smartbox

Project Report

Team Semma Clean

Aggrey Gisiora Mokaya
Gurucharan Ganesan
Hafizur Rahman
Maria Gabriella Manchini
Tachmajal Corrales Sanchez

Design Facilitator

Aspen Flynn

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1. Project Abstract

Patient traffic to primary health centres in the Chengalpattu region of Tamil Nadu typically ranges from 150 to 200 people per day. According to nurses, a quarter of these daily visits are from patients who require dressing of wounds and injuries. These individuals are at risk acquiring infections from in the health centre due to improper procedures or contamination of tools and equipment. The **S**anitary **MA**terials and **R**esources **T**ool **B**ox, SMART Box, is a simple, handy organizational tool for wound treatment equipment and supplies that reduces the risk of contamination, while facilitating health worker's productivity. This device strives to help healthcare providers limit their movement during wound treatment procedures, which reduces contamination, while providing a convenient and easy to use system tailor made to their work flow.

2. Context

2.1 Background

The maintenance of a sterile and infection free environment is the boon of most, if not all, healthcare facilities. In a place where one small gap in the clean chain management can cause deaths, maintaining hygiene standards is of paramount importance. This can be accomplished through practices as basic as hand-washing to sterilization of tools or other supplies by autoclaving or other higher order techniques. Often, due to cost or logistical constraints, surgical tools and supplies are re-used especially in rural health care centres. In order for the reused equipment to be patient safe, it must be sterilized or cleaned by following specific protocols. Methods of promoting behaviours that follow optimal sterilization practices and ways to ensure the instruments and other appropriate supplies are clean are necessary to prevent disease transmission between patients and hospital associated infections (HAIs).

2.2 Community Description

Chengalpattu (12.7°N 79.98°E) is a south-western suburb of Chennai city and in the state of Tamil Nadu, India. The staff and patients at two rural health centres, Manampathy Primary Health Centre and Salavakkam Primary Health Centre, constituted the studied community for this project. Under the Indian Primary Health System, each primary health centre is a referral facility for between 4 to 6 other small Sub Centres. A Primary Health Centre has a ward of 4 to 6 beds and is manned by a medical officer-in-charge in addition to 14 paramedical

staff of different cadres – ranging from nursing staff to lab technicians to pharmaceutical technicians.

2.3 Problem Framing Statement

Staff and patients attending primary health centres in rural Tamil Nadu are at risk of hospital acquired infections due to disorganization of tools and equipment in surgical dressing rooms and cross-contamination of both clean and used tools.

Figure 1. Dressing room tools at a Chengalpattu Health Centre.

3. Design Process

3.1 Problem Framing Tree

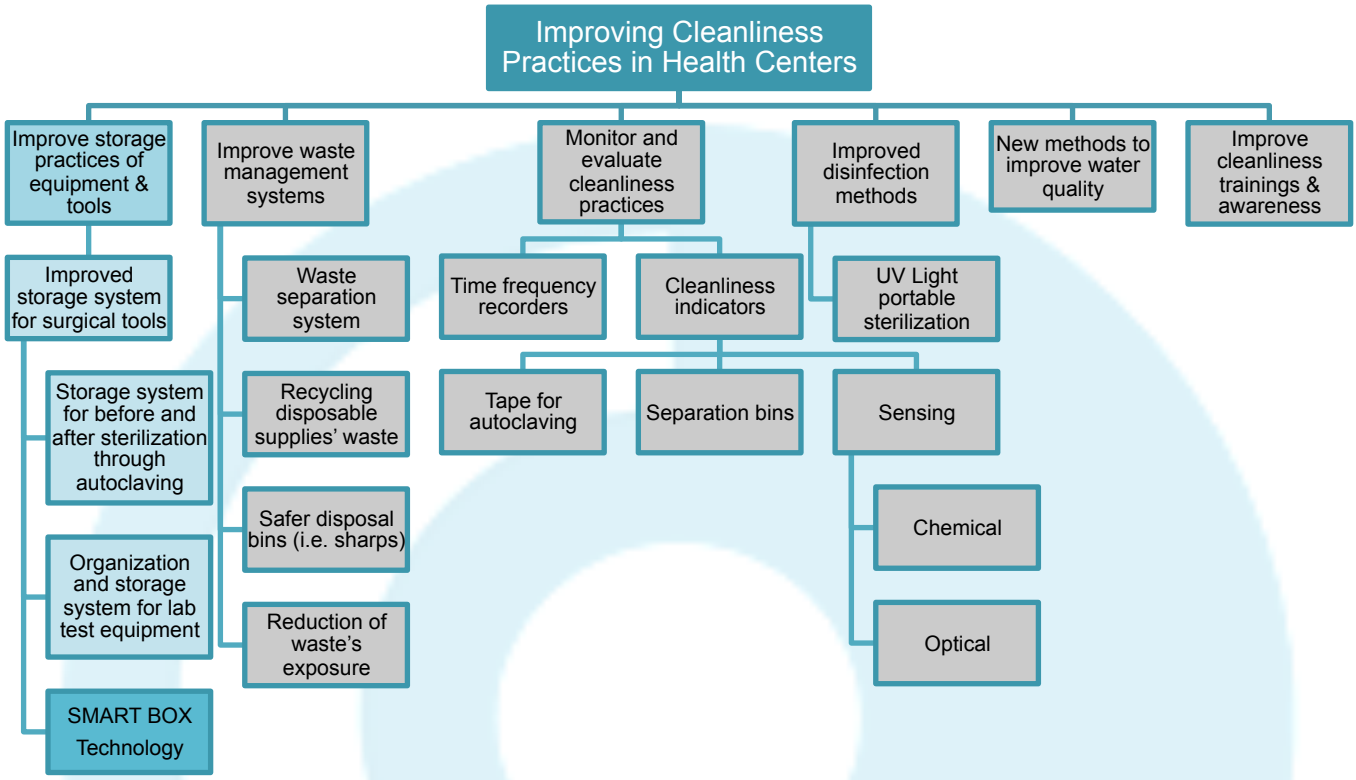

Figure 2. Problem Framing Tree diagram

3.2 Value Proposition

The SMART Box offers a durable and robust disinfection and organizational tool that strives to optimize the wound treatment experience while improving the health worker's overall productivity and enhancing patient confidence.

The device was designed for high usage capacity of up to 50 patients per day. A rotating plate was incorporated to avoid cross-contamination of tools. It is durable, resistant to corrosion and easy to clean as it is made of stainless steel. Its trays are compatible with autoclaving. The spirit bath was redesigned to enhance usability by allowing easy access to tools and at the same time decreasing the amount of alcohol solution needed. This design results in an increase in accessibility to tools, reduced flustering during organization and more time-efficient treatment.

SMART Box ensures that healthcare providers are able to carry out the task of surgical dressing in a hygienic, professional and composed manner. This increases their overall productivity and satisfaction while at the same time boosting patient confidence in their ability and the entire process.

3.3 Summary of the design process

Our design process begun with a couple of brainstorming sessions, in order to map out strategies for assessing cleanliness practices in health centres in Chengalpattu. In total, we had five separate visits to the community. We utilized the Observe – Ask – Try methodology to generate ideas and questions. The initial visits generated more questions than answers and provided a baseline for more targeted information gathering and feedback analysis in subsequent visits. Midway through the process, there was a push to pivot away from the health centres to address what seemed to be more pressing concerns at the community level. However, through the problem framing process and stakeholder analysis, we were able to narrow our focus back to the health centres. On our penultimate visit to the community we developed a sketch model to showcase our SMART Box idea to the community and the feedback we got was generally positive. We continued to improve the design through approximately eight different iterations, which resulted in a looks-like prototype, as presented in this report.

3.4 Analysis and Experimentation

The SMART Box is still in the early stage of development and we are yet to develop a fully functional prototype. We have been able to develop a complete looks like prototype and initial feedback from a few key interviews and focus groups with healthcare providers has been positive. A good part of the design has been informed by direct feedback from local and international healthcare providers.

4. Technology/Final Prototype

4.1 Design requirements

- ✓ Capacity for 50 patients per day
- ✓ Maximum dimensions 500 x 500 x 300 mm
- ✓ Autoclaving compatible
- ✓ Robust, durable and low-maintenance
- ✓ Improved spirit bath usage

4.2 Design specifications

CAD models of the initial design are shown below. All dimensions are in mm.

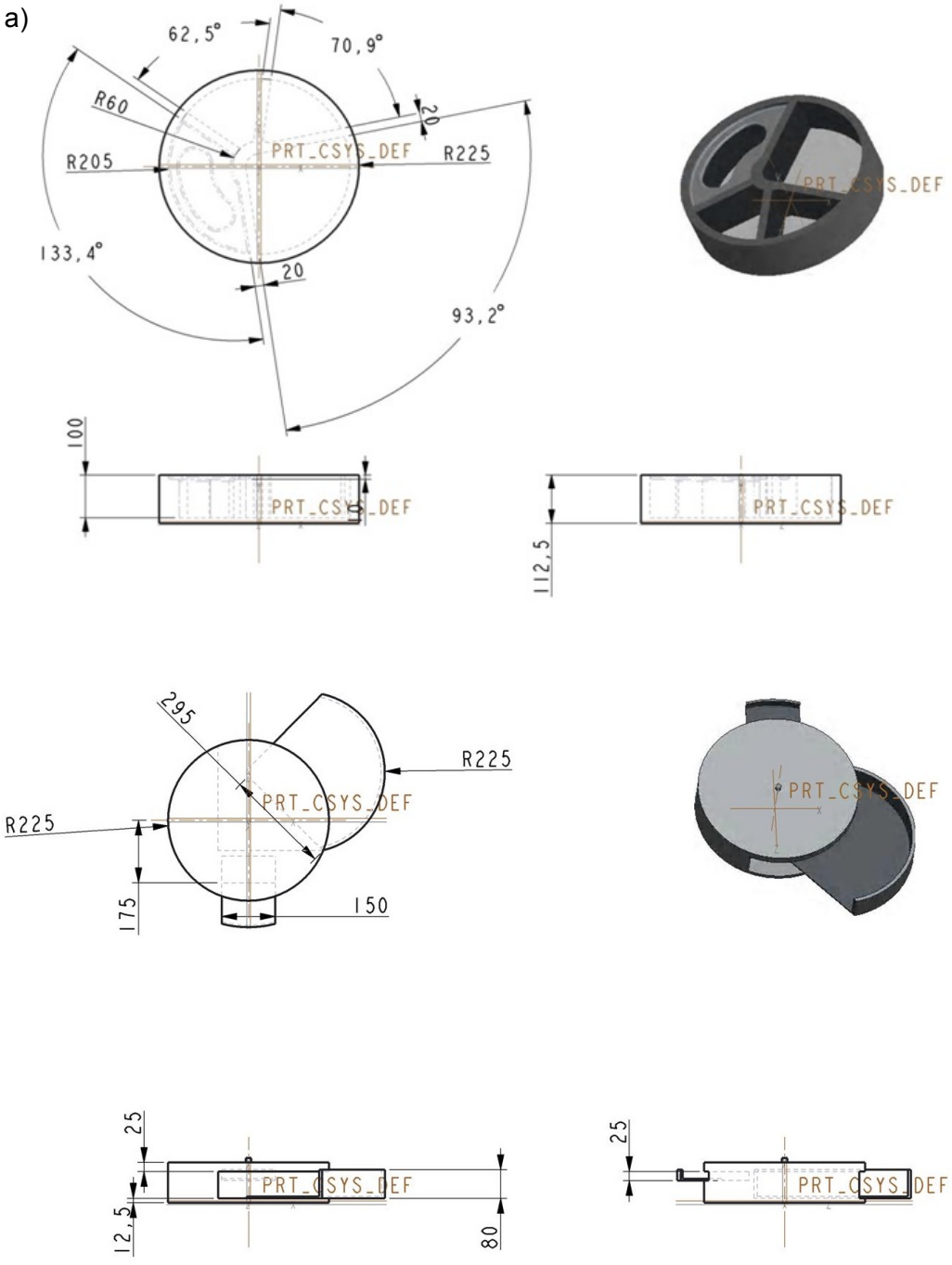

Figure 3. a) Top view of SMARTBox's top plate. b) Top view of SMARTBox's bottom plate.

Figure 4. SMART Box looks-like Prototype

4.3 How it works

Each day, the nurse will load the rotating top compartment with one day's supply of cotton and gauze, autoclaved tools, dressing ointments, solutions (betadine, saline etc). The spirit bath will be loaded the fixed the bottom compartment which also includes a lock box for controlled pharmaceutical drugs. The spirit bath compartment at the bottom is continuous with the tool storage compartment at the top when the smart box is in the starting position. Depending on the supplies needed, the nurse rotates the top disc to easily access them. In addition, the drug storage compartment is on the fixed bottom disc so that the nurse can easily access it as needed. After use, the nurse depresses a lever submerges the tools in a spirit bath to disinfect them (*Note*. The tools compartment has a sieve at the bottom).

To prevent the contamination of the cotton and gauze supplies, a spring-loaded mechanism is used to dispense them; hence the nurse does to have to reach into the compartment with potentially contaminated gloves or hands. Further, to ensure that the spirit bath is properly formulated, the spirit container will have markings to show the level of spirit required to water. The tools tray is autoclave compatible and can be used with existing autoclaves that are found in many health centres in Tamil Nadu.

4.3 Performance

Based on our observations, it took the healthcare worker an average of 12.5 minutes to dress one patient; not including the time taken to walk to and from the drug storage cabinet with contaminated gloves. We estimate that our smart box will reduce the time taken to dress a patient by at least 5 minutes – which we hope to verify during the field testing phase. Beyond that however, it will greatly reduce the risk of contamination of tools and other surfaces in the health centre and reduce the risk of hospital acquired infections.

4.4 Prototype's cost

Table 1. Bill of Materials (SMART Box)

ITEM	PART NO.	DESCRIPTION	MATERIAL	QTY
1	sboxbottom	Body of top rotating disc	Thermoplastic	1
2	sboxtop	Body of bottom fixed disc	Thermoplastic	1
3	sboxbear	Ball bearing for rotating mechanism	Steel	1
4	sboxshaft	Center Shaft	Steel	1
5	sboxbolt	Lock box opening mechanism	Steel	8
6	sboxroll	Lock box sliding mechanism	Plastic	6
7	sboxspring	Helical spring (cotton & gauze)	Steel	4

5. Lessons learnt

5.1 Community engagement

Working on this project served to introduce the entire team to the co-creation process. The community engagement aspect of this process has been vital to the achievement of the prototype. It was possible to get feedback from the health centre staff, which helped validate our thoughts and clarified any misunderstanding along the way. In addition, the team's perspectives and prejudices were challenged and changed for the better; for the benefit of our health centre community in Chengalpattu and for the team members personal benefit as part of the Semma Clean Team.

5.2 User feedback

Throughout the design process we had great feedback from health centre workers at Salavakkam and Manampathy. This was of great help to us in the initial design stage. As our

design began to take shape we had various healthcare workers both from India and around the world interact with our model and help us develop a more user-friendly design. Through this process we learnt that user feedback – especially criticism, is a necessary component for improving the design of a product.

5.3 Troubleshooting

As we are yet to develop a fully functional model, we have had limited time and opportunity for troubleshooting. However, this is the next step for the project and we hope to have more on this in due course.

6. Next steps and project's future

6.1 Reflection on project viability and other design opportunities

Based on the feedback that we have so far received from users, fellow designers and other stakeholders, we believe the project is viable and can be developed into a complete product within a year, all factors remaining constant. Throughout the design process we have come across several ideas that can either be included into our product e.g. an ultraviolet sterilization module or others that can be developed as individual products in their own right or utilization of an alternative disinfection chemical that removes the need for re-formulating the disinfection bath and possibly giving rise to a portable smart box.

The Semma Clean Team is committed to seeing the development of a fully functional SMART Box within the shortest possible time. We hope that we shall be able to start a venture around the product that can provide our solution far and wide to healthcare providers in low income settings. Further, if resources allow, we also hope to pursue some of the other ideas that we developed during this design process.

6.2 Continuity/ dissemination model

In the short term, we expect to develop a fully functional prototype and carry out user testing to ensure that the SMART Box works as advertised. To this end we will seek funding and technical support from various sources to ensure that this vision is realized. In keeping with our previous model of co-design, we will involve the community as much as possible in the field testing of our prototype.

In the medium to long-term we expect to increase our engagement with local partners and stakeholders in Tamil Nadu to ensure that relationships are maintained and strengthened as need be.

6.3 Six-month plan and team engagement (roles and responsibilities)

The table below summarizes our plan for continuing the SMART Box project for the next six months. It should be noted that the team members are committed to working on all aspects of the project, however, each objective has a person is responsible for the overall deliverable.

Table 2. Team Roles and Responsibilities

OBJECTIVE	ACTIVITIES	PERSON RESPONSIBLE
Acquire funding for prototype development	Desktop review; Preparing and submitting applications; Letters of support; Getting approval letters etc	Aggrey Mokaya; Maria Gabriella
Final 3-D model	Finalize design requirements; Developing final 3-D model	Hafiz Rahman; Tachmajal Corrales
Stakeholder engagement	Maintaining working relationship with health centre staff; communication with funders; Social Media etc	Gurucharan Ganesan; Aggrey Mokaya
Building prototype	Acquiring materials, tools, workshop space etc	Hafiz Rahman; Tachmajal Corrales, Gurucharan Ganesan
Testing prototype	Developing test parameters; Actual Field testing; Collation and analysis of results	Hafiz Rahman; Gurucharan; Aggrey
Monitoring and Evaluation	Data collection, analysis and reporting	Aggrey Mokaya; Maria Gabriella

6.4 Anticipated risks and challenges

The table below outlines our understanding of various risks and challenges that we are likely to face in our push to develop the SMART Box prototype, as well as our mitigation strategies.

Table 3. SMART Box Project Risk and Mitigation

Expected Risks and Challenges	Mitigation
Lack of funds	Take advantage of IDIN and other resources available to team e.g. crowd funding etc
Geographical Separation	Constant communication and updates including monthly Skype calls
Loss of momentum/ interest by team after IDDS Summit	Constant communication and updates including monthly Skype calls
Lack of technical expertise	IDIN mentorship

6.5 Stakeholders

Below is a list of key stakeholders important for the success of the SMART Box project:

1. Health centre workers/ Healthcare Providers
   Key stakeholder for field testing. End-user of SMART Box.
2. State government of Tamil Nadu
   Administrative support for testing. Strategic partner for development and purchase of finished prototype.
3. B. S. Abdur Rahman University
   Necessary facilities and skilled human resources for building the prototype
4. IDIN.
   Network to provide technical, financial and strategic support for the SMART Box project.
5. The Hive Innospace
   Necessary facilities and networks useful for product development.

7. Contact information

Chengalpattu community partner

Sujatha Natarajan

Team members

Aggrey Gisiora Mokaya	Kenya	agmokaya@gmail.com
Gurucharan Ganesan	India	gurucharan141996@gmail.com
Hafizur Rahman	India	hafiz8696@gmail.com
Maria Gabriella Manchini	Brazil	gabimanchini@hotmail.com
Tachmajal Corrales Sanchez	Costa Rica	tachmajal@gmail.com

Design Facilitator

Aspen Flynn USA

Figure 5. Team Semma Clean. Left to right: Hafizur Rahman, Maria Gabriella Manchini, Tachmajal Corrales Sanchez, Gurucharan Ganesan, Aggrey Mokaya, Aspen Flynn.