COLLABORATIVE PARTNERSHIP BETWEEN HUMANS AND ROBOTS IN THE ENVIRONMENTAL SERVICES INDUSTRY IN SINGAPORE

Department of Industrial Systems Engineering & Management

IE3100M Systems Design Project (AY2019/2020)

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Project Overview

Company Background

Softbank Robotics is the robotics arm of the Softbank Group, which is a leading provider in robotics solutions, utilizing innovation to generate solutions for end users.

Their latest innovation, Whiz, is a semi-autonomous robot introduced for vacuuming tasks in the environmental services industry.

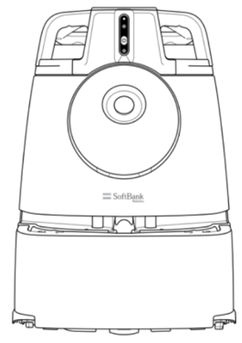
Problem Definition

Singapore has been struggling to ease its prevailing labour crunch in the environmental services industry amidst a greying population and tightened foreign labour employment policies.

Softbank Robotics hopes to use Whiz as a Proof-Of-Concept (POC) on the feasibility of adopting autonomous technology in the industry.

Project Objectives

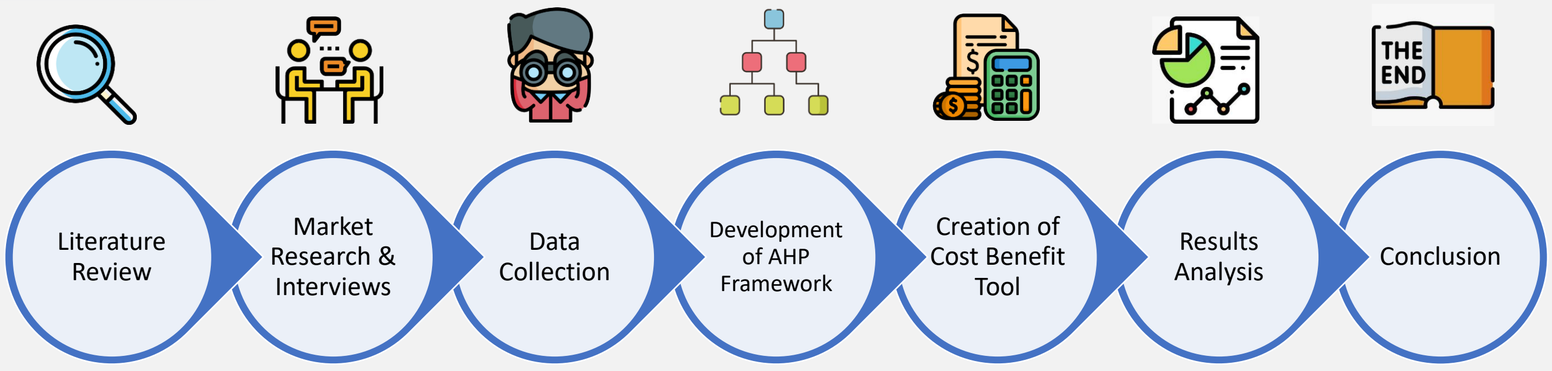
1. To devise a framework that assesses the technology adoption readiness level of environmental services companies
2. To evaluate the economic viability of incorporating Whiz into the cleaning operations of an environmental services company



Key Skillsets

- **Systems Thinking** – Gaining a holistic appreciation of the current practices within the environmental services industry in Singapore and understanding the interactions between various stakeholders
- **Multiple-Criteria Decision Analysis** – Using Analytic Hierarchy Process (AHP) to measure the readiness of technology adoption
- **Operation Research** – Optimising banding scores of technology adoption readiness index
- **Engineering Economy** – Performing Cost-Benefit Analysis (CBA) to calculate the cost and time savings achieved through deploying Whiz

Project Methodology



Market Research Findings

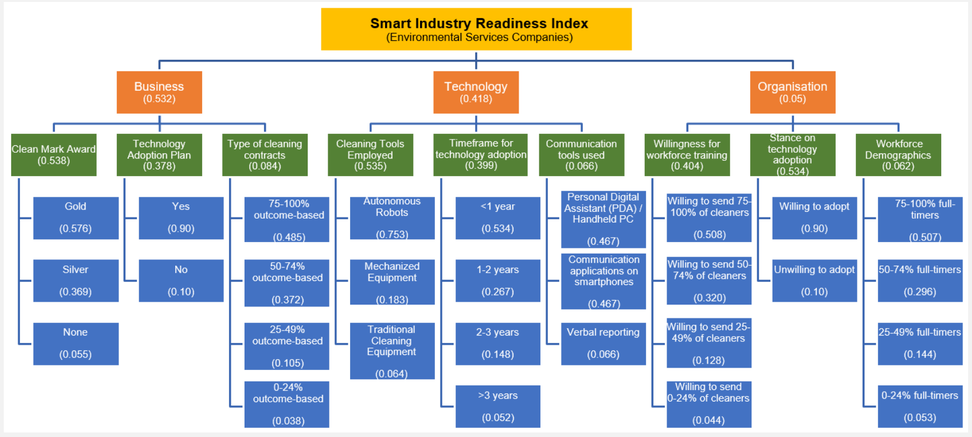
Profile of Environmental Services Companies in Singapore

- Ageing Workforce
- Heavy Involvement in Office Cleaning
- Low Technology Adoption
- High Interest in Automating Operations

Reasons for Not Adopting Robots

- Extremely Expensive
- Error Prone
- Ineffectiveness due to Spillage
- High Maintenance
- Lack of Trust in Technology
- Not Tech Savvy

Analytic Hierarchy Process



**The weightage is determined using Analytic Hierarchy Process*

Objective Function: **Maximising** the readiness score of the environmental services companies

$$\sum_{i=1}^{9} X_i = Z$$

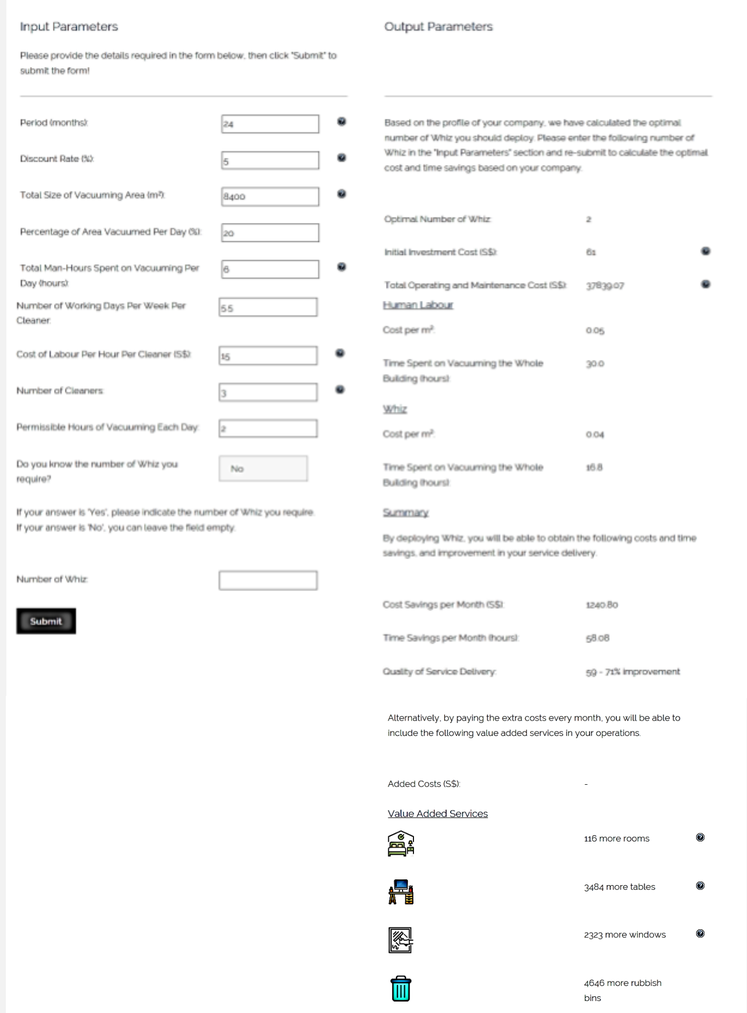
where $Z = \begin{cases} 0.41 \\ 0.7 \end{cases}$ when company readiness level attains 'Semi-Ready' status (0.41) and 'Ready' status (0.7)

$X_1, X_2, \dots, X_9$ refers to the scores assigned to each of the 9 questions

Readiness Status	Benchmark
Not ready for technology adoption	Readiness Score ≤ 0.4
Semi-ready for technology adoption	0.41 ≤ Readiness Score ≤ 0.69
Ready for technology adoption	Readiness Score ≥ 0.70

Environmental services companies could also use the established benchmarks to identify and narrow the existing gaps in their operations, in order to improve their technology adoption readiness levels.

Web Interface



Cost Benefit Analysis

Rationale: Determine the feasibility of Whiz adoption based on costs and time savings

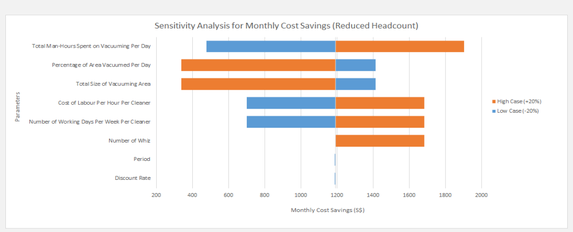
Approach:
- Time Value of Money
- Sensitivity Analysis
- Customer Profiling

Interface: Created an interactive interface using Javascript, HTML & CSS

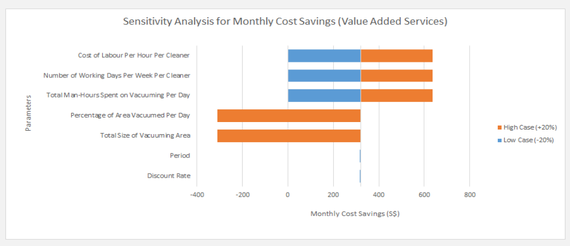
Input Parameters:
Period, Discount Rate, Total Size of Vacuuming Area, Percentage of Area Vacuumed Per Day, Total Man-Hours Spent on Vacuuming Per Day, Number of Working Days Per Week Per Cleaner, Cost of Labour Per Hour Per Cleaner, Number of Cleaners, Number of Whiz, Number of Permissible Daily Vacuuming Hours

Output Parameters:
Monthly Cost Savings, Monthly Time Savings, Value-added Services Gained from Time Savings

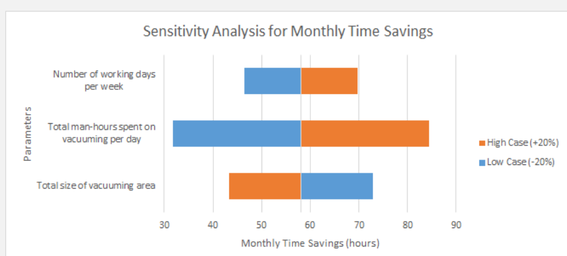
Sensitivity Analyses



For cost savings with reduced headcount, the most sensitive factor is 'Total Man-Hours Spent on Vacuuming Per Day'.



For cost savings when headcount remains constant, the 3 most sensitive factors are 'Cost of Labour', 'Number of Working Days Per Week' and 'Total Man-Hours Spent on Vacuuming Per Day'.



For time savings, the most sensitive factor is 'Total Man-Hours Spent on Vacuuming Per Day'.

Results

Analytic Hierarchy Process

The banding from the model allows various stakeholders to have a common benchmark in terms of incorporating technological solutions in the environmental services industry. Softbank Robotics would be able to utilize the readiness index to enable more effective communication with their clients.

The most important factor which would drive higher rates of technology adoption among environmental services companies would be the structural shift towards outcome-based contracts in the industry.

Cost Benefit Analysis

The CBA tool allows Softbank Robotics to identify and focus on clients who are best suited for the adoption of Whiz.

Through the process of customer profiling, Softbank Robotics would be able to better target potential clients who are more likely to benefit from the deployment of Whiz.

The type of clients identified are those who are able to operate Whiz at least 3 hours daily or a daily vacuuming area of at least 1500m^2.

Achievements

This project has successfully provided environmental services companies with a reasonable framework to assess their technology adoption readiness and justify the economic viability of deploying Whiz. This has enabled Softbank Robotics to prove the feasibility of collaborative partnership between human and robots in Singapore's environmental services industry. Through the implementation of Whiz in the cleaning operations, the problem of manpower crunch can be alleviated.