2021 EWB Challenge

Centre for Appropriate Technology *Cape York*

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1. Executive Summary

In Cape York, one of the most challenging forms of wastes to dispose of are plastic wastes such as plastic bottles, ghost nets and many more. The remoteness of the homeland makes proper management and collection of plastic wastes almost impossible. This is mostly due to the lack of and scarcity of education and services regarding waste management in Cape York.

Owing to the inadequate and ineffective waste disposal options available in Cape York, many of the communities have resorted to digging holes to bury their waste, which has had many detrimental environmental effects on the land. Thus, due to the lack of knowledge, resources and services on matters associated with plastic waste management, Cape York has been struggling with the disposal of plastic wastes, which has resulted in a slew of health and environmental issues.

The purpose of this report is to explore appropriate ways to manage the different types of plastic waste produced in Cape York whilst considering the context of the people, land, and resources. It aims to explore and investigate a variety of strategies for reducing or mitigating the negative effects of the plastic waste stream, and to present one design that is ideally suited to the context of Cape York. Furthermore, the report will explore the systematic way in which the final solution was attained, which involves analysing the context of Cape York as well as the design criteria of the schemes.

Overall, three project designs were devised, including a tip shop scheme, a litter trap scheme, and a reverse vending machine scheme. Out of the three, only one was eventually selected to be implemented in Cape York. This was achieved through a weighting table that rated the designs based on a design criterion that took into consideration sustainability requirements and context. At the end, the reverse vending machine scheme was chosen as the design that will be introduced to the rural Indigenous communities within the Cape York Peninsula to reduce or mitigate the negative effects of improper and insufficient plastic waste management.

2. Introduction

2.1 Cape York Peninsula

Cape York peninsula is the most northern point of Queensland, Australia, surrounded by the Coral Sea to the east, the Arafura Sea and Gulf of Carpentaria to the west and the Torres Strait to the north. The peninsular of Cape York is extremely remote, containing northern Australia's largest unspoiled area of wilderness, with the land being traditionally owned by indigenous Australians. There are many prominent bioregional issues existing today throughout Cape York including: the thickening of woodlands in some areas, the increase of feral and invasive animal species, and the change in land use from predominately low intensity pastoralism to significant areas under conservation and indigenous tenure [1]. The area is not complete wilderness however, as tenures include not only aboriginal land and national parks, but also bauxite and silica mining, nature reserves, tourism, and fishing sites which place constant pressure on nature conservation in the region [1].

The year 1606 saw first contact between European settlers and Aboriginal inhabitants on the western coast of the peninsula, by what is known today as the Gulf of Carpentaria. It was not until the discovery of large bauxite deposits during the 19th century that thorough exploration for this ore was undertaken by Consolidated Zinc (An Australian mining company from 1905-1962) [2]. This resulted in vast amounts of indigenous land being stolen in a search for profit, and the introduction of many mining towns and stations. The total sub ecosystem services value for Cape York has been estimated at approximately $130 billion per year, causing the local governments to consistently allow these mining corporations access to these ancient lands without regard for Aboriginal rights [3].

The area has a history of enforced destitution on the Aboriginal communities dating back to the 1960s when indigenous Australians were forcibly removed from Mapoon via the government's withdrawal of funding and services to the town [2]. In the 1970s local government enforced powerful state violence targeting Indigenous Australians who formed a resistance to bauxite mining in the town of Aurukun. This was made possible by the Queensland government sacking aboriginal elected councils from the area with the allegation that the communities had become brainwashed by radicals and held under a "reign of terror" [4].

2.2 Context

Today the area is still dominated by mining, but also grazing with approximately half of the bioregion being used for pastoralism. Currently there exists a population of around 18000, of which approximately sixty percent are Aboriginal islanders and Torres Straight Islanders [5]. From this there are five main communities of Aboriginal and Torres Strait islanders, who greatly support the travel and tourism industry throughout the area by offering services such as tours which provide opportunities for people to experience and connect with the ancient land and its past, while also diving into the regions rich cultural and controversial history.

Throughout the Cape York region, there exists escalating waste management and pollution challenges, proportional to the ever-increasing tourism industry and "Throwaway Culture". Communities throughout this region search their local beaches and estuaries collecting and disposing of ever-increasing amounts of marine debris. A case study conducted in these communities found that common issues surrounding this includes under-resourced waste management efforts, compliance with regulatory requirements, increasing retail and wholesale packaging and illegal dumping of these [5].

3. Challenges of Infrastructure Development

There are three major challenges on the development on infrastructure in Cape York Peninsula [6]. These challenges include:

i. A limited availability of skills [6].
ii. Maintaining road network standards [6].
iii. Natural heritage conservation and management requirements limiting the availability of resource [6].

Limited availability of skills:
A work readiness deficiency, work instability, training delivery and access issues in indigenous communities has limited the skill base in Cape York [6]. Furthermore, a neglect of joint ventures in Indigenous enterprise development combined with a lack of suitable housing has also limited the availability of skills required for developing infrastructure [6].

Maintaining road network standards:
Road closures can damage livestock, produce and other goods during wet season and rough conditions [6]. Furthermore, the continual re-sheeting of gravel due to wet seasons is environmentally unsustainable [6]. It will cost between $460 million and $2 billion To upgrade the Cape York Road network, and approximately $700 million to seal and weatherproof the Peninsula Development Road [6].

Limited availability of Resource due to Natural heritage conservation and management requirements:

The Cape York Peninsula Land Use Strategy (CYPLUS) objective of sustainable industry development and conservation has provided insufficient resources to manage park areas and has failed to encourage comprehensive property management plans among property managers [6].

4. Project Scope and Aims

"Throwaway culture" is a generalised term used to describe consumeristic behaviour – excessive usage of single-use items, disposable packing – of humans in society (predominantly evident in more economically developed countries) [7]. While brandishing advantages such as effectively stimulating economic growth and encouraging creativity and innovation, adopting this inherently wasteful throwaway culture induces an increased rate of waste production [8]. In most economically developed societies, proper waste management is a vital aspect of society and in these communities is typically established to a sufficient standard, however waste management in less economically developed areas is much more likely to be a neglected aspect of civil administration.

Project opportunity 6.3 outlined in the EWB challenge design brief (appropriate collection and management of plastics) extends the issue of the growing waste stream of plastics with only limited management processes in remote Indigenous communities [9]. To address this issue, critiquing current municipal waste collection services that "manage the different types of plastic waste produced in remote Indigenous communities" [9]. For the purpose of this report, any and all data from any remote Indigenous communities in Cape York are to be fairly acknowledged during analysis and discussion.

The objectives of this report – split into three discernible sections which specifically refer to the remote Indigenous communities of Cape York – is to: (1) review existing plastic management processes, (2) provide a thorough analysis of sustainable features to be considered when generating ideas for a design/solution, and (3) offer a potential viable design/solution to the lack of efficient plastic processing methods.

Section one will explore various aspects of immediate plastic management arrangements to explicitly define the pitfalls and advantages, imparting insight on how to design a that is probable to be seriously considered as an implementable solution.

For each the following considerations, section two will attempt to not only address how each of these points are relevant to Cape York Indigenous communities, but also scrutinise them with regards to necessity:

- Sustainability
- Community impacts & stake holders
- Environmental impacts
- Cultural & social factors
- Community engagement
- Cost & economic benefit

[10]. Finally, section three utilises the information presented in sections one and two and presents a devised design/solution supported by reasonable evidence related to:

- Effective technical design
- Material choice
- Delivery & ongoing management
- Remote diagnostics
- Seasonality
- Simplicity & aesthetic
- Disaster resilience

5. Stakeholders and Design Requirements

A stakeholder is a person or group of people that are affected by the project or those who support the project. Stakeholders can be identified as "people who have an interest in the issue under consideration, who are affected by the issue, or who – because of their position – have or could have an active or passive influence on the decision making and implementation process [11]." They can include individuals, groups of individuals or organisations. When developing a solution to a problem, such as the waste and re-use situation, the needs of the stakeholders must be highly prioritised. As the project proceeds, the issues and positions of key stakeholder must be taken into consideration to assist in developing a solution that is acceptable to the stakeholders. A waste and re-use project would affect most of the population of the Cape York Peninsula and hence close collaboration with those relevant stakeholders (e.g., Indigenous Australians, locals) throughout each process of development is necessary. The Cape York Peninsula has a population of 7,513 people, which is split into 52.8% males and 47.2% females [12]. Of this 7,513 people there are 3,876 indigenous or Torres strait islanders, which makes up 51.6% of the total population [12]. The average age group of the people of Cape York is 34 years of age, children aged 0 to 14 make up for 23% of the population and elderly, people aged 65 years or above, make up for 11.4% of the population [12].

There are several requirements that were identified for a design to be considered feasible for this project. These requirements are cost, safety, accessibility, waste storage capacity, aesthetics and to provide an incentive to the community. The cost of the design must be relatively low to allow the price to be within a reasonable range. Safety is an important requirement so that anyone involved with the designs construction or usage will avoid injury and the design is safe to used. Accessibility is another important requirement so that the design can be utilised by the community with relative ease. For the scope of this project, which is waste and reuse, the proposed design should have a large storage for the recyclable waste. Aesthetics is also a requirement because the design should be aesthetically pleasing, which is important for the community as they one of the stakeholders to be considered. The design should also provide an incentive to the community so there is a reason for the community to get engaged in the project.

6. Overview of your method

To better define the problem and develop a range of suitable solutions, the design context was explored through the identification of socio-political, environmental, and economic contexts, infrastructural development challenges and stakeholders within the Cape York Region via online sources. Local findings relevant to our scope on the current effective, and ineffective waste disposal methods within and outside of the Cape York region were identified in various online reports. These findings were discussed, to further develop the features of our own potential solutions. In consideration of sustainable design requirements, a possible solution was discussed, that utilised pre-existing methods of waste management. These sustainable design requirements included the impact on the environment, impact on community, cultural and social factors, community engagement, cost and economic benefits, effective technical design, materials, delivery, and ongoing management. A range of possible alternative solutions were additionally developed, and every proposed solution was reviewed and discussed among group members to be refined and improved.

7. Project Management

Figure 1 below is a comparison of our Budgeted and Actual Gantt Chart.

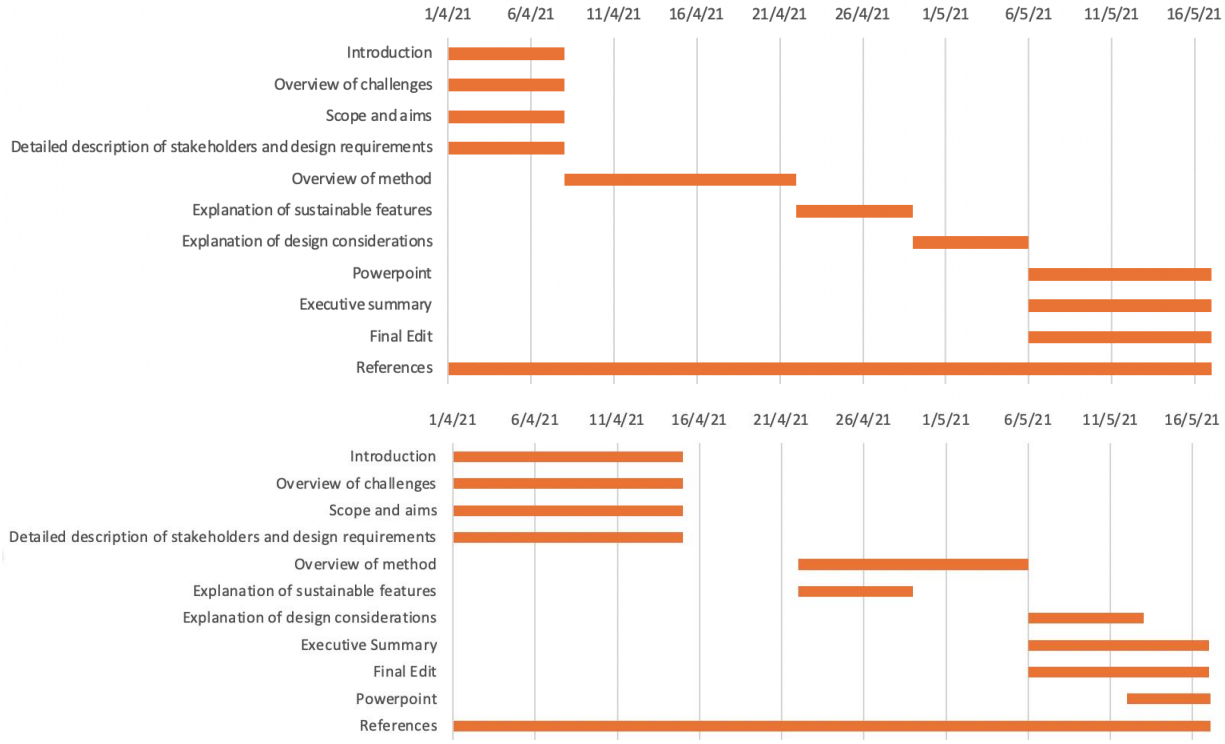

Figure 1: Comparison of Budgeted and Actual Gantt Chart

7.1 Resource allocation:

Regarding resource allocation, each week we would have a group meeting, where we would discuss our progress, any issues we have, and any other matters related to the assignment. During this time, we would also allocate tasks to each member of the group that we would have to specifically focus on for an allocated period of time. In general, we found that the easiest way to do this was to, firstly gauge who was the best person to do a particular task, as well as take into consideration the amount of workload each person has for each week, to ensure minimum stress which increases efficiency and effectiveness in finishing a task. Secondly, we found that the best way to allocate tasks to each person was to assign each member with one of the numbered tasks in the project brief document. However, if a certain task/number cascaded into multiple parts, we would then separate the workload accordingly between each member.

7.2 Schedule:

After allocating the tasks during our weekly meetings, we would then decide as a group a reasonable deadline for finishing the tasks and would note it down in the minutes, so that everyone is accountable and know when certain tasks are needed to be done. As a group, although we set deadlines, we did notice that we were flexible with the deadline, as long as we are able to manage our time, so that the task was still completed.

7.3 Cause of delays or changes during project:

The main cause of delays in our project was the constant changing of our project design. As a group, we did not settle on a project design until the very last few weeks of the semester, which was partly due to evolving knowledge on the context of Cape York, and therefore our design kept changing to cater for the needs of Cape York and its context. Even when we were set on a project design, features of the scheme chosen, kept changing to make the design very well suited to the context of Cape York. Other than that, we really did not have many problems that caused delays.

7.4 Room for improvement:

This report has transformed our understanding of group management, and municipal waste disposal. The report has helped us to recognise the importance of effective communication, task allocation and design context. Our team communication was adequate but needed improvement. Our team primarily communicated via a Messenger group chat. It allowed quick and easy communication however, we could have improved our communication through more frequent group chat message checking, acknowledging every message and informing the team of any setbacks such as unattendance in group meetings. We could further improve our team communication via more frequent usage of Microsoft Teams, which was the recommended communication method.

7.5 Challenges:

Our team found it troublesome to develop a design that fully considered both the socio-political, environmental, and economic contexts and challenges of infrastructure development in Cape York Peninsula, while also considering the design requirements. Managing our time was also a troublesome, as considerable proportion of the scheduled tasks were completed late. To develop a solution with greater ease, pre-existing waste management strategies were discussed, assessed, and modified for use in our designs. Our weekly allocation of tasks and recap on what our team had accomplished was excellent, and ensured our team was informed on what we had to accomplish and when by.

8. Overview of Designs Explored & Decision-Making Process

The three possible solutions that were developed will be assessed to a criterion. The criterion we developed for our solutions based on the context, were that it needed to be, cost effective, safe, accessible to the public, provide an incentive to the public, feature large waste storage capacity, aesthetically pleasing, with accessibility being recognised as the most important criteria. A table is constructed, and each criterion is given a weighting from 2 to 7, 7 being the most important. The design choices are given a rating of 1 to 3 for each criterion, 3 being the most effective. These ratings are multiplied by the weighting for each corresponding criterion, for each given design, and the total rating for each design is calculated. A higher total indicates a more effective design. Figure 2 below is the table used for the weighting system.

	Criteria	Cost	Public Incentive	Public Accessibility	Aesthetics	Waste Capacity	Safety	Total
	Weighting	6	4	7	2	5	3	
Design Options	Tip Shop	1	2	2	2	1	1	40
	Drain Sock +	3	1	1	1	2	3	53
	Reverse Vending Machine + Skip Bin + Wheelie Bin	2	3	3	3	3	2	72

Figure 2: The weighting table used to rank the effectiveness of each design.

To determine the recommended design, both the rating, the pros and cons of their individual components will be discussed evaluated, with the chosen solution including appropriate justification for its selection. Hence the Reverse Vending Machine was chosen as the recommended design due to its highest rating via the weighing system.

8.1 Reverse Vending Machine

This is the recommended solution and consists of three major components. Despite this, the scheme will be referred to as the 'Reverse Vending Machine' scheme for convenience's sake. The scheme incorporates:

i. Reverse vending machines that are a modification of those used within the New South Whales 'Return and Earn' scheme [13].
ii. Distribution of 'x' number of units of roll-on roll-off plastic recycling skip bins based on the community's population size and accessibility.
iii. The provision of 240L kerbside weatherproof plastic recycling wheelie bins to homes with accompanying educational pamphlets on proper waste disposal and biodegradable bags.

A 240L weatherproof wheelie bin is provided to each household and reverse vending machine for kerbside collection. These bins are to be used for the disposal and collection of recyclable waste only and are emptied at a 3-week interval via plastic recycling trucks. To correctly dispose of and sort their waste, residents can use the provided biodegradable bags and refer to the written instructions provided on the pamphlets given to their household or available at their local reverse vending machine. Figure 3 below depicts the proposed design of the wheelie bin from a top and front view.

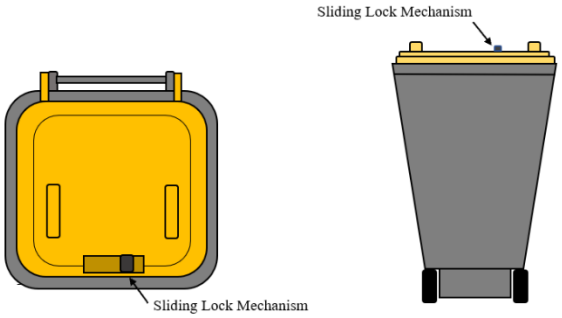

Figure 3: Basic design of the proposed 240L weatherproof, recycling wheelie bin and its key features.

It is recommended that if the wheelie bins are full prior to their emptying, residents should dispose of their plastic recycling into the $30m^3$ roll-on roll-off plastic recycling skip bins provided. The skip bins are collected and replaced at a bimonthly interval via back loaded trucks when possible. During wet seasons, road access to rural communities can be limited, and thus the skip bins are to be relied on for long term storage of recyclable materials.

The skip bin design will feature:

- 8 lockable top lips.
- A collection tray located at the rear end of the skip bin. This prevent waste from spilling into the environment as the skip bin is transferred onto the truck.
- A front opening for offloading waste.

Figure 4 below depicts the proposed design for the skip bin from a side and top view.

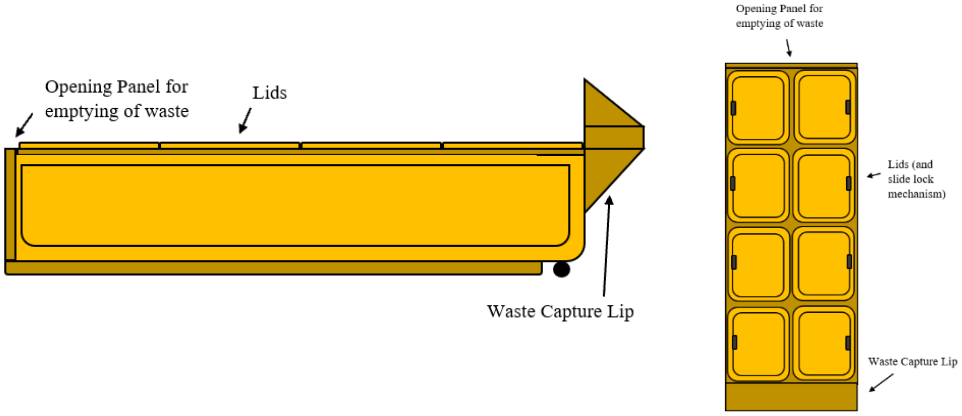

Figure 4: Basic design of the proposed $30m^3$ roll-on roll-off recycling skip bin and its key features.

Residents can dispose of eligible Plastic Bottles into the Reverse Vending Machine to receive a 10c refund for each bottle via PayPal, EFT, or a retail voucher [13]. Plastic bottles are eligible if it they:

- Are not broken or crushed [13].
- Have their labels attached [13].
- Are Empty [13].
- Are between 150mL and 3L capacity [13].

To receive payment, residents must acquire a scheme identification [14]. It is recommended that this design operates in conjunction with the current Queensland 'Containers for Change' recycling scheme, and hence residents must acquire a scheme identification via the scheme's app [14]. Disposed Bottles are to be collected from the rear compartment of reverse vending machine at a 4-week interval via the recycling trucks. This is achievable by using storage containers, that are of the same dimensions as the wheelie bins. The proposed reverse vending machine design is a modification of the pre-existing Reverse Vending Machine currently used

within the New South Whales ‘Return and Earn’ scheme (See Figure 5, 6 and 7 below).

Figure 5: A photograph depicting the Reverse Vending Machine used within the New South Whales ‘Return and Earn’ scheme.
Source: Adapted from [15].

Figure 6: A photograph depicting the front of a Reverse Vending Machine used within the New South Whales ‘Return and Earn’ scheme.
Source: Adapted from [15].

Figure 7: A photograph depicting the open rear exterior of a Reverse Vending Machine used within the New South Whales ‘Return and Earn’ scheme.
Source: Adapted from [15].

Modifications to the design include:

- Limiting each disposal compartment to the disposal of eligible plastic bottles.
- Extending the awning for increased protection against weather.
- A wall mounted storage compartment for educational pamphlets on proper waste disposal.
- A wall mounted storage compartment for biodegradable garbage bags.
- Replacing the pre-existing software with the Queensland ‘Containers for Change’ Reverse vending machine software, for compatibility with the app.
- Implementing a slot closing mechanism that prevents the entering of animals or other unwanted items into the reverse vending machine.
- A scrap crusher to crush plastic bottles.

Figure 8 Below depicts the design to be used and its key external modifications.

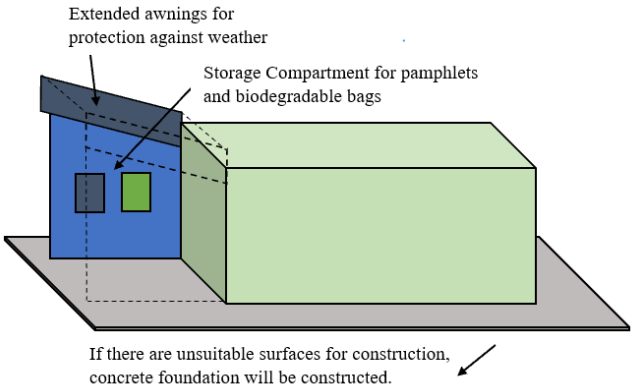

Figure 8: Basic design of reverse vending machine. Key modifications are labelled.

Recycled plastics collected via the three main components of this design are to be transported to the nearest recycling centre. If a rural community within the Cape York Peninsula that incorporates this scheme cannot not be accessed by the back loaded and recycling trucks at the interval stated due to its location, weather, or does not support the proper infrastructure for any number of the components, adjustments can be made to which components it will receive, and the interval at which waste is collected.

8.2 Tip Shop

An alternative solution was the introduction of tip shops within Cape York's community. This idea relies on the initiative of the locals and enables full control over operations. A tip shop is a recycling shop where people can sell or buy their junk, however it can also be viewed as rubbish collection point. While the scope only targets plastic waste polluting the environment, the tip shop is a more versatile option, allowing trading of other materials and resources such as old electrical appliances or old furniture.

The tip shop would consist of two sections: one for products able to be purchased by locals, and one for waste collection. Such a layout hopes to raise awareness for the effects of careless waste management on the environment and provides a facility where little effort is required to operate it. The main objective of a tip shop is to eliminate reasons for locals to simply throw their rubbish in holes or leave it lying around and to bestow independence and responsibility where applicable. Locals may also be provided with easy-to-interpret signs on how to categorise different types of waste so that it may be appropriately transported to waste/recycling facilities.

8.3 Litter Trap Scheme

A considered design idea was the installation of 'litter traps' to stormwater drains and marine outfall points. The purpose of these traps is a practical method for the prevention of waste entering into the marine environment. One trap idea makes use of a cage, which when placed under the side entry of a stormwater drain, captures any rubbish flowing through. These traps must be cleaned regularly to ensure water can flow freely during heavy rainfall or flooding [16].

Another aspect to this design is the installation of large concrete cage traps to storm drain outlet points to capture litter, preventing it from entering the ocean or waterway. The main design feature for these traps is that water can continue rushing through during heavy rain or flooding. To clean, tractors can drive inside the trap and scoop up litter [16]. An alternative to this is a "drain sock" design, where netting is attached to the ends of storm drains which capture waste while allowing water to flow as normal. To clean and obtain the captured waste these must be removed. Litter removed from these traps is to be stored and collected via recycling trucks at regular time intervals throughout the year.

9. Sustainable Features

9.1 Community Impacts

Cape York's Indigenous communities insist on solutions to the growing waste stream issue without intervention from external parties. A simple, intuitive design and ease of operation to the Reverse Vending Machines means locals can tackle waste issues independently. Meeting this requirement may induce a sense of achievement within the community and boost moral for elders, knowing they themselves are directly tackling their issues.

9.2 Environmental Impacts

The management of plastic waste is an important issue to consider for the impacts that plastic waste has on the environment. Plastic has a plethora of uses, such as bottles and containers, and therefore an abundance of plastic waste that is being produced. This waste impacts the environment by damaging the local flora and fauna.

The proposed solution of a reverse vending machine will increase rate of plastic recycling, which then reduces the amount of plastic that is sent to landfills. This results in a very positive impact on the environment. The inclusion of a scrap crusher is to reduce the environmental impact. This is achieved by compressing the plastics inside, so they take up less space and reduces the energy required to recycle the plastic [17].

The long-term impacts that the proposed design will have on the environment are positive. This is because the aim is to reduce the amount of plastic waste that can be found in the environment

of the Cape York peninsula. There are however short-term impacts. Construction of the vending machines could cause some minor damage to the surrounding environment. Wheelie bins or skip bins used for collecting plastics can overflow and thus harmful, non-biodegradable plastic waste can spill out into the environment. As stated, prior, emptying of roadside wheelie bins and skip bins at frequent intervals can prevent or at least minimise this overflowing. Overall, it was deemed that this design would result in a net positive impact on the environment as the reduction of waste found in the environment is more beneficial than the minor damage caused by the setup of the vending machines and the possible overflow of the bins.

9.3 Cultural/Societal Factors

Sociocultural factors are what influence people's lifestyle or the values and ideologies of person or a community. In relation to Cape York and our proposed Recycling Centre and Refund Depot these factors are to be considered to prevent an invasive impact on the indigenous Australian population. A report conducted on the Needs, Values and Aspirations of the people of Cape York, emphasised their concern that the natural environment should be preserved for its significance to them as their sense of place and space and for their recreational activities [18]. Activities such as fishing and hunting were seen as both recreational and culturally significant by the native respondents. Another interesting point made is that indigenous communities are in fact in favour of some industrialisation where it helps communities to stay economically viable by providing work for individuals, without impacting their way of life or the quality of the natural environment [18].

Our design incorporates these considerations while tackling the issue of plastic waste spoiling the environment. Our design emphasises the clean and sustainable disposal of household waste via the provision of recycling and waste bins to homes, while also providing an incentive to remove additional waste from the environment through the reverse vending machine scheme, hence meeting the sociocultural beliefs/values of the local population, without intruding or forcing a change on their lifestyles.

9.4 Community Engagement

Communities can participate and engage with the scheme by utilising all aspects of the project design to improve plastic waste management in Cape York.

Reverse Vending Machines:
The reverse vending machines is the most engaging component of the recommended design /scheme for the community This component will allow the residents of Cape York to dispose of empty beverage containers for a refund of their choice. They can begin to participate with this feature of the design by creating a scheme ID through the Queensland, Container's for Change app, or via scanning the QR code located on the reverse vending machines to receive their refund. The reverse vending machine gives members of rural indigenous communities a degree

of agency within their wasted disposal methods.

Skip and Wheelie Bins:
The residents of Cape York can participate and engage with this feature of the scheme/design by sorting their wastes, then depositing miscellaneous plastic wastes into these bins. In this way, the plastic waste stream in Cape York can be improved by ensuring that plastics do not become contaminated due to improper waste management.

Pamphlets:
To increase community engagement, this project design also plans to provide pamphlets which will be placed on the reverse vending machines. These pamphlets will aim to inform the residents in Cape York on how to operate the machine, but also educate them on how to properly sort and dispose of their plastic wastes. Thus, residents of Cape York can increase their knowledge of improper waste management's impacts and therefore will have the self-efficacy to make a change.

Raising funds for charities and community groups:
The reverse vending machines can also be utilised for raising funds by charity groups. This can be achieved by organising events where people deposit their plastic wastes through the reverse vending machines and choose to donate the money that they earn to the charity groups to raise money for specific causes of their choice.

9.5 Safety

A CHAIR (Construction Hazard Assessment and Implementation Review) has been used to identify and minimise risks regarding the recommended design. Figure 9 below is the table used to conduct the CHAIR.

Figure 9: Table used to conduct the CHAIR.

Hazard ID	Guideword	Risk Issue(s)	Cause(s)	Consequence(s)	Safeguard(s)	Action(s)
1.	Size	No significant risk identified				
2.	Height / Depths	No significant risk identified				
3.	Position / location	Large travel distance to skip bin	Inappropriate placement of skip bin	Fatigue or injury to public		Place bins within close proximity of houses
4. 1	Poor Ergonomics	Use of Reverse Vending Machine	Improper usage (insertion of appendages, foreign objects, animals)	Injury to public / animals damage to reverse vending machine	Written instructions for correct usage located on reverse vending machine	Implementation of sensors and slot closing mechanism.
5.	Maintenance /	No significant				

	Repairs	risk identified				
6.1	Movement / Direction	Movement of recycling and back loaded trucks to and from indigenous communities.	Poor weather conditions blocking road access.	Limited collection of waste resulting in harm to environment and public health. Injury to drivers.	None	Rural Indigenous communities given access to additional skip bins during wet seasons for long term storage. Weather is assessed before movement of trucks to determine if safe for transportation.
7.1	Load / Force	Collection of Municipal Waste	Lifting of Skip / wheelie bins via trucks	Injury to public	Designated waste removal procedures (Diver checks surroundings and inside of bins)	All trucks should emit warning sound when disposing of waste. Warning Signs near skip bin and Reverse vending machine.
7.2	Load / Force	Construction of Reverse Vending Machine	Transportation of heavy construction materials /equipment.	Injury to workers / public	Standard PPE, barriers erected	None
8.	Energy	No significant risk identified				
9.	Timing	No significant risk identified				
9.	Egress / Access	No significant risk identified				
8.	Environmental Conditions	Severe weather conditions	Tropical Climate	Mild injury, discomfort to the public	Increased shelter over reverse vending machine	None
9.1	Environmental Impact	Municipal recycling waste in environment	Overflowing of skip and wheelie bins depositing waste on the ground	Damage to ecosystem, Injury and health deterioration public, marine life, and wildlife.	Distribution of pamphlets to public. Pamphlets recommend depositing recycling into skip bin if household wheelie bins are full.	Emptying of household wheelie bins at a 3-week interval and bimonthly empty and replacement of skip bins
9.2	Environmental Impact	Municipal recycling waste in environment	Extreme weather tipping over and emptying bins	Damage to ecosystem, injury and health deterioration public, marine life, and wildlife	None.	lids and locking mechanisms included on wheelie bins and skip bins

9.6 Ethics

The reverse vending machine featured within the recommended design and can financially support low-income families or individuals through the 10c refund. The design thus considers and improves the quality of human life within remote indigenous communities.

Marine debris, specifically marine plastic within the scope of this report, poses significant harm to natural ecosystems and people dependent on them [19]. Through the implementation of the recommended design, plastic waste streams that contribute to marine plastics are mitigated. This reduces the:

- Ingestion of indigestible plastics by animal species [19]. Animals such as sea birds, cetaceans, fish, and turtles often mistake items such as plastics for food [19]. These plastics are unable to be digested and can cause perforations, blockages, and other health problem [19]. This may lead to the eventual death of the animal [19]. The reduction of plastic waste streams through the recommended design reduces these deaths.
- Habitat loss caused by regions of shorelines being buried underneath municipal waste [19]. Correctly disposing waste through the recommended design allows wildlife to access these areas for breeding, nesting, and other vital activities [19].
- Presence of microplastics within the ocean, that contain toxic chemicals capable of compromising the health of marine's species and other species that are dependent on these marine species for food. This includes humans [19].

The recommended design considers and improves the wellbeing of both people, the environment, marine life, and wildlife.

9.7 Cost & Economic Benefits

As of 2016, the Australian Bureau of Statistics (ABS) reports that on average, the median weekly household income is $961 where the average people per household is around 2.8 [20]. According to a report on the economic viability of Cape York, the capabilities of the residents are overall poor in terms of employment, income, wealth and assets, health and safety, housing, education, social capital, and governance [21]. With these facts in consideration, the design of the reverse vending machine must be economically sustainable for it to limit negative impacts on the community and maximise waste reduction.

Cost Benefits:

Reduced Council Costs on Matters Related to Plastic Waste Management:

In the year 2018, Cook Shire alone, which makes up a large proportion of Cape York, invested about 1.8 million dollars on waste management [22]. Through the reverse vending machine scheme, this number could significantly reduce. According to international evidence, where the reverse vending machine scheme has been implemented, it is evident that these devices have the potential to reduce the financial burden on the council in a variety of ways [23]. It mainly accomplishes this by lowering the cost of recycling, decreasing the amount of plastic waste that ends up in landfills and reducing the cost of kerbside collection and public space maintenance. Furthermore, the use of reverse vending machines in Cape York has the potential to assist communities in transitioning from mixed recycling collection to a single stream method, which primarily distinguishes plastic bottles from other forms of plastic as well as non-recyclable wastes. This not only increases the opportunity for improved material/plastic recovery, but it also reduces the costs associated with employing workers to sort incorrectly recycled wastes.

Economic Benefits:

Provides Local and National Green Jobs:

In Australia, the recycling industry is worth about $15 billion and offers several economic and social benefits [24]. The introduction of the reverse vending machine scheme in Cape York further adds to these advantages by generating a range of jobs both locally and nationally, benefiting Cape York's economy even more than if they were to send their recyclable plastic wastes to landfill. According to Planet Ark, for every 10,000 tonnes of waste recycle, 9.2 full time jobs are created compared with just 2.8 jobs when the same amount of waste is sent to landfill [24]. By analysing the life cycle of a reverse vending machine, jobs may arise from the production of the machine, implementation of the machine, maintenance of the machine, disposal of the machine, handling of the plastic containers returned and finally, staff who work at call centres and more. Keeping in mind that all of the jobs that have been listed can be found locally or nationally. This is evident due to the fact that similar schemes such as the Return and Earn have claimed to have created around 500 jobs [25]. Overall, the implementation of reverse vending machines manage plastic waste in Cape York, has the ability to create more jobs both nationally and locally, boosting the economy of Cape York.

Support low-income families:

In 2016, an individual above the age of 15 years in Cape York had a median weekly income of $447 [26] which is significantly lower compared to the median weekly income of Australia as a whole, which was $662 [27]. The way the reverse vending machines works allows the residents of Cape York to return their plastic drink containers to designated collection points, and in doing so will be reimbursed a small sum of money. In this way, the reverse vending machines offer an incentive in order to encourage communities to properly manage their wastes. Although the incentive may be small, it greatly supports low-income families in Cape York by providing them a source of income when they deposit large amounts of acceptable plastic wastes.

10. Design Considerations

10.1 Remote Diagnostics:

Regarding the reverse vending machines, a service maintenance program will be included in the scheme to provide communities in Cape York with the support they need to keep the machines operating at a high performance.

To ensure that the machines remain in excellent condition and work to the best ability, the program will include and provide a variety of services, including access to a team of experts who can diagnose and fix any issues that may occur with the machines.

The program will provide:

- Two-hour average turnaround time
- Remote assistance between 7 am – 7 pm on weekdays and 9 am to 7 pm on weekends
- Necessary inspection every six-months that will include a cleaning of the machines, system repairs and necessary software upgrades.

In the event of a crisis, the reverse vending machines will have the contact information printed on the front of the machines which can be easily obtained by anyone. Furthermore, the contact information will also be included in the pamphlets that are distributed throughout the communities. Support will be provided either locally (in person) or remotely (via the phone or the internet.) Remote support is beneficial for minor issues and offers flexible and convenient assistance, whereas local support is better suited for complex service issues such as a systems repair.

10.2 Materials:

Given the fact that the Reverse Vending Machines will be implemented in various weather conditions such as wet and dry, materials durable to the elements are required.

Material	Properties	Application
Aluminium	• Corrosion resistant • Ductile • Non-toxic	Used for the main frame of the Reverse Vending Machine
High Density Polypropylene (HDPE)	• Corrosion resistant • Tough • Increased working temp.	Larger panels of HDPE form the overall structure of the Reverse Vending Machine
Polyethylene (PE)	• Impact resistant • Chemical resistant	Makes up the bodies of the wheelie bins

10.3 Construction and Implementation:

The wet season blocks road access, therefore preventing the transportation of workers, equipment, and materials to rural communities within Cape York. Thus, the construction of the design is to begin after the ending of the wet season and continue throughout the dry season to ensure an uninterrupted work schedule. All construction workers are to wear PPE during the construction process.

The reverse vending machines are to be constructed via repurposed shipping crates [28]. The shipping crates are modified to include insulation and both exterior and interior lighting [28]. The insulation must be extensive to account for the wet season. The reverse vending machine and skip bins are to be implemented in consultation with members of the community, regarding its location. It is recommended that the reverse vending machine is implemented within the highest population density area of the rural indigenous communities, and /or within the vicinity of retail stores to provide a convenient disposal of plastic bottles. It is recommended that the $30m^3$ skip bins are evenly distributed throughout the community to ensure ease of access for all members of the community. Flat, vacant land, or kerbsides of sufficient size are suitable locations for reverse vending machine placement. The chosen location also must provide sufficient space to allow for the manoeuvrability of the recycling and back loaded trucks that are needed to access these design components. If there are no suitable locations for placement of the reverse vending machine, a concrete foundation will be constructed to compensate that includes steps and/or ramp.

The skip bins, wheelie bins and components of the reverse vending machine will be manufactured outside of the community. The construction and implementation of the components within the community will utilise external and local community workers.

10.4 Aesthetics:

The reverse vending machines will be built and clad in non-reflective, graffiti-resistant materials, that will provide protection from the elements, increasing its life expectancy. The exterior design of the reverse vending machines will be as simplistic and minimalistic. The reverse vending machines will only have the instructions and caller information on the body as well as a pamphlet holder containing the pamphlets. Furthermore, one side of the machine will be completely clear with no existing designs, which is made available for the community to design however they like with the assistance of the council.

10.5 Amenity:

The reverse vending machines will only be operational during a certain period, and will most likely adhere to the permitted operating hours according to the council, otherwise it will be permitted for use between:

- 7 am and 7 pm on Monday to Saturday.
- 9 am to 7 pm on Sunday and public holidays.

Due to the weather patterns in Cape York, with 6 months of wet seasons causing heavy storms and floods, and 6 months of dry seasons bringing a warm tropical climate to the land, the reverse vending machines will be equipped with wide and large awnings to protect the machines from the elements as well as shelter individuals utilising the machines during extreme weathers. Furthermore, the skip bins and wheelie bins that are a part of the scheme will feature a simple locking feature that will protect the bins from overflowing with water and therefore prevents the plastic from escaping the bins. Lastly, the machines will be accessible to everyone, especially to people with disabilities.

11. Conclusion

Waste management throughout cape York is an escalating issue due to ever-increasing tourism and the prevalence of "Throwaway Culture". Community efforts to combat this are usually highly under-resourced, which consequently result in growing health and environmental issues throughout the area. This report explores appropriate management methods for plastic waste produced in Cape York whilst considering the stakeholders, and the context of the people, land, and resources. A variety of strategies for reducing or mitigating the negative effects of the plastic waste stream have been explored, while ultimately presenting a design which is most ideal in relation to the problem and context of Cape York. Three project designs were devised, including a tip shop scheme, a litter trap scheme, and a reverse vending machine scheme. The report focuses on the reverse vending machine scheme which was chosen as the ideal design to be introduced to Cape York. The design requirements we determined for this are explored as well as all sustainable features and the design considerations of the scheme. This design focuses on assisting rural indigenous communities with reducing the negative effects of improper and insufficient plastic waste management, by providing a sustainable solution.

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