MEng Innovation by Design
2020/2021 Ideate-Prototype-Realize

SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

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To create a set of guidelines for for consultant-client interactions in the space of radical-innovation of the Pre-Project Phase (PPP) of Knowledge-Intensive Business Service (KIBS) work in the Singapore

Aim & Goal

Aim: To increase the success rate of radical-innovation consultancy projects and thus, achieve greater innovation activity in Singapore

Goal: To create a guideline/framework in client-designer relations & interactions in the space of radical-innovation focusing in the pre-project phase of KIBS work and small consultancies.

Focus & Scope

The scope is divided into 3 levels, we look at the National Innovation System, the Interactions and dynamics between each stakeholder as well as the individuals and their roles within the local innovation system.

We look at interactions pertaining to radical innovation between small firms with KIBS - be it their primary or secondary capabilities and their clients in the pre-project stage and the different stakeholders involved in the Singapore local context. We look at how each stakeholder views success and what does value creation mean to each of them.

We then create a guideline to to optimise the value creation and success in relation to the 3 main points. The local innovation system, design process, knowledge transfer system between the different stakeholders.

The challenge will be to tackle the problem of the service paradox (Kohtamaki 20 l6) in terms of the pre-project phase.

Research Questions & Hypothesis

[RQ1] What are the current management methodologies prominent in radical Innovation (RI) consultancy projects?			
Hypothesis	Current management methodologies should be modified for RI projects		
Sub-Questions	**[RQ1A]** By what means can we distinguish RI and Incremental Innovation projects?	**[RQ1B]** How can we improve on the methodologies?	**[RQ1C]** What constitutes an RI project?
Sub-Hypothesis	Distinguishing between both helps in understanding the methodology to use	Methodologies do not focus on effective communication in the pre-project phase.	Lack of understanding and appreciation of the nuances of Innovation projects.

[RQ2] How involved are individual stakeholders in the pre-project phase of the RI projects?			
Hypothesis	Individual stakeholders are not involved enough in the pre-project phase of the RI projects		
Sub-Questions	**[RQ2A]** What are the channels for client-designer interaction in the pre-project phase of the RI projects?	**[RQ2B]** What is the best way for individual stakeholders to be involved?	**[RQ2C]** Which part of the pre-project phase should individual stakeholders be involved?
Sub-Hypothesis	There is no Primary channels for communications, thus leading to misunderstanding	Lack of ways for which designers can be involved.	Understanding where each stakeholder should be involved increases efficiency.

[RQ3] How is Radical Innovation being managed in Singapore?		
Hypothesis	There is a lack of RI success in Singapore because of inefficiency in interactions	
Sub-Questions	**[RQ3A]** Why is it that even with fiscal efforts, there is a lack of RI in innovation in Singapore	**[RQ3B]** Why is there lack of RI success even when many reports show that innovation in Singapore is high?
Sub-Hypothesis	Fiscal spending encourages more RI efforts but does not increase efficiency of those efforts.	Singapore's lack of success is due to the value creation being low - focus on single-event projects.

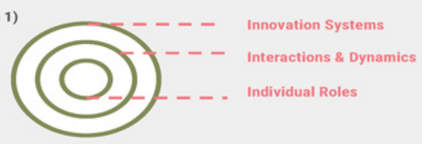
[RQ4] What does each stakeholder mean when they say a project is successful?			
Hypothesis	Definitions of success do not align with what needs to be achieved for RI projects.		
Sub-Questions	**[RQ4A]** What does success mean to the different stakeholders?	**[RQ4B]** What are the methods to value the measure of success in consultancy Projects?	**[RQ4C]** Why is it important for the definition to be aligned?
Sub-Hypothesis	Definition of success is different, creating lack of clarity for RI	Methods used to measure success focuses on short-term success for the client	Alignment increases the rate of success.

Research Clarification

Review-Based

(1) We reviewed the current state of the art in relation to **Innovation Systems** pertaining to **Radical Innovation [RQ1A] & [RQ1C]**, the **Interactions** & **Dynamics**. This relation can be summarised below.

(Fig 1)



(1) We also looked into the state of the art of the **Value Creation** of each interaction and how **Value Creation and thus, Success is Calculated [RQ4B]**.

(1) Lastly we looked into the geographical context of our research - **Singapore** and look into the **Innovation Policies [RQ3A]** that are used. This is pertaining to how innovation is valued.

Descriptive Study 1

Comprehensive

Interview & Activity with stakeholders (Prepared &on hold till IRB approval)
(Advisor just sent the reviewed interview questions.

Interview Questions in part 1 follows the main research questions & hypotheses that we are looking at.

Part 1
(a) Introduction
(b) Innovation in Singapore
(c) Pre-Project
(d) Success & Value Creation

Part 2
Exercise on Relationship Map during preproject phase

Prescriptive Study

Initial

Building map of Innovation Input & Innovation Output in Singapore. Below is initial relationship stemming from Global Innovation Index (GII) of Singapore.

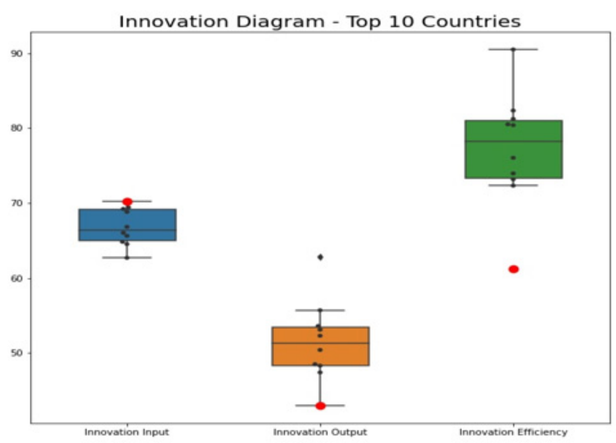
Our focus is on this arrow, for which why the discrepancy in ranking. We looked at reviews of GII, its pros and cons, how they apply to Singapore from a radical innovation and consultancy point of view.

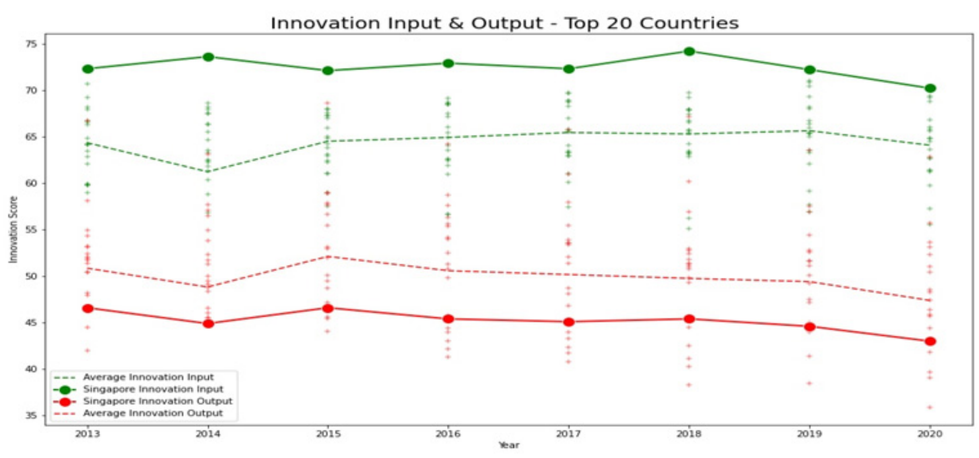
Which leads to modifications and suggestions of interaction points of stakeholders help with value creation and success in PPP.

Analysis of Global Innovation Index (GII) Dataset

We look at the GII 2020 dataset and see why's innovation Output is low, and where it stands with the most innovative countries around the world.

1. Singapore has bad efficiency
2. Its not a one time statistic in 2020, but has been going on from 2013





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3D Visualisation and segmentation of lower limbs for prosthetic socket design.

Aim: Utilising Ultrasound and photogrammetry to generate a virtual representation of a patient's limb.

Purpose: The purpose of this is to serve as a potential alternative diagnosis method for prosthetist to help better visualise and design sockets for lower limb patients.

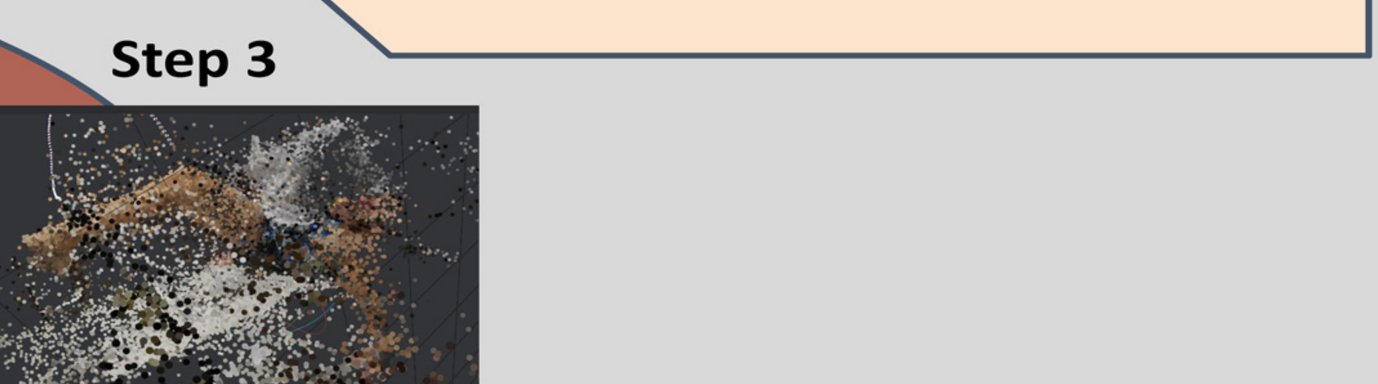
3D Photogrammetry Process:

1. Using a phone camera to record a video of the desired object
2. Breaking the video down into its keyframe images via photoshop
3. Importing the images into MeshRoom for virtual image rendering.
4. Export the render into Blender for the cleaning of excess information and noise.
5. Lastly, importing the cleaned render into Fusion360 for smoothing and canvasing the segmented images.

Ultrasound Image Process:

- In partnership with Khoo Teck Puat Hospital

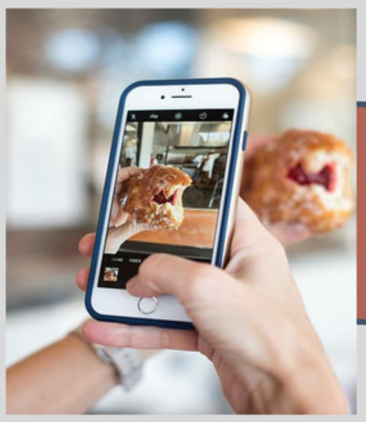
1. Using Python and open-sourced programming function OpenCV.
2. The ultrasound images is exported into python.
3. The script the analyses the ultrasound images and picks out key features(mostly bone).
4. The images are then stitched together to create a partial section of the cross section.



Incorporation of data

- The stitched ultrasound images can be layered in the segments of the 3D model to create an atlas segmentation of the limb
- This can provide the prosthetic and doctor to have a clearer picture of the client's limb without the need for MRI or CT scan

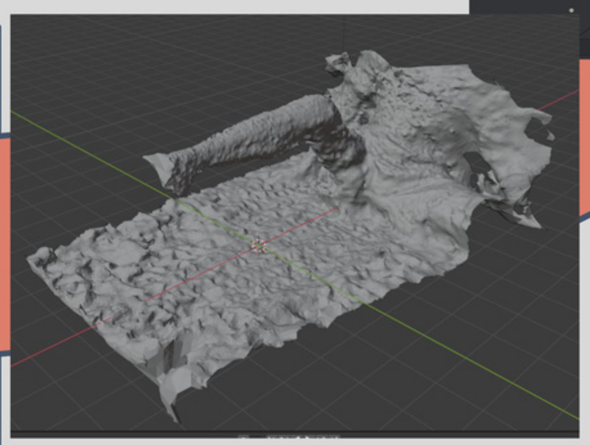
Step 1



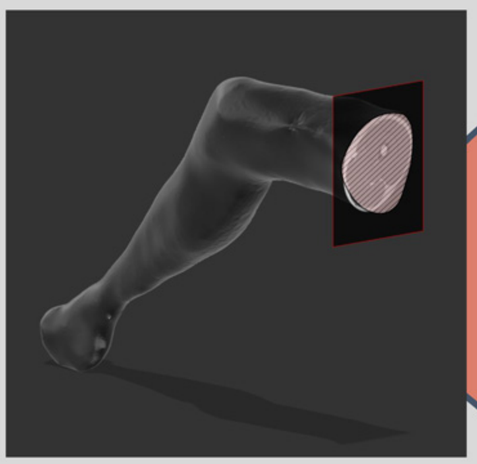
Step 2

Step 3

Step 4



Step 5



Possible Applications:

- Most prosthetist utilise hand modelling technique to prepare sockets for clients.
- By utilising this diagnostic method, we hope it can assist prosthetist to design better sockets.
- This visualisation method can help locate bone spurs, muscle group and potential nerve bundles.

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Designing for and Measuring Patient Compliance in patient adaptable healthcare products - a concept design framework

IDEATE

Why

The customization of healthcare products, eg. orthoses, is an **expensive, tedious and time-consuming process.**

Thus, patient adaptable healthcare products holds great potential to achieve benefits such as **mass customizability, reducing costs, optimizing a product's life cycle for use, sustainability** and **increasing variety**.

What

Patient adaptable healthcare products =
Standard products can be modified or reconfigured at the patient's end without the producer's/ clinician's direct intervention to better suit a patient's needs.

Opportunity

Current concept design methods cannot guarantee PAHPD which embody the benefits of adaptable design while minimizing the impact of poor patient compliance.

This implies that there is a need to come up with an approach to design and evaluate the suitability of patient adaptable healthcare product design concepts.

PROTOTYPE

Proposed framework

Concept Generation

Recommendations:

Methodologies that help guide the initial research and requirement definition stage:

- User Journey Mapping
- Goal Directed Design
  - Considering needs through detailed user personas and goals

Concept Assessment

Measuring metrics:

Four metrics for evaluating patient compliance and are further elaborated on in the form of attributes.

To offer a simple but effective manner of evaluation, measurement scales of low (0), medium (1), and high (2) are employed to indicate its attributes. The scale of each attribute is then formulated into a scaled single integer value for each metric, in which 1 means poor and 10 means excellent with regard to each metric.

Metrics	Attributes	Formula
Flexibility of function	Flexibility of function across time, Flexibility of function across use cases	$F = 9 * [F_{T1} + F_{T2} + F_{U1}] / 6] + 1$
Self-management ability	Intuitiveness, Ease of use, Skill dependency	$A = [9 \times [A_I + A_E + f + A_S] / 8] + 1$
Self-management motivation	Sense of autonomy afforded, Perceived competency in usage	$M = [9 \times [M_{ID} + M_{IN} + M_C] / 6] + 1$
Self-management support	Feedback, Teachability, Boundary setting	$S = [9 \times [(S_{F1} + S_{F2})/2 + S_T + S_B] / 6] + 1$

Attributes	*Symbol*	*Low = 0*	*Med = 1*	*High = 2*
Intuitiveness	A_I	High cognitive load involved in a product's adaptation	Some cognitive load involved in a product's adaptation	Low to No cognitive load involved in a product's adaptation
Ease of use	A_E	High number of steps involved in adaptation	Fair number of steps involved in adaptation	Low number of steps involved in adaptation
Skill Dependency	A_S	Excessive/repeated instructions or training of end user likely necessary	Partial/ one-off instructions or training of end user likely necessary	No instructions or training of end user likely necessary
Frequency of action	f	Adaptive action must be performed excessively often by user	Adaptive action must be performed often by user	Adaptive action must be performed rarely by user

REALISE

Case study

Context: Forearm casts for paediatric care

Concept Generation

Paediatric Forearm cast example

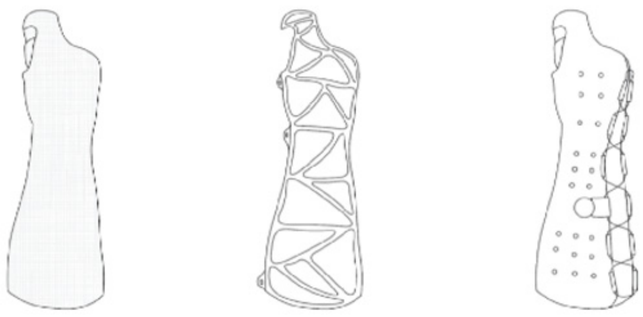
Characteristics: Typically <12 yo, high activity levels, Low levels of product care

Domain expertise: Uncertain self-efficacy, Low situational understanding

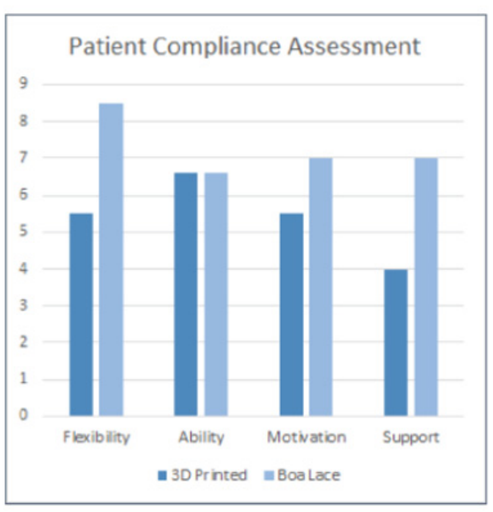
Technical expertise: Low technical understanding, Low prior tech use

Design requirements	User need/ goal
Quality of cast fit	- Extent of skin irritation
Breathability of cast	- Extent of moisture build up - Extent of odour
Water resistance of the cast	- Convenience in daily task - Lifestyle activities
Aesthetics	- Customizability of look
Longevity of use (throughout healing)	- Frequency of clinical check ins/ clinician intervention

Concept Assessment



Plaster	3D printed	BOA lace
- Traditional plaster of paris - Non adjustable fit, Custom fit at point of application	- Custom fitted - Slight adjustments to tightness can be made by user	- Custom fitted - Adjustments to fit made by dial and lace system - Custom design



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Integrate **Data-Driven Decision Support Systems** with **Mixed-Reality and IoT systems** To Optimize Indoor Vertical Farming (IVF) operations

Problem Statement

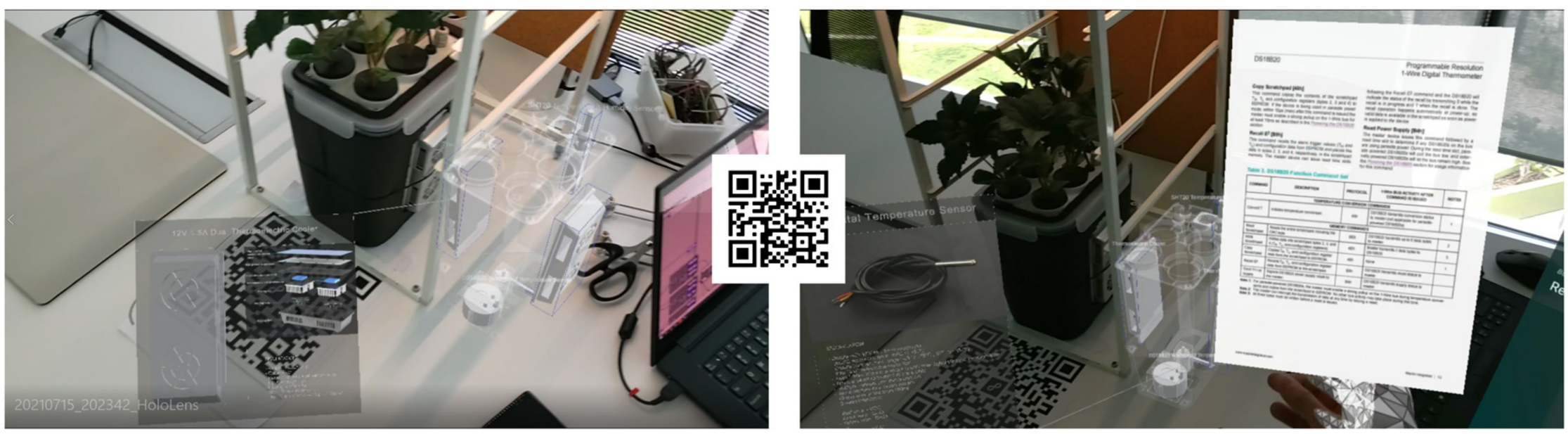
Urban Indoor Farming is increasingly reliant on data-driven approaches as management strategy, as operations become more automated, the role of a typical indoor farmer will also evolve, to a combination of labour tasks and high level decision making that is driven by information derived from the farming environment. However, the interface between the labourer, machines and information has yet evolve to truly to support the vast information available that could be utilized.

IPR Goal

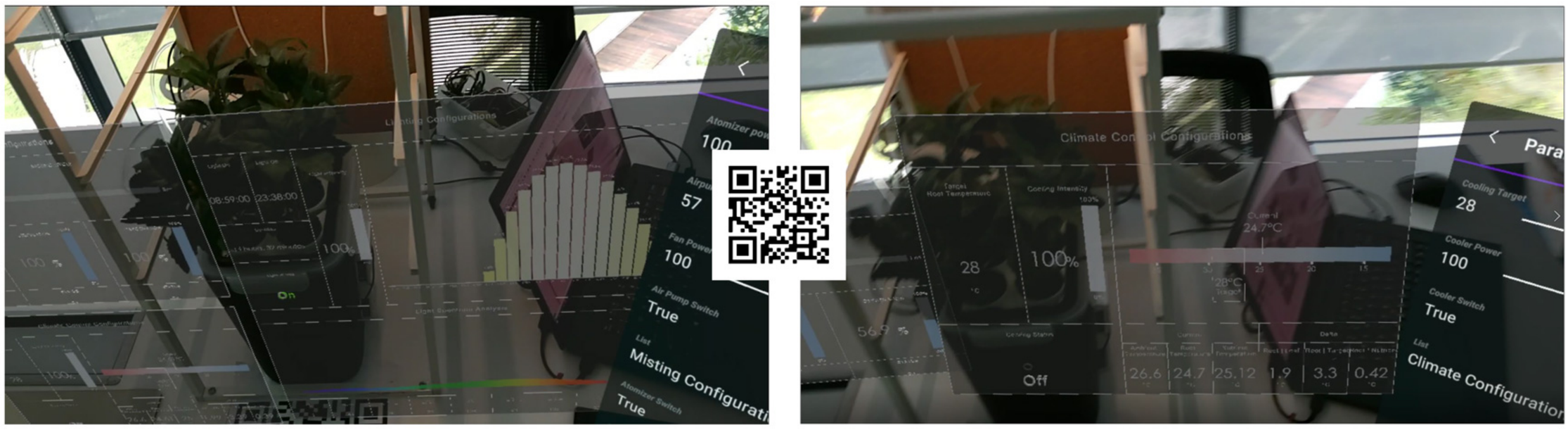
The goal of the IPR project is, therefore, to develop an Extended Reality interface that integrates IoT data from Indoor Farming systems as a viable farm management strategy and evaluate its potential to improve labour productivity.

XR-IoT | Crop Monitoring, Real-Time Environmental Data

XR-IoT | Digital Twin, Component Information Support



XR-IoT | Configuration Dashboards



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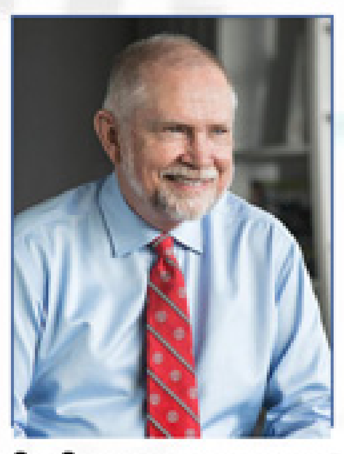

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SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

SUPPLY CHAIN DURING PANDEMIC

Problems

- Ineffective vaccine allocation to different dispensing locations from central stockpiles base on projected supply availability , current estimates of unvaccinated population and distribution profile.
- Longer lead time and no proper optimized data for 2 dose vaccination

Aims

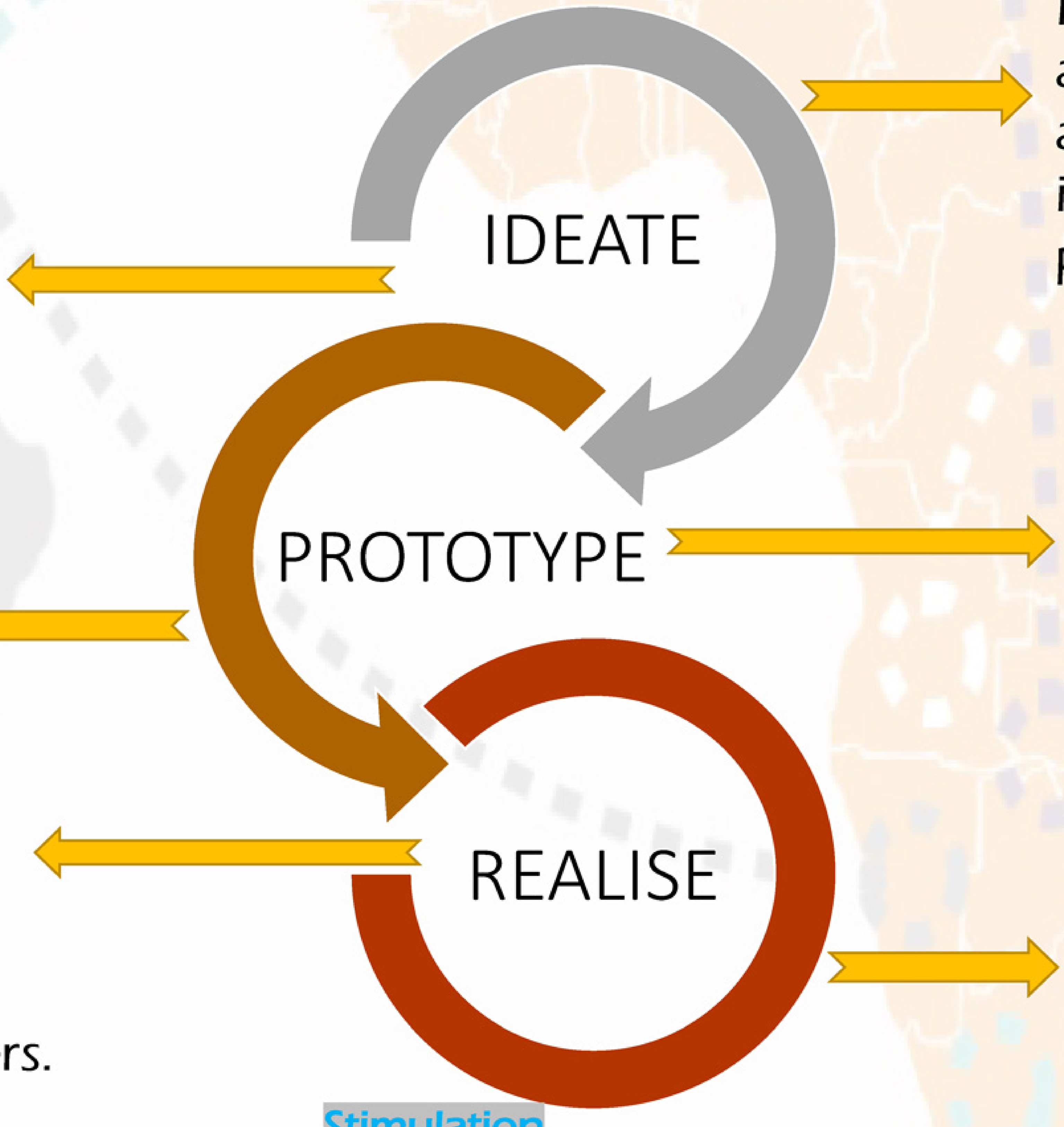
- To improve vaccine allocation and reduce misallocation/wastage of vaccines, track information of where vaccines have been allocated and demand rate in all regions.
- Avoid over or under supply supply of vaccine in dose one in order to avoid shortage or excessive warehouse stock in second dose.

Goals

- Develop and apply methodology to recommend how to allocate stocks of vaccine to multiple regions and all the dispensing locations. Need to ensure that the individuals who received their first dose receives their second dose in a timely manner and make sure sure to avoid stockouts especially in second dose.

How to organize efficient vaccination policy and procedure which determines capacity and capability requirements before scaling up vaccine administration.

How do we enforce fairness and provide transparency amongst all the parties involved in distribution process?

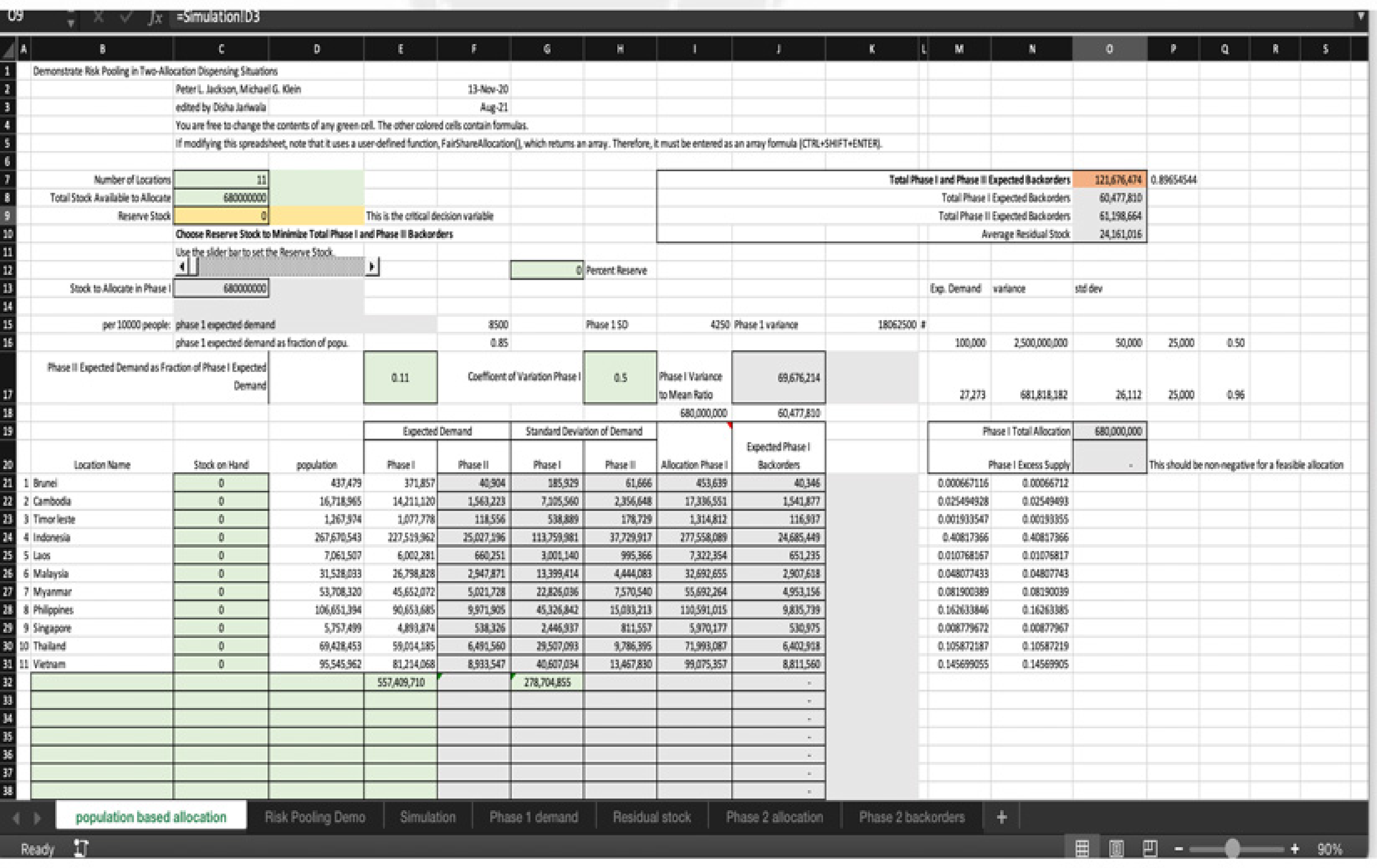


Working on different models of spreadsheet to produce the most suitable model which helps solve all the problems as well ss achieve the desired goals.

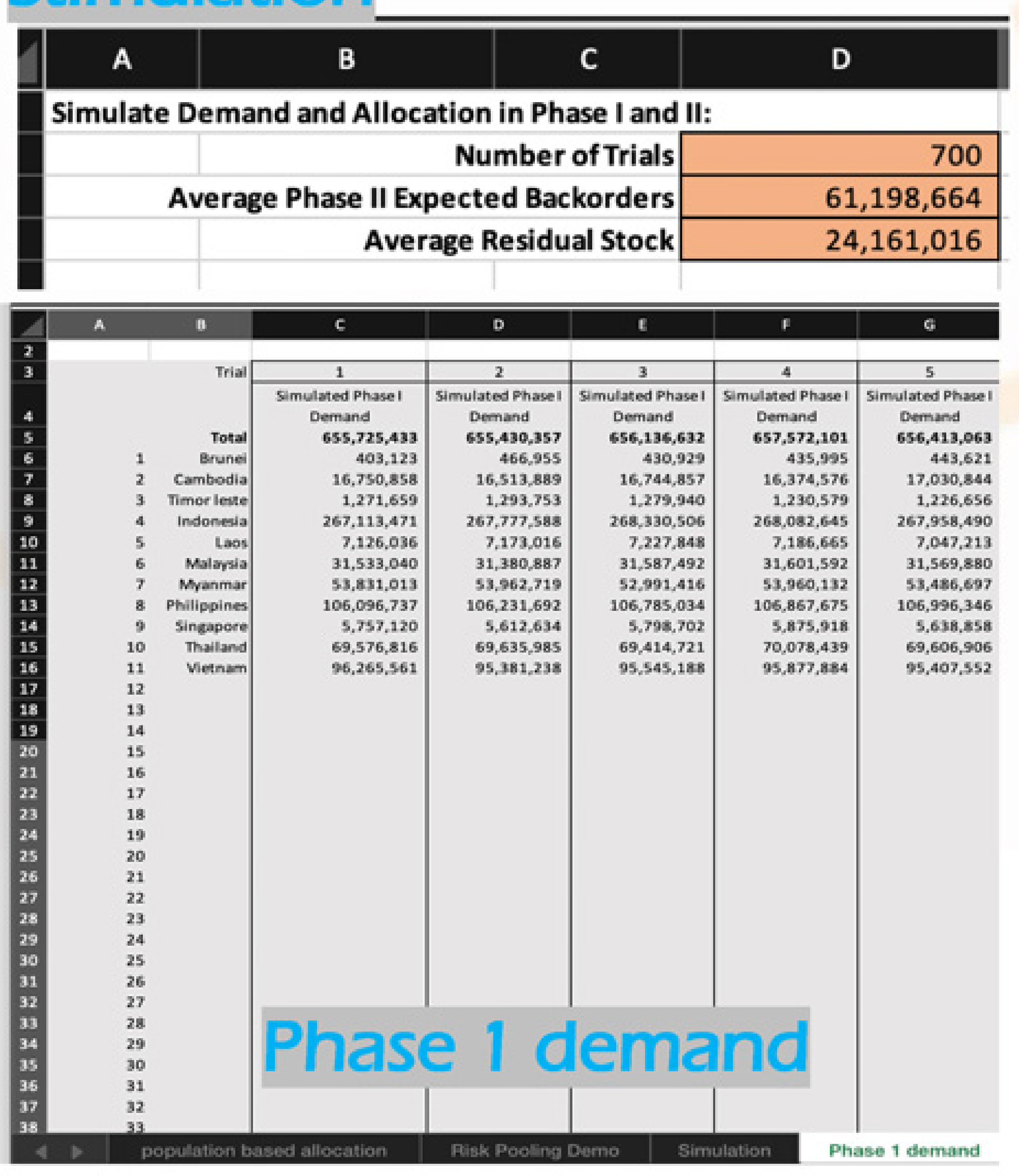
We worked on many prototypes and few examples are: SimpleAllocationOptimization, RiskPoolingDemo, CIDDP VaccineDistribution V1-9, SimpleAllocationOptimization, etc.

This model includes population-based allocation, Risk Pooling Demo, Simulation, Phase 1 demand, Residual stock, Phase 2 allocation and Phase 2 backorders. Hence solves all the problems.

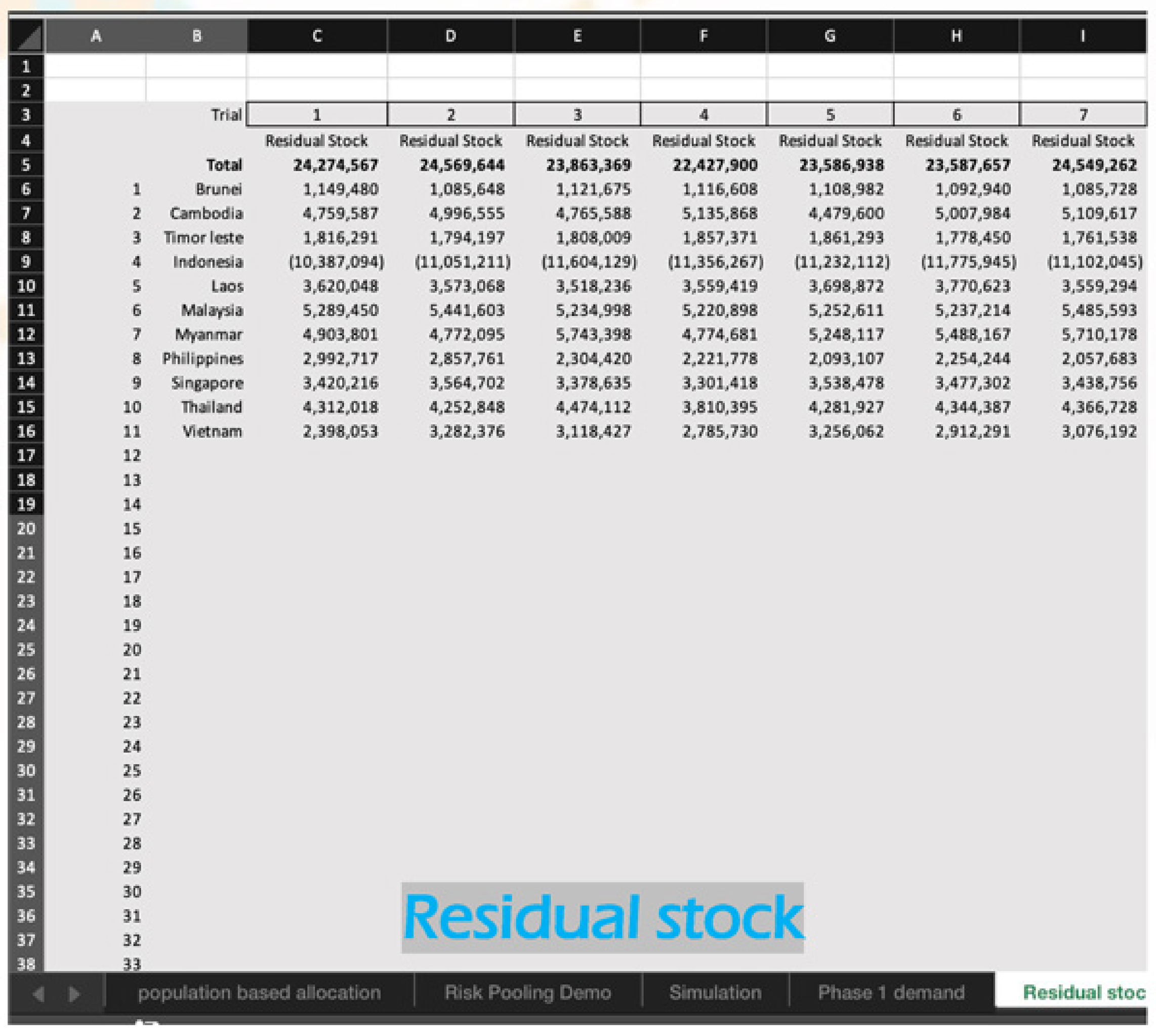
Literature review and decided to move further with RiskPoolingDemo model for Asian countries.



Stimulation



Phase 1 demand



Residual stock

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EXPRESSIVE AVATARS FOR SOCIAL ANXIETY AND DISCLOSURE

INTRODUCTION / AIMS

People who have social anxiety tend not to seek help when needed due to inherent social interaction characteristics. Parallelly, past studies have demonstrated positive effects of avatar interactions on interpersonal outcomes. This project aims to gather greater clarity in existing avatar and communication research about how a person's use of avatars as a Computer Mediated Communication (CMC) tool affects communication.

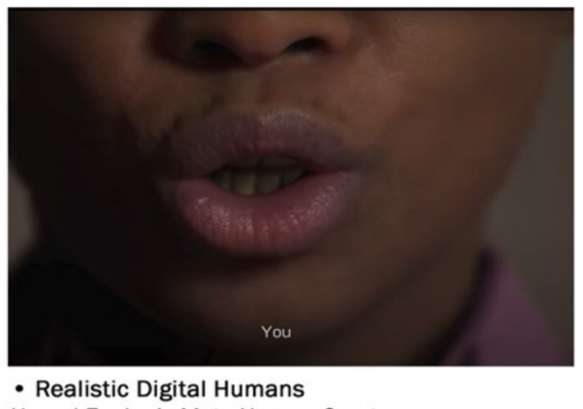
TRENDS & MOTIVATION

Extended to practice, expressiveness of avatars have the potential to create a safe spaces for disclosure, lending itself as a practical medium for synchronous counselling.

• Overcoming barriers through CMC mediums
Kid in VR shares struggles about his special needs
(https://youtu.be/ZvKCpn4vnl4)

• Gestural and Facial tracking softwares
Facial capture using Unity and IPhone X
(https://youtu.be/0_QqFeZTqxY)

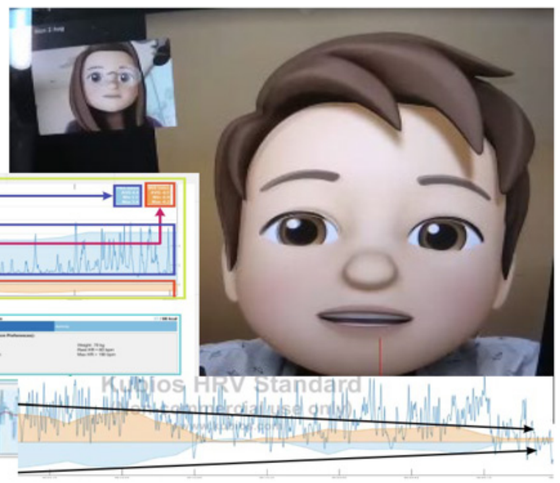
• Avatars as a means of self-expression
Kid talks about being bullied
https://youtu.be/KZWOXgc7PA4)



• Realistic Digital Humans
Unreal Engine's Meta Human Creator
(https://www.unrealengine.com/en-US/digital-humans)

RESEARCH QUESTIONS

- Can digital self-representation and interaction via avatars increase psycho-emotional safety and reduce social anxiety?
- Can user of expressive avatars facilitate hyper-personal communication outcomes?
- Do users feel motivated to use expressive avatars for communication?
- Are expressive avatars an effective/conducive CMC medium for users?



AREAS OF STUDY

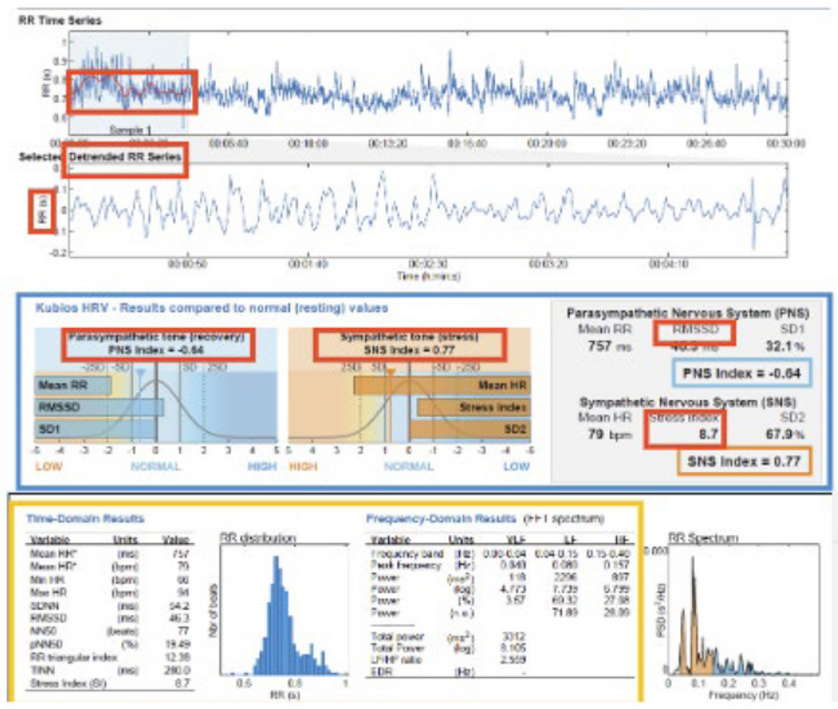
- Experiment Design
- Statistical Analysis
- Heart Rate Variability (HRV) Analysis
- Role-playing, Transformed Social Interaction
- Communication Research, Emotional Safety, Therapeutic Alliances

METHODOLOGY

- Laboratory sessions with/without avatar conditions
- Trait Anxiety Scales and Disclosure Scales
- Sympathetic (SNS) / Parasympathetic (PNS) response
- Post-session reviews and qualitative analysis of content
- Visual observation of gaze and social interaction

KEY FINDINGS

- General (116.25) < With Avatars(123.75) < CMC Without Avatars (127.5)
  [Disclosure scores based on Wheeless' (1987) Disclosure Scale]
- Impaired efficiency of session: ability to read nuances
- General SNS dominance on 1st sessions, PNS dominance on 2nd sessions
- For profiles with Higher-Anxiety scores:
  - Increased sense of emotional safety, Lower PNS, Higher stress indexes
  - PNS does not take dominance on 2nd sessions
- For profiles with Lower Trait-Anxiety scores:
  - Normal to high PNS, face-to-face CMC preferred



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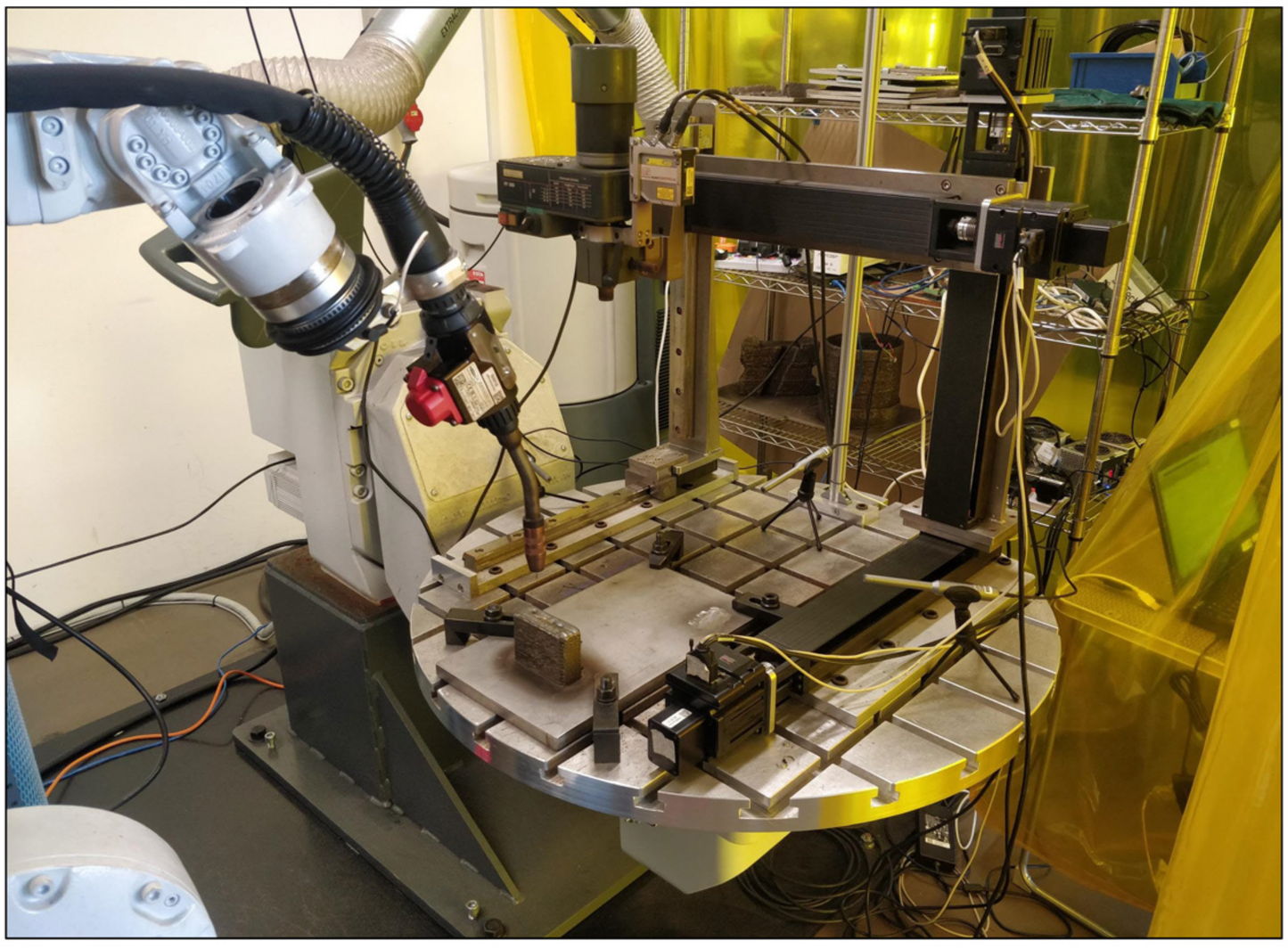
Making WAAM Technology More Accessible

What is WAAM?

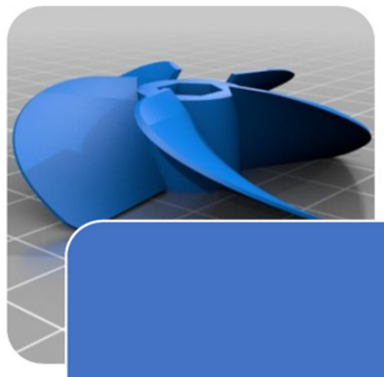
Wire Arc Additive Manufacturing is a 3D Printing Method used to deposit large amounts of materials, forming a Near Net Shape of the final product. This product will need to be post processed to meet the final material properties and dimensions.

WAAM is commonly performed using a Welding Robot or a Welding Attachment and can be used to deposit all metals that can be welded. Common materials include AL 5183, Inconel, Titanium, Stainless Steel (316) and Aluminium Bronze.

WAAM is currently being explored for large sized, high value items, such as propellers and replacement parts.

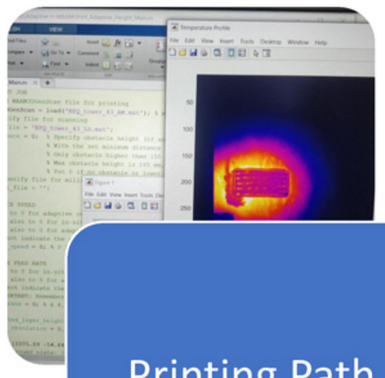


WAAM Development Workflow

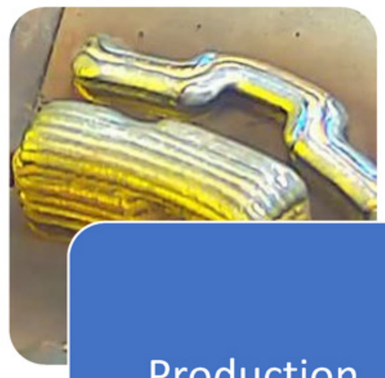


3D Modeling

Material Characterization



Printing Path Development



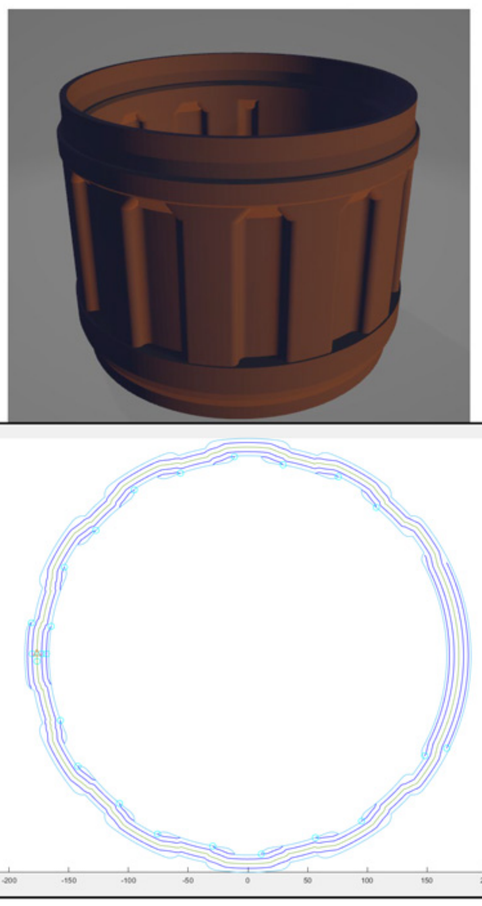
Production Testing

Printing Path Development

No general-purpose software is currently available for WAAM systems. In addition, WAAM systems need to be able to print overhangs and curved surfaces. Since welded metal does not behave like plastic deposit in FDM systems, single-bead characterization is used to obtain the parameters required to print complex geometries with acceptable bead profiles.

A mathematical interface is then used to calculate the position of each bead. The objective is to obtain long continuous beads with flat, even weld surfaces. Overhang defects such as spattering, gaps and missed deposition can also be addressed in this phase.

An example of this is shown in the diagram on the left. This study focuses on path development for circular shapes with enclosed features. This will be used to produce Oil and Gas subsea components out of Inconel 718.



References:
3D Modeling: Propeller Picture: https://www.thingiverse.com/thing:1667362, Boat Propeller by byedesign July 11, 2016
Material Characterization: Internal Study by Prof Soh Gim Song and Chen Zhe

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2020/2021 Ideate-Prototype-Realize

SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

Tan Jing Jie | Student
Chong Keng Hua | Advisor

KEY TERMS IN THIS STUDY: ADAPTABLE USER INTERFACE; ELDERLY; PERCEIVED USEFULNESS; PERCEIVED EASE OF LEARNING

Problem Statement

Elderly are still facing many challenges when they are using new technologies especially when e-Government services have been widely integrated into the daily lifestyle such as Singpass or Healthhub.

Research Aim & Goal

The aim is to increase digital participation amongst elderly aged between 55 to 65 in Singapore. The goal is to increase usability and learnability of consumer health mobile application using adatable user interface

Research Question & Hypothesis

Perceived Ease of Use

H1: Quality of navigation aid is corelated to perceived ease of use

Perceived Usefulness

H2: Quality of UI design is corelated to perceived usefulness

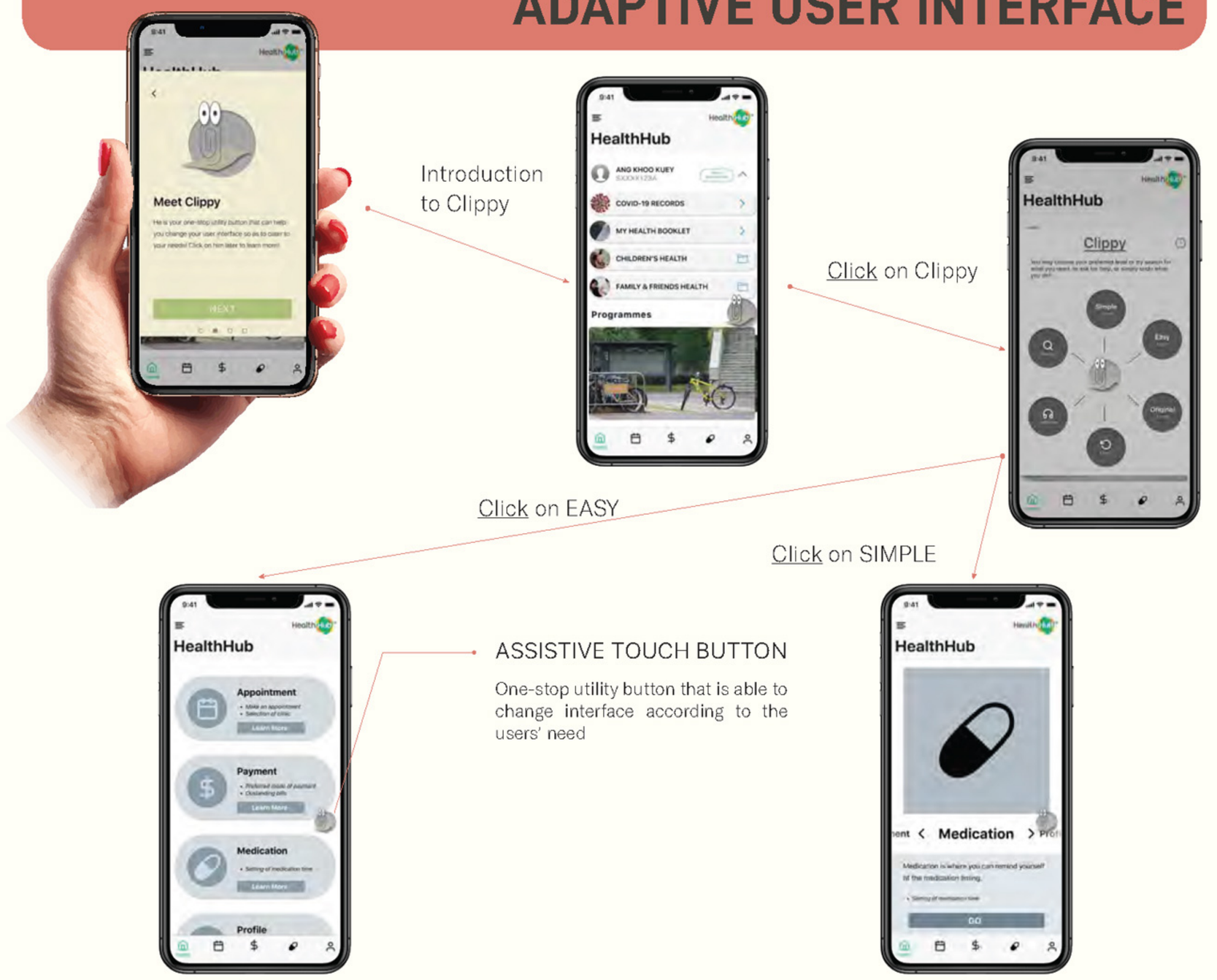
Self-Efficacy

H3: Requisite knowledge is corelated to perceived usefulness

Intention of Use

H4: Intrinsic Motivation is corelated to intention of use
H5: Low cognitive is corelated to intention of use
H6: Level of mobile anxiety is corelated to intention of use

IMPROVING USABILITY AND LEARNABILITY OF CONSUMER HEALTH TECHNOLOGIES THROUGH ADAPTIVE USER INTERFACE



Research Approach (Qualitative)

Elderly from Care Community Service Society (CCSS) and SimpleIT will be participating in this research. Around 15 - 17 elderly will be interviewed.

Results (So far)

72% of the participants from pilot study thinks that an avatar is good for guidance and learning.

90% of the participants from pilot study thinks that less than three operational layers within the application is good for navigation.

81% of the participants from pilot study thinks that having options (physical / digital) for assistance is helpful in learning.

Future works

My research will focus on learnability and usability for elderly while using Clippy. However, to bring this research one step further, more research could be done to see how Clippy could elevate elderly from a mediocre level to an intermediate level and finally to proficient level.

More interviews with the elderly need to be conducted to validate my findings thus far. Progress are still ongoing despite the delay due to COVID-19 pandemic.

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2020 | 2021 Ideate-Prototype-Realize



SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

Laura Fernandez | **Student**
Lynette Cheah and Michael Budig | **Advisors**

Reducing the environmental impact of parcel packaging waste

DISCOVER Paper based packaging materials produce the most amount of CO_2 emissions and solid waste for e-commerce.

Amount of CO_2e [Metric Tons - Mt] from Express Packaging Delivery Materials in China

Amount of solid waste [Thousand Metric Tons - Mt] from Express Packaging Delivery Materials in China 2017

Why is cardboard the major contributor of GHG emissions and solid waste?

MATERIAL PRODUCTION

Raw material and manufacturing processes require more resources than plastic based packaging, leading to the generation of more NO_x and CO_2.

TRANSPORTATION

Paper based packaging materials are heavier than plastic based materials which require more transportation resources for their distribution.

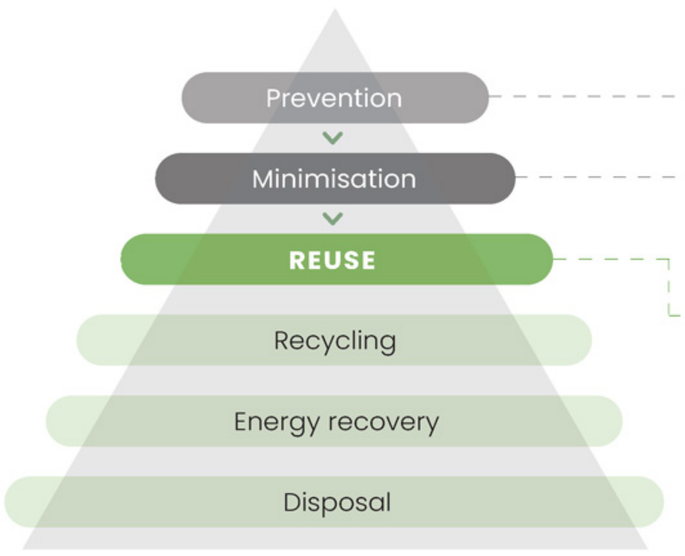
MAIN PARCEL PACKAGING

Corrugated boxes are the main parcel packaging material for the e-commerce industry. 80% of parcels are packed in corrugated boxes, which sets cardboard in the first place for waste generation of packaging materials.

IDEATE

DEFINE How might we reduce the environmental impact of cardboard parcel packaging waste in e-commerce?

WASTE HIERARCHY



CONCEPTUALIZATION

CHALLENGES

Redesigning the mailbox system for receiving parcels without packaging	- Product safety, protection and privacy - Implementation
Framework for e-commerce companies to shipped products in its own container [SIOC]	- Logistics strategy - Implementation - E-commerce adoption
Platform to connect users for reusing parcel packaging waste	- Logistics - Reliability & engagement -Adoption

Cardboard boxes are an important element of the parcel delivery logistics cycle. Shipping products without packaging is not a scalable solution to create positive environmental impact.

Reusing the parcel packaging reduces waste and GHG emissions.

CUSTOMER NEEDS

Survey Insights

80% of participants not willing to compromise parcel protection and safety over environmental impact.

73% are willing to take further action with parcel packaging after receiving the product.

User identification

SUPPLY Givers

Give away their packaging materials from e-commerce for free.

- E-commerce customers
- Local businesses or markets

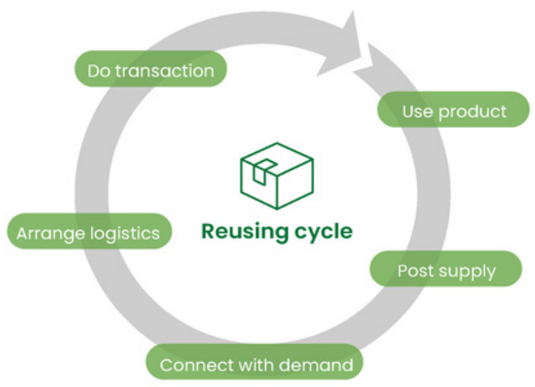
DEMAND Getters

Users interested in acquiring packaging materials for multiple purposes.

- Local sellers
- Resellers
- Recycling co.
- Movers

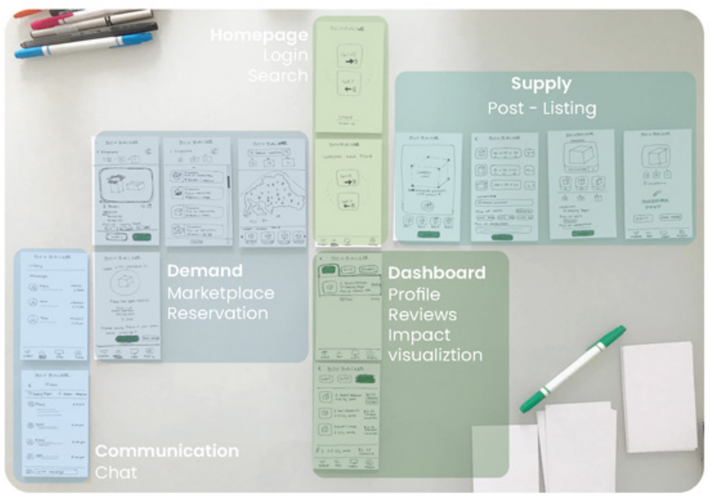
DEVELOP A platform to connect supply and demand of packaging materials waste in Singapore.

CIRCULAR ECONOMY STRATEGY



Cardboard is a single-used product for e-commerce. The average cost of a box is $3.00 SGD. The boxes can be reused multiple times until they are no longer functional, then recycling is the next step for reducing the environmental impact of this material.

PROTOTYPING UX | UI DESIGN

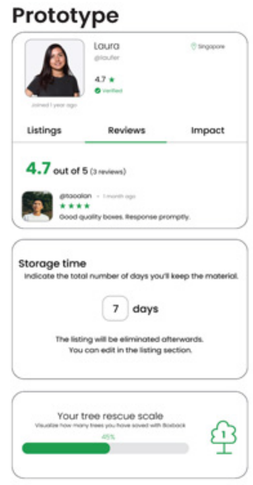


INTERVIEW INSIGHTS

User needs after testing first prototype in FIGMA

Needs		Solution
Reliability	Concern about user being trustworthy from both ends	Reviews & rating system of the users
Convenience	The amount of effort required	Online shopping time vs reusing efforts.
Storage Time	How long do they need to storage the boxes?	Timeframe set up in the listing form. Listing gets eliminated after time is out.
Impact Visualization	Making the impact more relatable	How many trees are saved for each reused box?

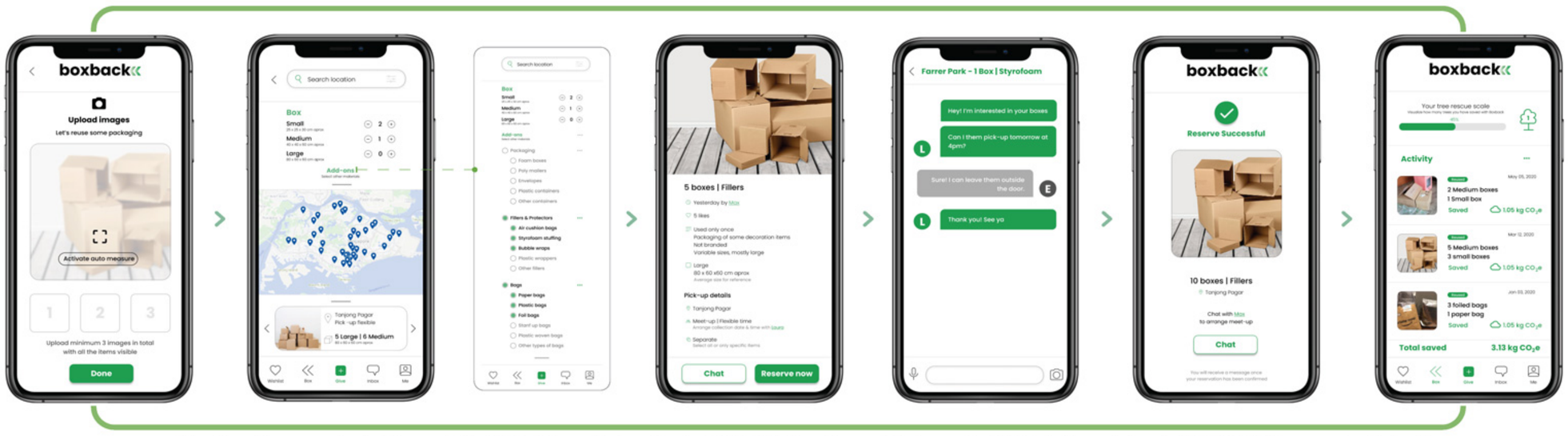
Prototype



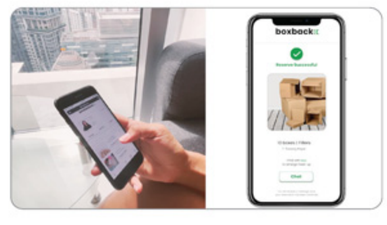
PROTOTYPE

DELIVER Boxback is a digital platform which connects users for reusing parcel packaging waste in the local comunity.

FINAL UX | UI DESIGN



BOXBACK AD



boxback

https://vimeo.com/585241948

https://www.figma.com/proto/WmceochTOmMdRXqL7f9qom/Boxback?node-id=190%3A113&scaling=contain&page-id=0%3A1&starting-point-node-id=94%3A78&show-proto-sidebar=1

REALIZE

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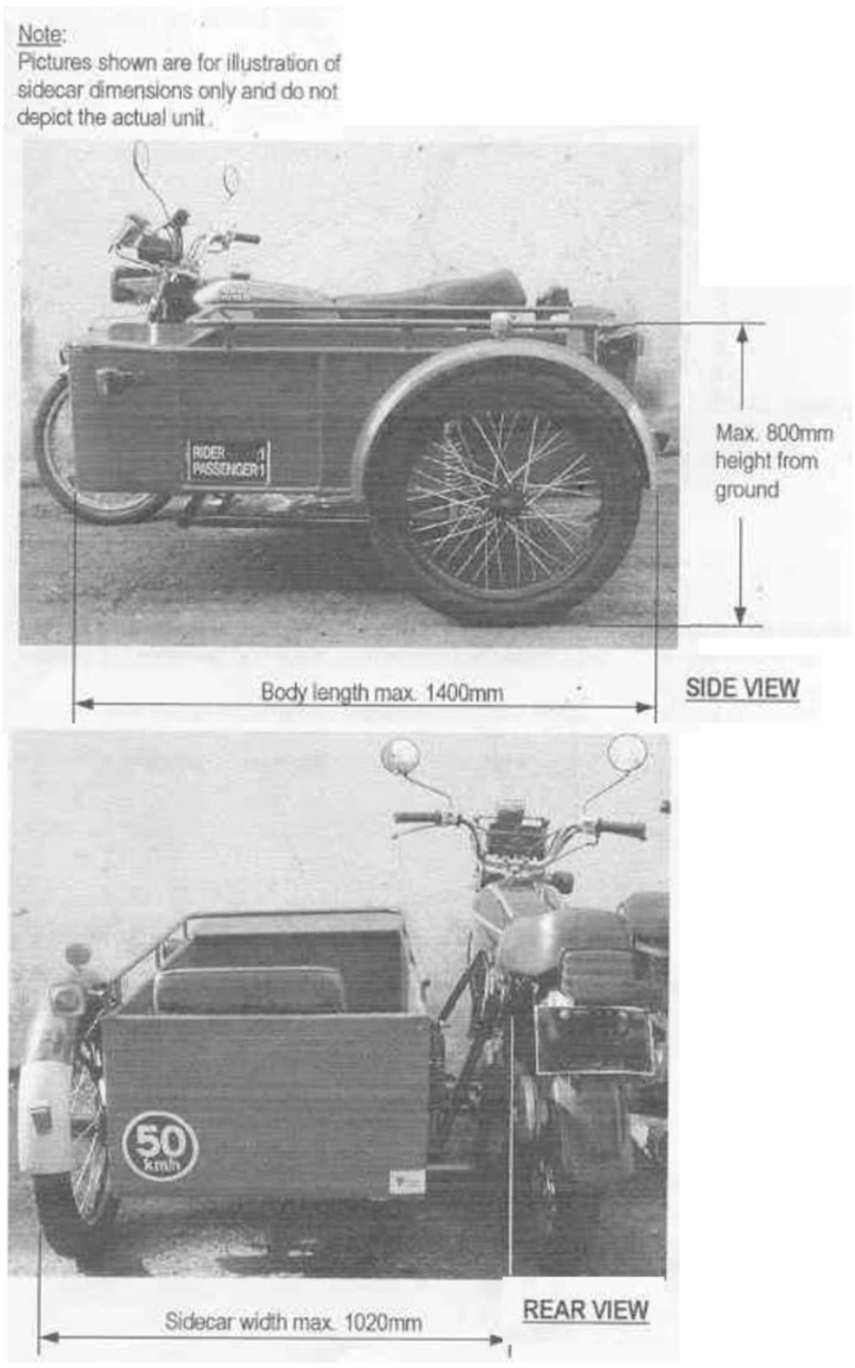
SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

Tan Lu han | Student
Dr Lim Seh Chun | Advisor

Singapore special sidecar



Problem

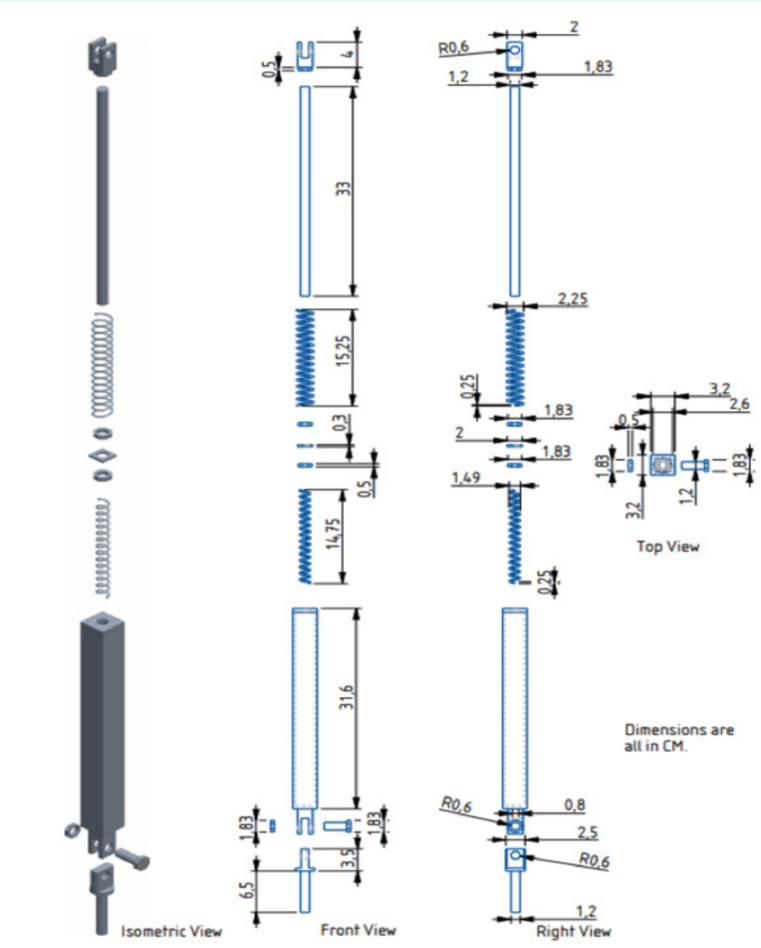
- Handling of the motorcycle with the sidecar attached (unable to lean)
- Size limitation due to LTA's stipulated dimensions

analysis

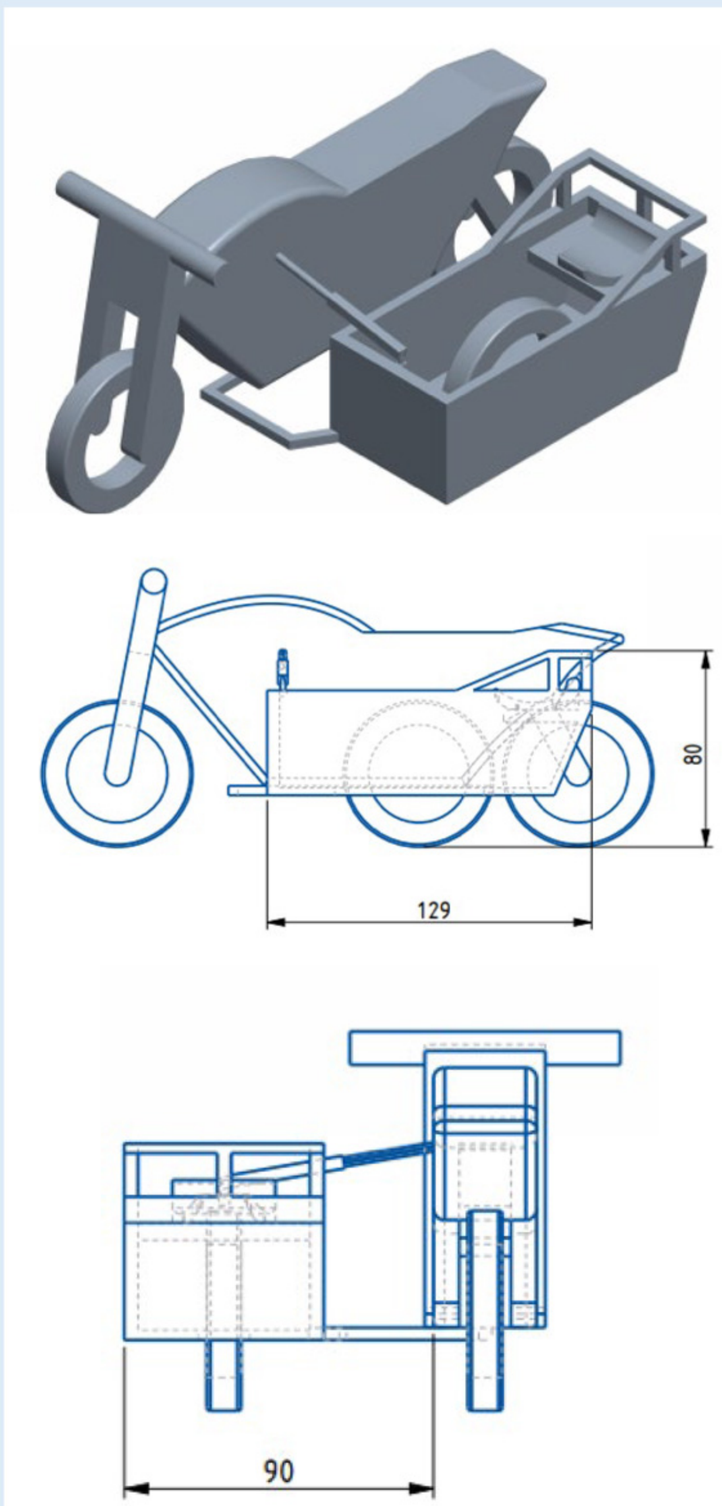
Sidecars in Singapore are rigidly connected which restricts the rider from leaning. While leaning sidecars are available, they fail to meet LTA's requirements.

Solution

- A leaning sidecar with the wheel in the middle.
- A special spring to balance the heavy motorcycle (272kg).



To overcome the instability of the motorcycle at low speeds, a custom made 2-way spring was installed between the motorcycle and sidecar. The assembly returns to center on both pulls and pushes. This allows the motorcycle to function like a rigid sidecar at low speeds (stable) and also allows leaning at higher speeds.



After going through three major changes to overcome the issues faced during multiple tests, the **Singapore Special Sidecar (SSS)** was born.

This research has taught be about prototyping and overcoming challenges in research. I also learnt that documentation is as important as the product itself, as research cannot exist without data.

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MURALI KRISHNAN | Student
ARLINDO SILVA | Advisor

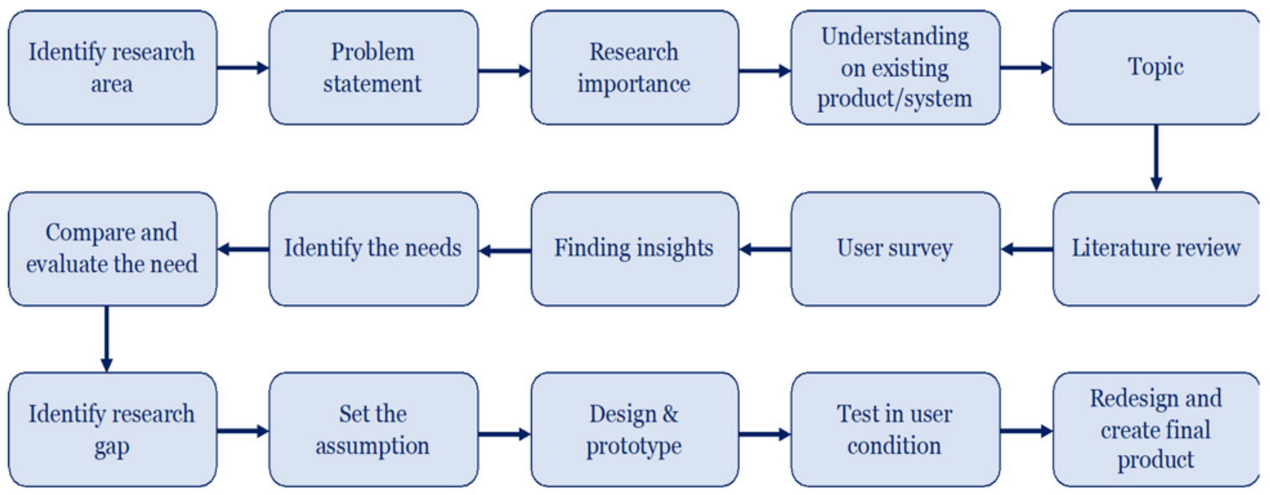
1. Problem statement:

- The existing system are **difficult** to rescue the child from borewell when the situation is **complex**.
- The traditional method called **parallel borewell dig** is mostly preferred in which it require **heavy machineries** are required to perform the task.

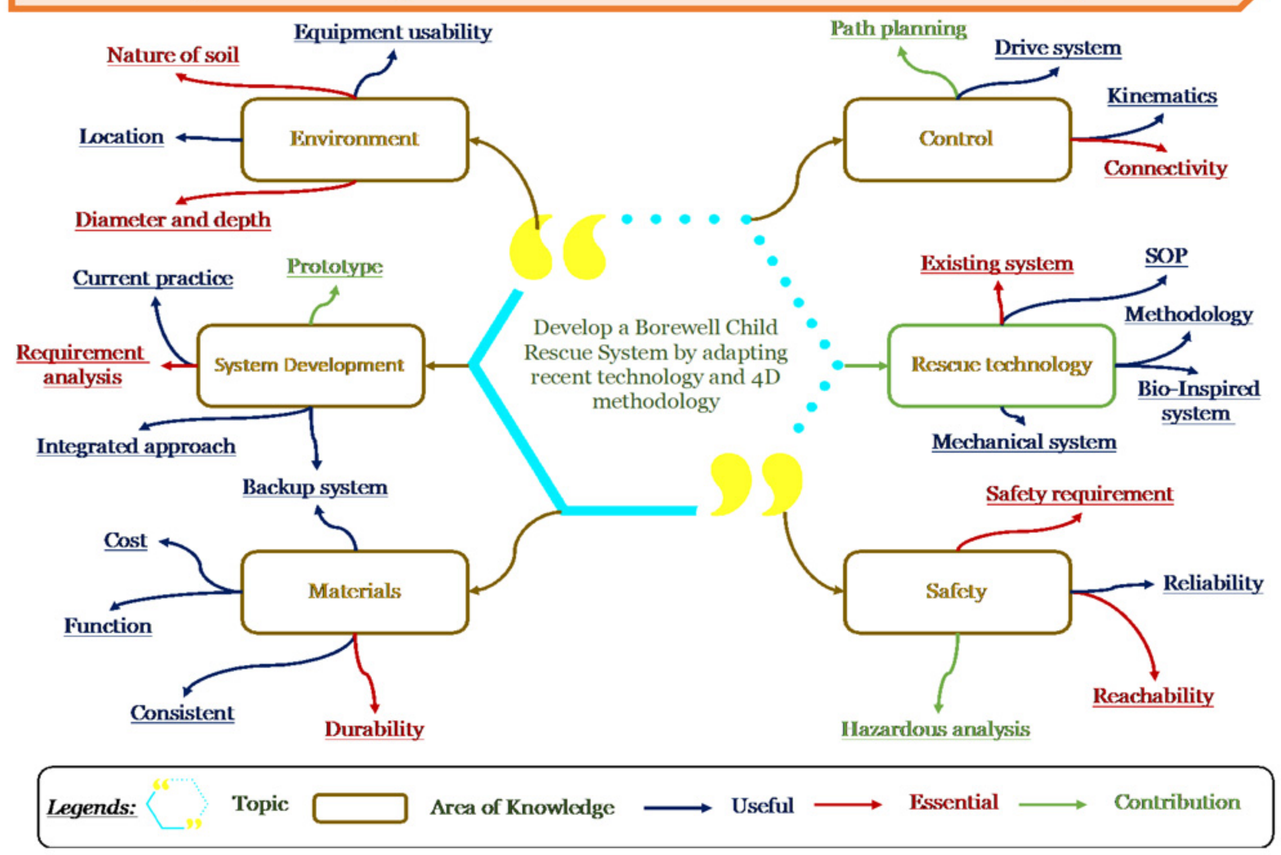
2. Aim and Goal

- To understand the **complexity and environmental** condition of rescue operations and to develop a low-cost with **minimal footprint.**
- To **successfully** rescue the child from borewell in any environmental situation - condition of soils and land in and around the borewell by adapting **new** rescue technologies and design innovation methodology

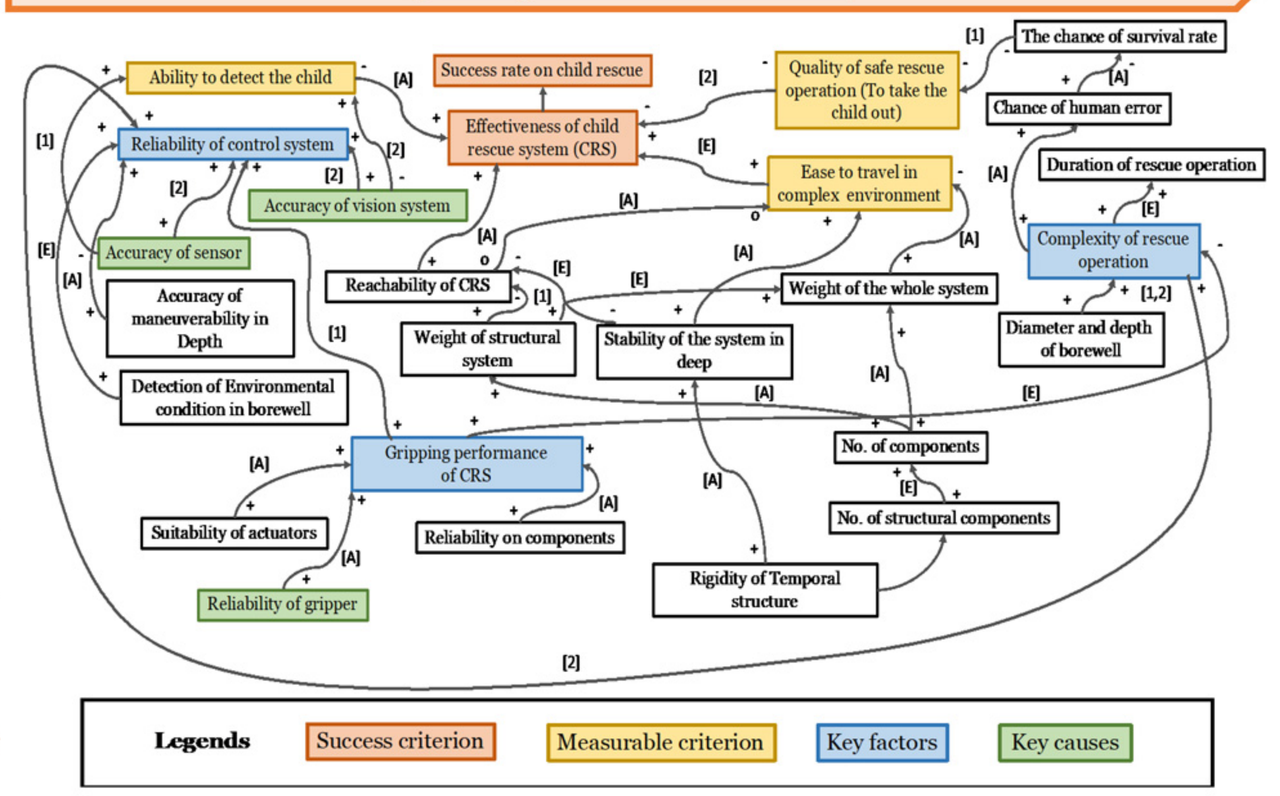
3. Research Approach



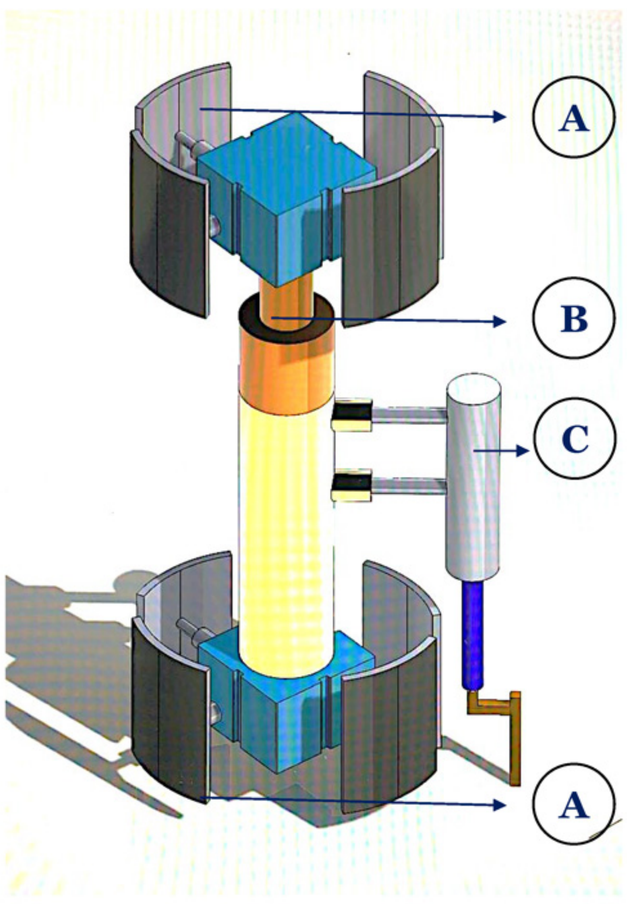
4. Area of Relevance and contribution

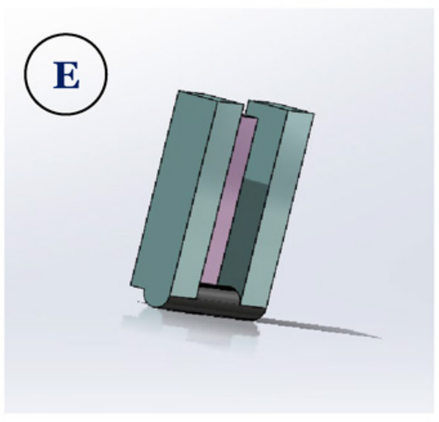


5. Reference model



6. Design of rescue system





7. Working principle

A. Pneumatic glider – Each gliding shields is attached to a hydraulic telescopic pistons in a spherical joint method and free to move in all direction.

B. Hydraulic motor – Help to rotate the system clockwise and anti-clockwise in order to match the clamping position of victim.

C. Master cylinder – Attached with two different hydraulic pistons which helps it to move side wise also it has the capability to tilt at certain angle.

D. Cantilever support – Loaded with spring and top side has trigger control which is attached to solenoid valve. The support passes underneath to lift the child out from the trap area.

E. Hoses (Green) – Due to presence of toxic gases and high temperature, the two hoses are used to Supply oxygen and atmospheric air into the borewell

8. Deliverables

- Promote a low-cost and adaptable CRS for various scenarios.
- Deliver potentially effective system for successful rescue operation
- Automated system with built in surveillance, gas detection sensor to monitor live conditions etc.

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SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

Nasiruddin Abdul Nasir | Student
Soh Gim Song | Advisor

Mechanical Design of a rope climber for airframe application

Aim

To automate aircraft sanding process to reduce manpower and overall time taken.

Goals

1. To develop a function system framework on the process towards automation in aircraft application
2. To create specialized subsystems to carry out specific tasks such as replacing used sandpaper.
3. To build a robot capable of carrying payload and maneuverer it to cover bigger surface area.

Design Approach

Mechanism Selection
- Identify key functions.
- Have a study of what's been done in the industry

Lit Review/ Concept Gen
- Search and evaluation of the available literature on the specific mechanism.
- Generate overall concept ideas

Prototype & Testing
- Prototype each subsystem
- Integrate all subsystem

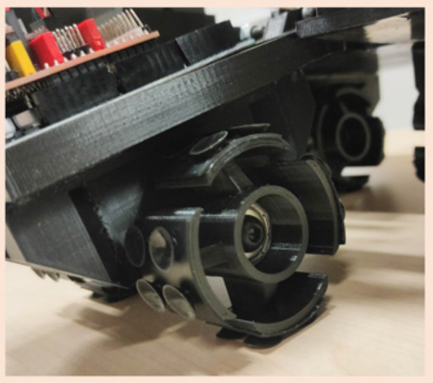
Mechanism and Key Functions

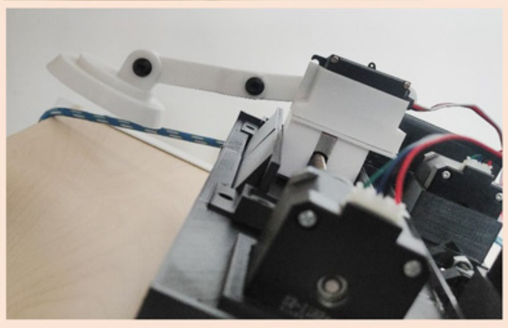
1.Contact Surface:
- Gaps by wheel-leg design to overcome obstacles
- Wrapped with octopus legs suction cups to be able to stick to surface

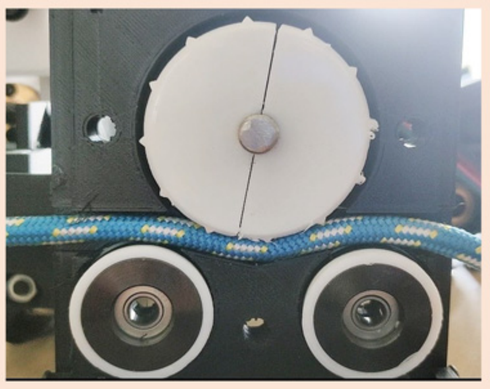
2.Sander:
- Adjustable bendable arm to conform to the different curvature surface angles
- Able to maintain linear motion – Wider area of coverage

3.Climber:
- Rollers acting as rope guide
- Spur gear providing sufficient bite and grip force to drive and hold the climbing rope as required

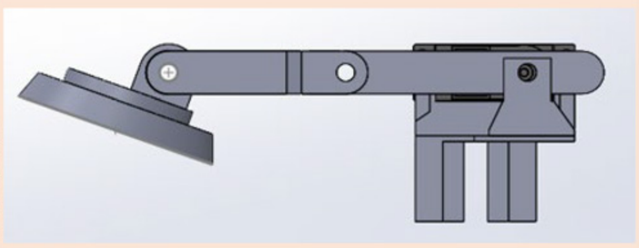
Physical Design

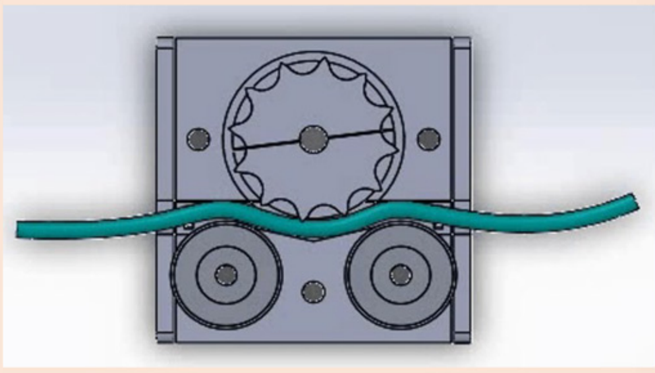




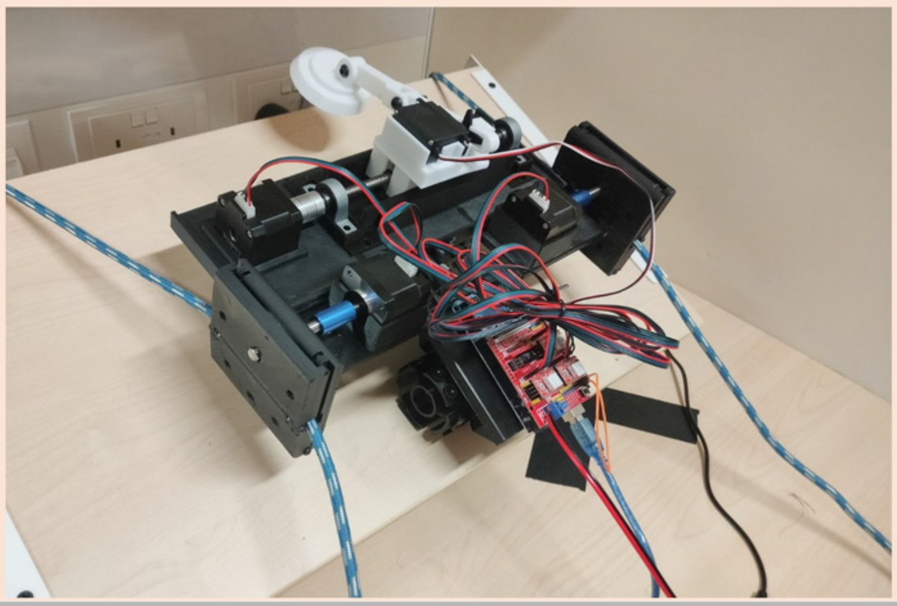


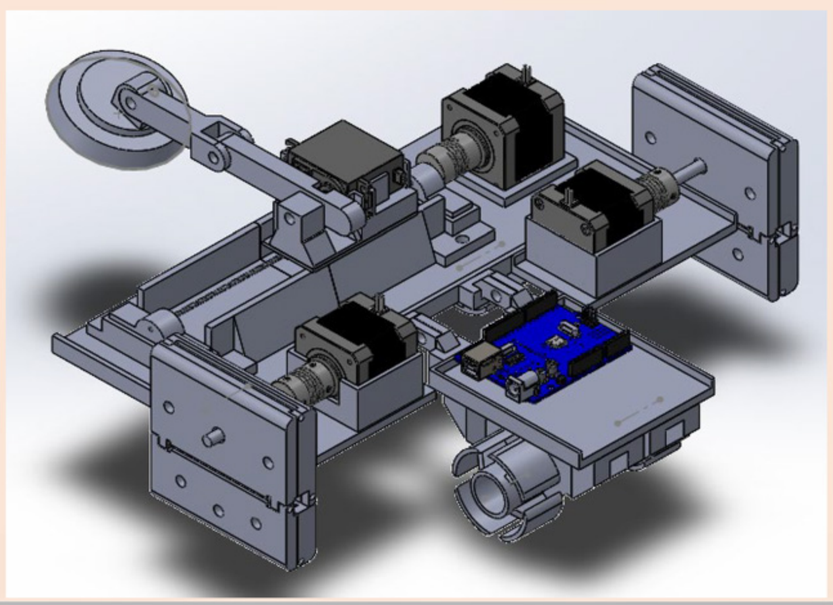
Rendered Design





Final Design:





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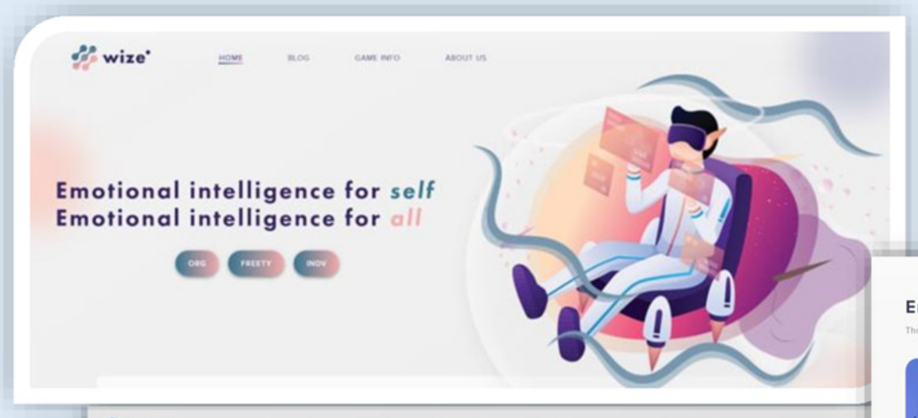
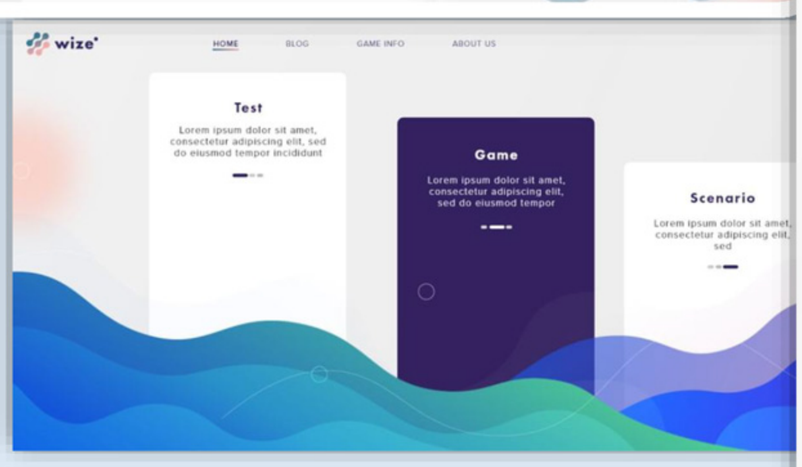
SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

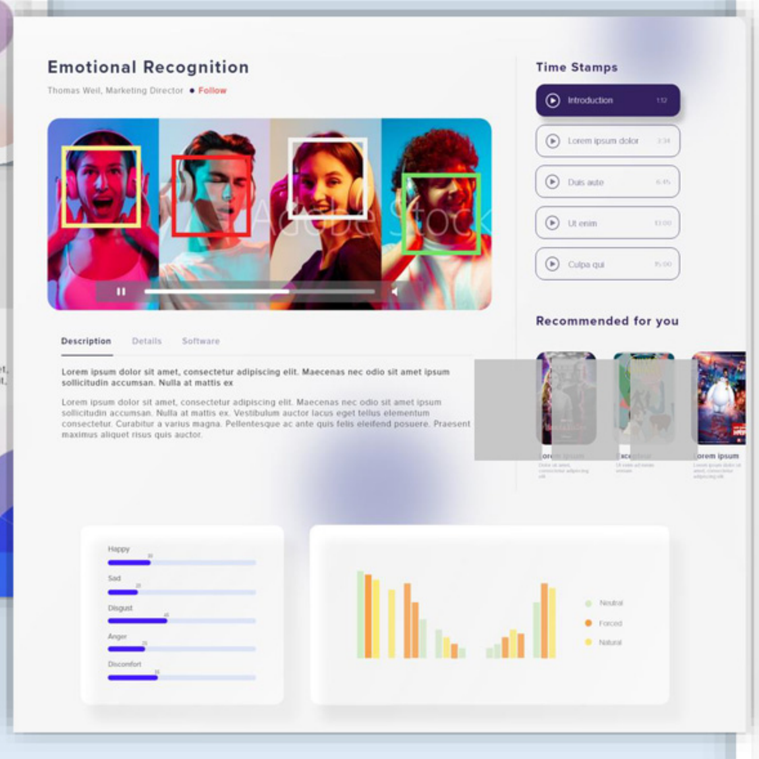
Povendhan Palanisamy | Student

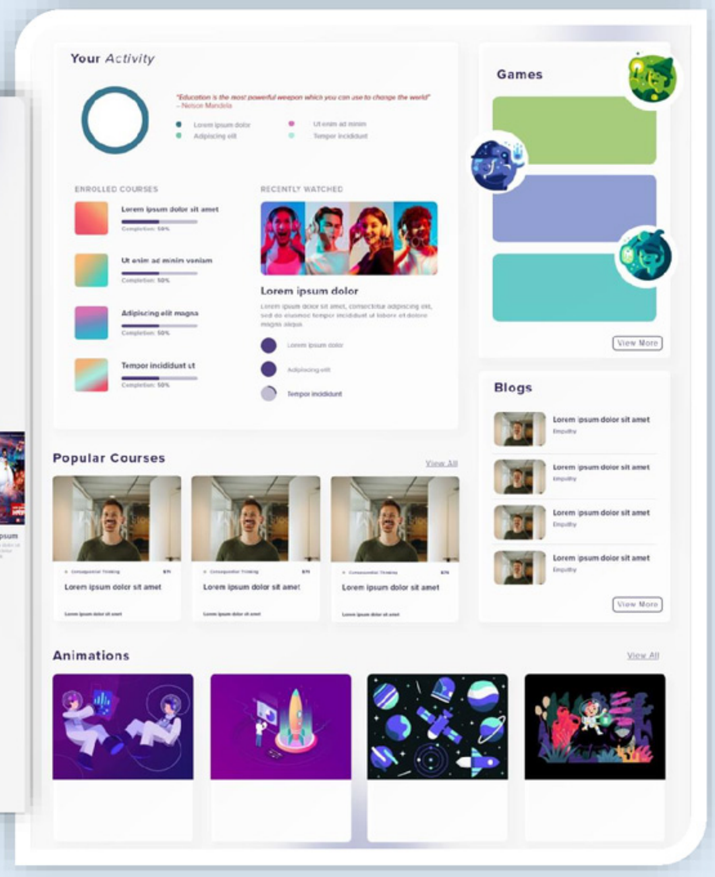
Mohan Rajesh Elara | Advisor

How might we make learning Emotional Intelligence Fun and Impactful within Universities and Organizations





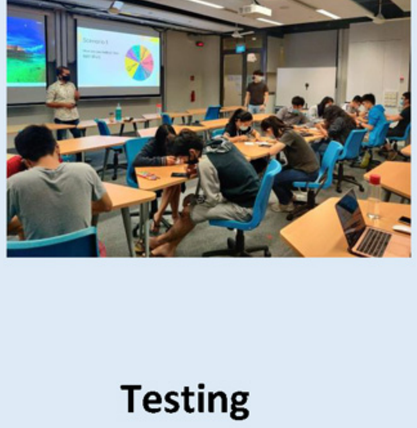




Design Process

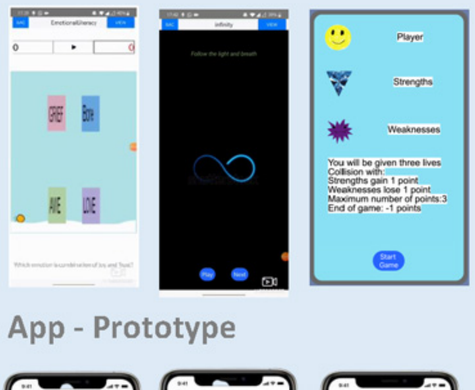
Ideate

Research & Design methods Activities



Testing

Workshop with University Student



Prototype & Testing

Thunkable and Figma

Interest Group

Realize (WebApp)

FrontEnd- React, HTMl, CSS

Backend – node.js, express

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Tanvi R Thombre | Student
Lucienne Blessing | Advisor

GreenAiry: Plant-based indoor air purification

Indoor air pollution is an unseen health hazard, which can be tackled by using plants as air purifiers. This project aims to **build an effective and desirable indoor plant-based air purifier**.

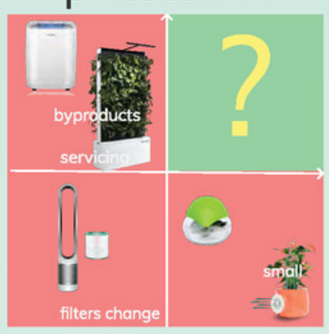
IDEATE

SITUATION

90% DAY SPENT INDOORS
X
11,000 BREATHS A DAY
X
2-5X DIRTIER INDOOR AIR

MARKET GAP

Effective against pollutants



Accessible by everyone

APPROACH

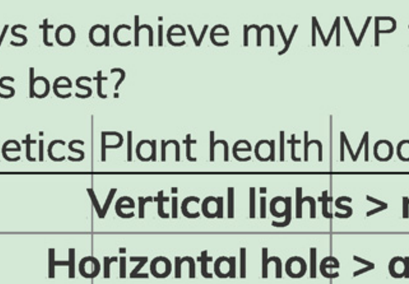
HMW create an effective (*removes air pollutants to a level that is healthy for humans*) **AND** accessible (*can be maintained by users without external assistance or tools*) air purifier (*for an office or apartment*)?

- Optimising the **plant conditions** can improve the efficiency of phytoremediation for air.
- Improving the **modularity and usability** of the purifier can improve its accessibility.

PROTOTYPE

LITERATURE REVIEWS

Which factors affect phytoremediation (purification)?
Which factors affect plant health?



Plant type
Growth medium
Airflow & pressure

Lighting
Water & nutrients
pH & temperature

MARKET REVIEW

What do users love and hate about current air purifiers and plant towers, the 2 products we are most like?

FUNCTION PUGH CHART

Of multiple ways to achieve my MVP functions, which fulfill user needs best?

	Aesthetics	Plant health	Modularity	Purification
Lights	**Vertical lights > ring lights**			
Hole	**Horizontal hole > angled hole**			
Fan	**Stackable tower fan > bladeless fan**			
Reservoir	**Pullout water reservoir > capped reservoir**			
Timer	**Mechanical timer > wifi timer**			
pH	**Manual pH strips > pH sensor**			
Feedback	**Light strip user feedback > screen feedback**			

FORM IDEATION AND ITERATION

The difficult part here was ideating a form which ensured separate water and air flows.

REALISE

PLANTS

Choose the hardiest amongst plants for each pollutant

HL-acclimatised Dypsis lutescens (ARECA PALM) for CO2

Sansevieria trifasciata (SNAKE PLANT) for smoke

Chlorophytum comosum L. (SPIDER PLANT) for dust

Epipremnum aureum (MONEY PLANT) for formaldehyde/toluene

FEATURES

Modular cross lighting

Ensure plants get sufficient lighting

Replaceable plants

Customise plants to indoor pollutants

Absorbent medium

Maintains microbe and moisture levels

Modular tower fan

Push pressured air through roots

Sensors

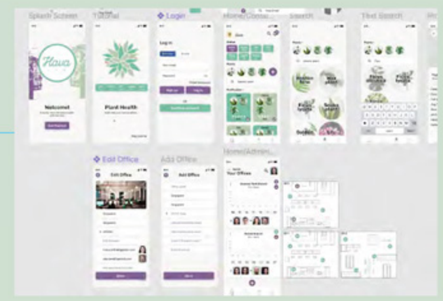
Air quality and plant condition readings

Water reservoir

Ensure plants can auto-water

Accompanying app

Make maintenance and user feedback easier



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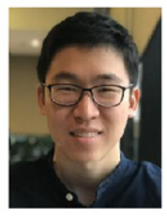


SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

Wong Zhi Heng Timothy | Student
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Improving the Flight-Efficiency of a Monocopter

Ideate

How Might We...

1 ...design an improved nature-inspired UAV platform?

2 ...design an improved monocopter platform?

Identify Potential Users
- Aerial Photo/ Videographers
- Couriers
- Foresters
- RC Hobbyists

Identify User Needs
Payload | Camera | Noise | Endurance

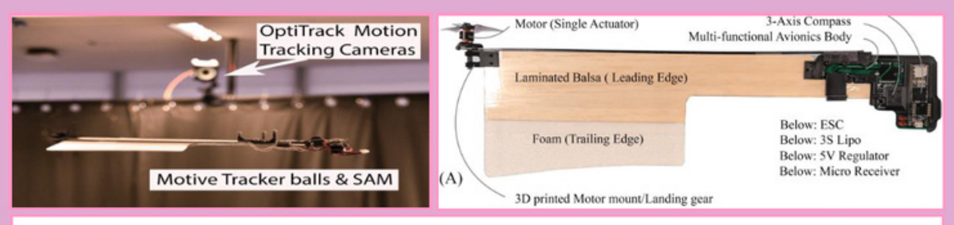
3 ...improve the *payload-carrying capability*...
...improve the *image-capturing capability*...
...reduce the *noise generated in-flight*...
...improve the *flight endurance/efficiency*...
... of a monocopter platform?

Monocopters

- Small, single-winged aerial vehicles
- Nature-inspired design: winged samara seeds
- Gyroscopically-stable rotation while falling

(Left & Centre): A Single-Winged Samara; (Right): Samaras Rotate While Falling

- Flies by rotating around its centre-of-mass
- Rotates when a thrust force is generated by the propeller
- Two actuated parts: *Motor/Propeller* and *Flap*
  - *Motor speed* provides collective (up-down) control
  - *Flap deflection* provides cyclic (side-to-side) control



(Left): A Monocopter In Flight; (Right): A Monocopter Prototype

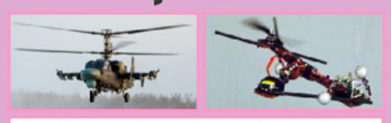
Source: L. S. T. Win, S. K. H. Win, D. Sufiyan, G. S. Soh and S. Foong, "Achieving Efficient Controlled Flight with A Single Actuator", 2020 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM), Boston, MA, USA, 2020, pp. 1625-1631

4 **Opportunity Statement:** How might we improve the *flight-efficiency* of a monocopter?

Prototype

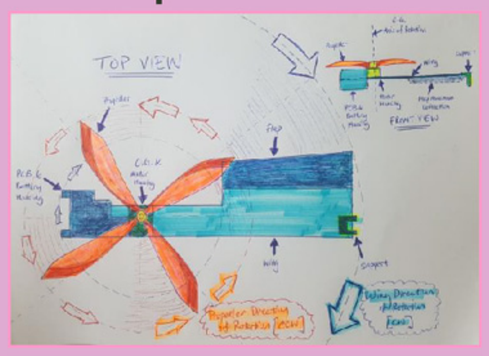
Initial Idea for a New Propeller Layout

- Substantially increase the propeller size
- Relocate and reorientate the propeller
- Counter-rotating propeller and wing
- ↑Lift-generating bodies = ↑Efficiency

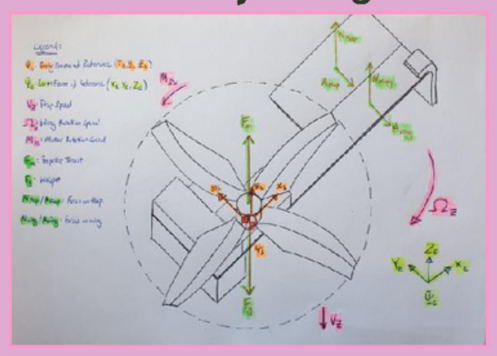


(Left): Co-axial Helicopter "Ka-52"
(Right): ETH Zurich "Monospinner"
Source: Alex Beltyukov/Wikimedia; Robohub.org

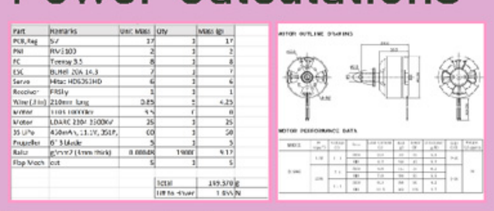
Concept Sketch



Free-Body Diagram

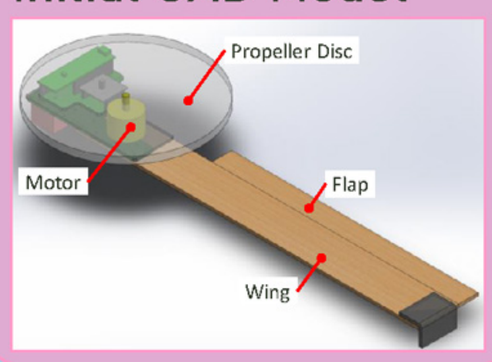


Iterating Weight and Power Calculations



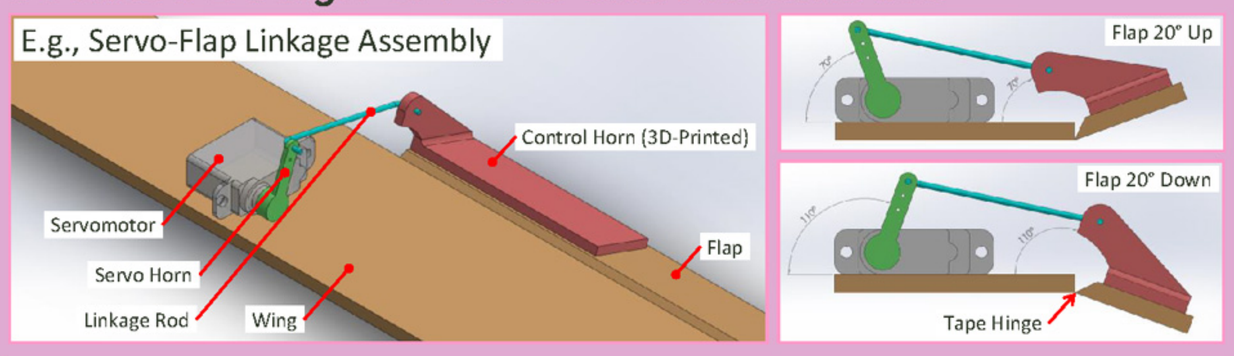
E.g., for motor/propeller selection: total mass ≤ thrust @ 50% throttle

Initial CAD Model

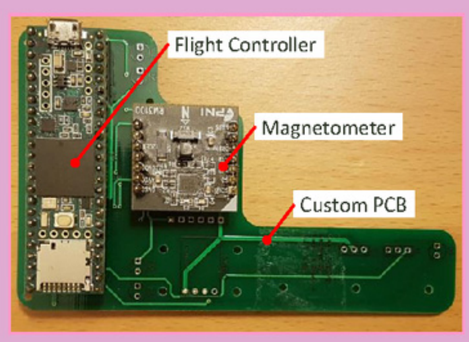


Realize

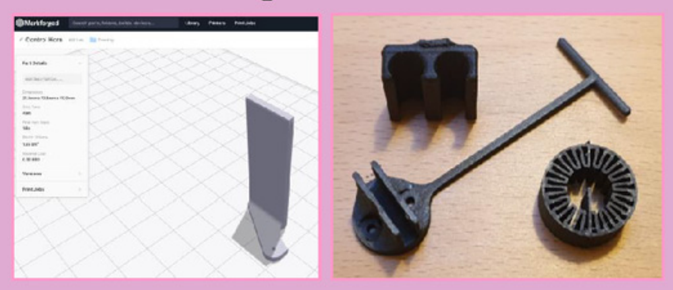
Detailed Design of Parts and Assemblies



Printed Circuit Board



3D-Printing of Parts



Material: Carbon Fibre Reinforced Nylon

Future Work

1. Assemble Monocopter
2. Program Flight Controller
3. More Test Flights and Design Iterations
4. Investigate Impact on Flight-Efficiency
5. Correlate Results with Simulation Models
6. Master's Thesis

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SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

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Additive Manufacturing Part Selection:
A Pre-Screening Framework for Assessing Obsolete Parts for Additive Manufacturing

Background

Advantages of Additive Manufacturing (AM)
On demand capability of 3D printing and the potential of combining components for part count reduction for low-medium demand

The use of 3D Printing to produce spare parts has been on the rise

Companies new to the process, may **not have the knowledge** of AM to select parts **&**
Lack of a formal guideline that **bridges knowledge** between the company and supplier

How Might We
Create a framework that is:
1. **Accurate** Informative
2. **Pre-screen** a list of parts for AM
3. **Bridge the info gap** between company & supplier

Goal

To develop a **methodology/framework** to:
1. **Streamline** the part selection process for additive manufacturing
2. Introduce **vital criterions** to industries and companies during the preliminary screening stage.
3. To help industries and companies make more **informed decisions** when selecting the additive manufacturing process.

Research Questions & Approach

Q 1 **What are the main concerns of companies when selecting spare parts for AM?**
a. What are the current additive manufacturing methods and their limitations?
b. How do the requirements of additive manufacturing differ for different materials?
c. How do requirements for companies/industries differ?

Q 2 **What is the current part selection process for AM and its constraints?**
a. Where in the current process deter companies from proceeding?
b. Where do companies get the information about additive manufacturing processes?

H1 **A general guideline that addresses the key concerns of companies would reduce the time required for reviewing parts for AM and increase the AM adoption rate.**

H2 **Having a standard of information to understand the various additive manufacturing processes available at the supplier will improve time and resource efficiency when companies choose the type of AM process for a part.**

Literature Review → Identify Key Criterions → 1st Prototype → Case Study and Analysis → Cost Estimation Tool → Current Framework → User Testing

Expected Contributions

Academic
- ***List of critical factors, both technical and business, important to companies for AM***
- ***Preliminary framework for selecting parts for AM***

Practical
A tool in the form of Excel that:
1. ***Reduces time** for part selection*
2. ***Increase** adoption rate*
3. ***Accurate pre-screening** of parts*
4. *Let companies know what is available at their supplier*

Stage 1: Identifying Potential Parts

Spare Part → Stage 1: Identifying Potential Parts → Stage 2: Aligning to User Goals

$F_1 = \prod_{i=1}^{4} A_i M_i S_i C_i$
F_1: Potential Value of Part for AM

A: **Obsolescence of Part**	M: **Feasibility of Part**	S: **Potential Inventory Savings**	C: **Properties of Part**
A_0: Time to Obsolescence	M_1: Material Availability	S_1: Current Safety Stock	C_1: Complexity of Part
A_1: Warranty of Part	M_2: Process Availability	S_2: Current Unit Price	C_2: Criticality of Part
A_2: Production of Part	M_3: Size Availability	S_3: Current Lead Time	

Assessing based on Inventory Savings

Stage 2: Aligning User Goals

1. Select 4 Variables

Variables	Description	Scoring
Surface Quality	How important is surface quality to the application (1- High, 5- Low)	1- Human and Machine Interaction 2- Human Interaction 3- Machine Interaction 4- Little Machine Interaction 5- No interaction/Importance)
Unit Cost	Estimated Unit Cost of the product using AM **Online Tool** 1. If a digital copy of the file is available in .stl,.obj, etc formats, an estimate can be obtained by uploading the parts to selectam.io **Excel Tool (Light Blue Tabs)** 2. However, if not digital copies are available and users wish to estimate the cost of producing the part via AM, the excel sheet attached will aid in that. 2a. Users will have to select the printer and material to use as well as input the following into the excel sheet: **Production Size/Parts** **Part mass/kg** **Part Height (Nonmal to Build Plate)/cm** **Part Projected Area in build orientation/cm2** (This can be estimated by multiplying the L X W of the part)	1- Higher than previous 3- Similar 5- Lower than Previous
Lead Time	Estimated Lead time in using AM to produce the part	1- Higher than previous 3- Similar 5- Lower than Previous
Initial Start Up Costs	Start-up costs of procuring/preparing for AM (Includes machines, scanning/designing of files)	1- No AM processes in place (No relevant Machines/Designs available 2- Some AM processes in place/outsourced but no machines 3- AM processes in place with available designs of files 4- AM processes in place with relevant machines 5- AM Processes fully in place (With Machines and Designs Available
Supply Risk	Are there any potential threats to the supply of this part currently?	1- No future/current threats to supply 2- Few future threats to supply 3- Few current threats to supply 4- Future and current threats to supply 5- Severe ongoing supply thread/ Disrupted supply
IP Challenges	Are there any challenges to overcoming the IP/Patents of the part?	1- Many challenges (Licenses, Lum-Sums, Technical Drawings) 2- Some Challenges (Lum-Sums/Licenses) 3- One challenge/Restricted Usage (Lum-Sum, Technical Drawings, License) 4- Potential Challenge/IP restrictions 5- Open-source/No challenges/IP restrictions
Demand/ Quantity of Part	What is the expected demand of the part in a year?	1-2 > 1000 3- 1000 pcs, 4-5 < 1000 pcs
Printability	Is there a need to redesign or split parts to fit into the machine? (Are there available CAD files) Are there other technical requirements that need to be considered?	1- Redesign & Technical requirements required 2- Redesign required 3- Technical Requirements 4- Splitting of Parts 5- Print as it is

2. Assign Weightage (Sum = 1)

Variable	V_1	V_2	V_3	V_4
Weightage	$W_1 = 0.4$	$W_2 = 0.3$	$W_3 = 0.2$	$W_4 = 0.1$

3. Score Parts

	W_1	W_2	W_3	W_4	
Part No.	Variable 1 (V)	Variable 2	Variable 3	Variable 4	Score
1.	$V_{1,1}$	$V_{2,1}$	$V_{3,1}$	$V_{4,1}$	$F2_1$
2.	$V_{1,2}$	$V_{2,2}$	$V_{3,2}$	$V_{4,2}$	$F2_2$

$(V_{i,j})$ between 1-5 for each part.

4. Final Score

$$F2_j = \sum_{i=1}^{4} V_{i,j} \times W_i \text{ , where } j \text{ is part number}$$

The higher the score, the more aligned to user goals. Therefore, the highest score should be the first considered for additive manufacturing

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