wrong drugs being dispensed is a risk since we may use third-parties to restock machines. Hence, we must remind users to check the medication before using and send feedback if they got the wrong medications.

6. Feedback mechanisms should be built into the machine that make it convenient for users to send feedback on the machine.

7. After using the hand-crank, the user's blood pressure would be artificially higher, providing inaccurate readings. Hence, the user is to use the hand-crank after BP is taken.

8. Over time, the efficiency of the solar panel and battery will fall but even if the system suffers losses of 90% , it will still be able to serve 25 users per day.

9. Modularity is a double-edged sword. The fleet of vending machines becomes more versatile however, the base cost for each machine rises due to greater compatibility software, hardware and expertise expenditure. A middle-ground is to focus on having modularity where we try to have a forward-thinking approach to designs. For example, leaving buffer capacity in available energy and space within the vending machine and VICN. For example, we should purchase machines with +20% of the capacity to serve cases where some machines require frequent refills or that some locations need a different kind of medication on top of the current selection.

10. Timeline, capability, and costs – Please describe what you think is required to deliver the solution, including estimated time and cost to total up your summary, capital, and operating costs and add as an attachment (up to 500 words).

See Attachment 6 (A6) for answer.

11. Online References – Please provide links to any publications, articles or press releases of relevance (up to 500 words)

- See A1 for all the links used to justify analysis made in other questions, the links below are less niche and explore the problem and solution in a more holistic light.
- https://academic.oup.com/jphsr/article/13/4/396/6961007
    - This link leads to an article that details a cost-benefit analysis on the dispensation of non-prescription drugs. It depicts drug misuse to be a major

concern that needs to be addressed. VICN’s punch-card cooldown solution as well as ensuring users only get drugs that match their symptoms and health conditions.

- https://www.youtube.com/watch?v=kDaQR4NudKw
  - This link shows a video of a hand-crank powered vending machine that can dispense 7 drinks powered by 70 rotations of the hand-crank.
- https://www.dice.com/career-advice/hand-cranked-vending-machine-is-disaster-ready
  - A short article on how vending machines were advantageous during times of crisis in japan.

12. How did you find this Challenge? – please indicate what drew you to this Challenge, including any relevant advertising or marketing that you followed to this Challenge.

I came across this challenge while browsing the Wazuko Crowd website. I got to know about the website on the r/crowdcompetions subreddit. This is my first time participating in a crowd competition.