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CADT-UH 1062: Contextual Innovation in Society
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The AD Drinking Fountain

Introduction

An article published in *Khaleej Times* in February of this year reported on 'Dubai Can', a new environmental initiative in the city of Dubai focused on reducing the use of single-use plastic bottles. The initiative has so far seen the installation of over 30 permanent water stations across the city to encourage members of the public to refill their own water bottles instead of purchasing plastic bottles. The initiative is particularly timely given that, according to the article, the average UAE resident uses around 450 plastic water bottles annually; in 2019, this translated to a total of 8.3 billion tons of plastic generated in the UAE alone.

Finding alternative solutions to plastic bottle usage is thus of obvious significance to the UAE and to our planet, and the provision of refillable water stations in Dubai represents a key first step in making progress on this front. However, one might wonder why water refill stations were chosen over another key drinking facility: drinking fountains.

Drinking fountains arguably have their unique appeal – they operate on what could be called a 'drink-and-go' principle, where any passerby can stop, take in a small amount of water, then continue on their way. This system obviates the need to carry a drink bottle around, making it particularly convenient for exercisers and individuals who prefer to walk empty-handed around the city. In a place like Abu Dhabi which boasts areas like the Corniche, a popular running, and walking spot, drinking fountains would be a welcome addition for thirsty children and adults alike.

Why, then, do we see an apparent dearth of drinking fountains in our home city of Abu Dhabi? Why did the Dubai Can initiative choose to install refill stations instead of drinking fountains? We might speculate about the reasons for these decisions (or lack thereof), some of which may be logistical or economic in nature. However, there are also a number of reasons related to the specific design and function of drinking fountains themselves – issues that continue to plague even the cities which have already made this facility widely accessible to their populations. It is our goal to find ways to work around – if not solve – these issues, so that we may offer a new vision of a drinking fountain fit for use in Abu Dhabi.

Background

The first drinking fountains can be traced back to 530 AD in Nepal. They were built to address the problem of scarcity of accessible water for the everyday Nepali resident. Known locally as *dhunge dharas*, they consist of carved stone spouts through which water flows uninterrupted from underground sources.

A similar tool emerged in the UK in the 19th century when the country was addressing the inadequacies in water supply by private water suppliers. During this time, the UK was seeing rapid population growth resulting in unprepared private water suppliers being overwhelmed and supplying the public with inadequate and contaminated water causing outbreaks of cholera in the country. In response, the Metropolitan Free Drinking Fountain Association was formed. The Association built multiple water fountains throughout the country to provide free and accessible drinking water to all UK citizens. These fountains, stone structures with single taps and a few metal cups chained to them, became hugely popular with some servicing over 7,000 people a day.

The significant innovation of the drinking fountain that followed happened in the United States in the late 19th century with the invention of the "bubbler". This innovation was inspired by the rise in unhealthy alcohol consumption in the country that was brought on by the scarcity of accessible and clean drinking water. In response, in 1888 in Kohler, Wisconsin, a water faucet company designed the bubbler – a drinking fountain that shot water one inch straight into the air with the excess water running back down over the sides of the nozzle. The bubbler became hugely successful and thousands of bubblers were installed all over the country. With this design, many people began to put their lips directly on top of the spigot, making the bubblers very unsanitary. Therefore, although effective in making water accessible and successful in lowering the dependence on alcohol for hydration, bubblers resulted in the eruption of diseases such as cholera and even caused coliform bacteria poisoning in the areas they were installed. In response, Luther Haws in Berkeley, California, and Halsey Taylor in Warren, Ohio separately designed the modern-day drinking fountain in the early 1900s.

This new drinking fountain had water being shot out of the spigot assuming a more curved trajectory as opposed to the vertical trajectory offered by the bubbler. The curved trajectory made drinking water from these fountains an easier and more sanitary process as water mixed with saliva from the drinker would not trickle down over the tap as it did with the bubbler. In addition to this, the modern-day drinking fountain contains a cap over the spigot to prevent people from putting their lips directly on it.

These new drinking fountains received general acceptance from Americans and the American government as they helped reduce the over-reliance on alcohol for hydration and supplied clean water to people who had access to the. These fountains were especially welcomed in low-income communities as they reduced the costs they had to incur to attain safe drinking water. The design gained popularity quickly all over the world, particularly in western countries where the problem of overconsumption of alcohol was present.

This technology, however, did not spread to countries with governments with weaker financial standing. This includes countries in Africa as well as South Asia. This is likely because of the high cost associated with maintaining these drinking fountains and insuring their safety. A single water fountain costs around USD 500 - USD 1,500 to install (excluding the maintenance cost). Furthermore, most countries falling under this category had adopted the use of taps and

wells that served the needs of their communities more completely i.e they provided water in volumes that were enough to both drink as well as to collect for domestic activities all at once.

Dhunge Dharas in Nepal

19th century water fountain in the UK

The “bubbler”

Present-day drinking fountain.

Problem Statements

Although drinking fountains were a revolutionary step in the way of providing an essential service to the public, the innovation has its own set of problems that have become increasingly relevant today. Perhaps the biggest problem with drinking fountains is their hygiene; this is exemplified by a study undertaken in Yorkshire, England, in which 39 local schools were surveyed in order to gain information about the means by which they provided their students with drinking water. Many of these schools had drinking fountains, but the quality of these fountains greatly varied. The study reports that “many of the fountains in school toilets were found to be dirty, badly maintained, out of sight, and overlooked” (Walters 2002).

Additionally, “microbiological results from the traditional swabs taken at the fountains’ spouts revealed that many fountains had high colony counts, above the levels that would be expected or desired on any drinking water facility used to obtain clean drinking water.” Another study from the United States– one focused specifically on drinking fountains in the schools of California– recorded interviews with “school administrators and staff, health and nutrition agency representatives, and families,” finding that many of these stakeholders had “concerns about the appeal, taste, appearance, and safety of fountain water” (Patel 2010). A 2016 study in New Taipei City also provided a correlation between drinking fountain usage and the spread of illness (Chen 2016). This spread is likely due to bacteria being deposited onto the fountain nozzle and the buttons that (in most modern fountain designs) must be pressed in order to use the fountains. Although these issues can be mitigated by regular cleaning of the fountains, the source of the problem is the deposition of these bacteria, along with other contaminants, by the many individuals who regularly use the fountains. In the case of fountains located outdoors, which are

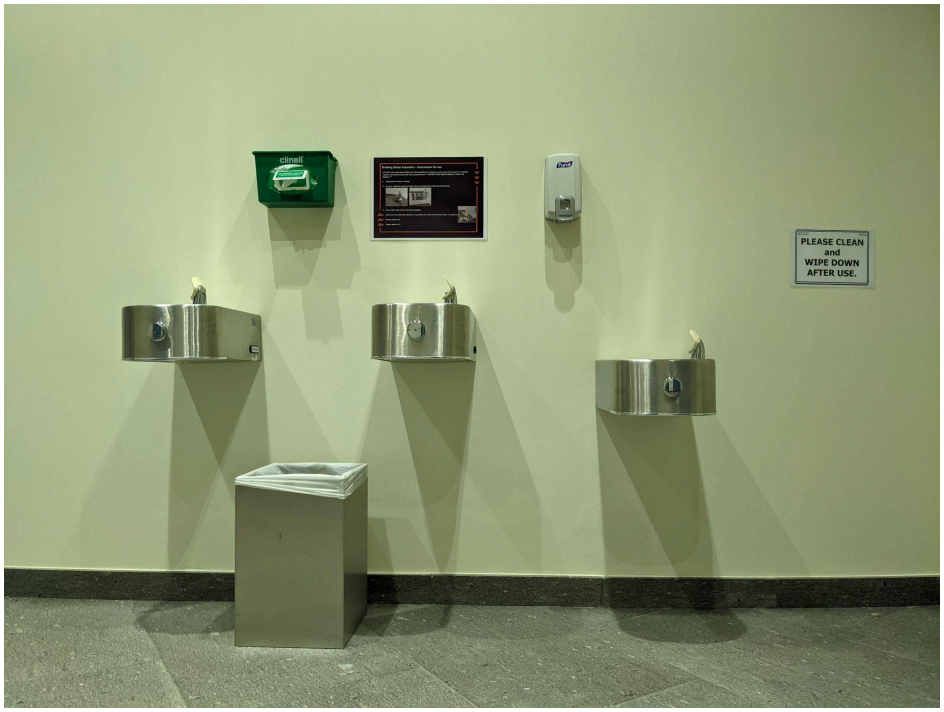
subjected to damage and contamination from the environment and are all but guaranteed to be used by more people, the problem of hygiene worsens.

On top of the external surface of a drinking fountain being capable of spreading bacteria, there is also the problem of the fountain's interior. Damage to the piping within the fountain can cause germs and other contaminants to leach into the drinking water, sending these contaminants directly into the bodies of people who use the fountain. Although this isn't nearly as common as the issue of bacteria on outer surfaces, it's much more expensive to fix and impossible for a random person using the fountain to spot. The result of this is that people trust drinking fountains much less. This is illuminated by various sources: in 2014, a study from the United States used data from a nationwide survey of people from ages 9 through 19 to show that nearly 40% of American youth "disagreed school water fountains were clean and safe" (Onufrak 2015). Additionally, an article from the Washington Post highlighted the trend of people moving away from drinking fountains and towards bottled water. According to the author, Pierre-Louise, this mistrust, which has contributed to the decline of consumption from drinking fountains, has, in turn, led to people becoming "poorer, less healthy, and less green" (Pierre-Louise 2015). Pierre-Louise also notes that this trend was exacerbated by bottled water companies such as Perrier encouraging the mistrust of water from taps, leading people to doubt the safety of the water as well as the integrity of the fountains.

One example of how poor hygiene – at least concerning the external surfaces of the fountains – might be mitigated is by having those who use the fountains take a number of steps to ensure they don't spread or receive pathogens from the fountain. A notable example of this practice can be found in the halls of our university, NYU Abu Dhabi. As can be seen in figures 1 and 2, a sign above the drinking fountain asks users to disinfect their hands, the drinking fountain's nozzle, and the operating button before and after getting water from the fountain. Additionally, people can't drink directly from the fountain; they must have their own bottle or cup in order to collect water. These measures were taken as a way of mitigating the spread of pathogens in response to the advent of the COVID-19 pandemic, and altogether they can double or triple the length of time required to get a drink. These measures would solve the problem if there wasn't anything more than a sign to enforce this rule. Unfortunately, there isn't, and people used to the quick, convenient experience of drinking directly from the fountain have the ability to do so at their leisure. Even if the rules were more adequately enforced, the net result would simply be that fewer people use the fountains.

The problem statements we seek to address in our design can thus be summarized as follows:

1) Drinking fountains are unhygienic – they can spread bacteria from user to user.
2) Drinking fountains are perceived as unhygienic by users themselves.
3) Attempted solutions to statement #1 are not well-regulated, and are also cumbersome, which only further deters usage.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and
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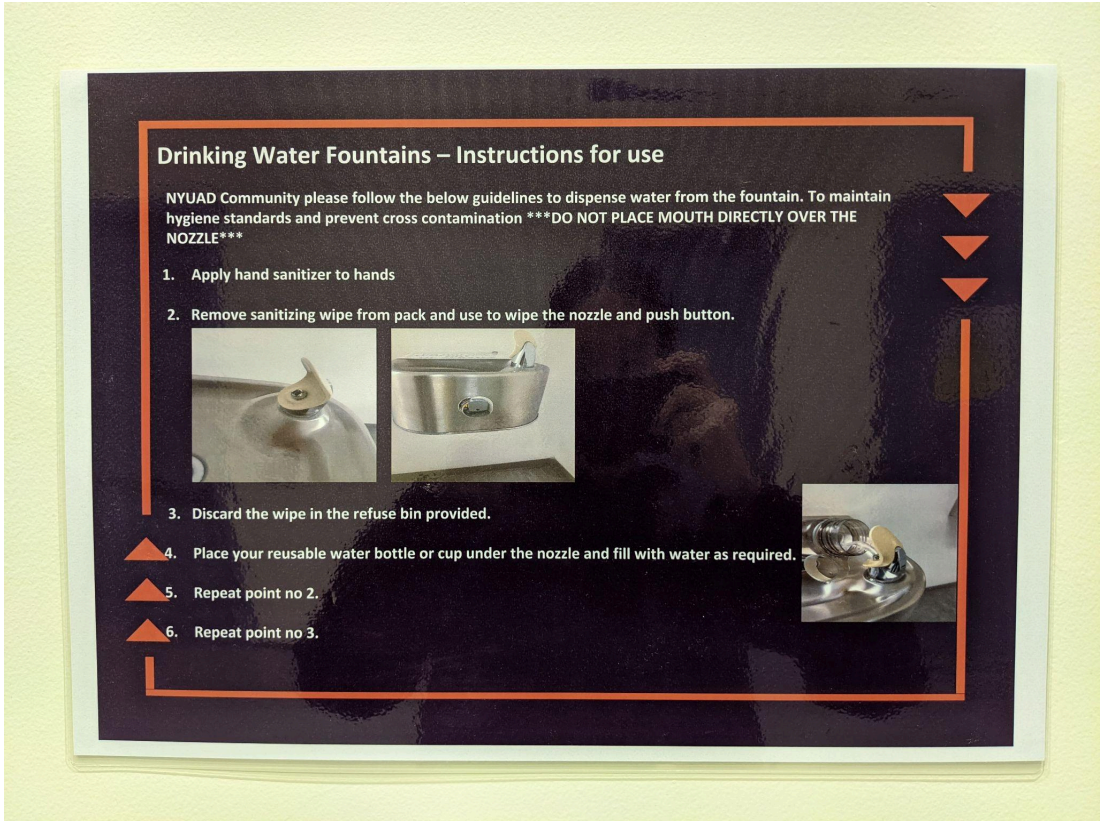
AFTER USE.


Drinking Water Fountains – Instructions for use
NYUAD Community please follow the below guidelines to dispense water from the fountain. To maintain hygiene standards and prevent cross contamination ***DO NOT PLACE MOUTH DIRECTLY OVER THE NOZZLE***
1. Apply hand sanitizer to hands
2. Remove sanitizing wipe from pack and use to wipe the nozzle and push button.
3. Discard the wipe in the refuse bin provided.
4. Place your reusable water bottle or cup under the nozzle and fill with water as required.
5. Repeat point no 2.
6. Repeat point no 3.

Specific Context

We design our drinking fountain with the specific context of Abu Dhabi's Corniche in mind. The Corniche is a major landmark in the city of Abu Dhabi, stretching 8 kilometers in total across the northwest-facing waterfront of the city, all the way from Mina Zayed to the Emirates Palace on the southern side. Dotted along this stretch can be found cafes, restaurants, pedestrian walkways, cycling paths, children's playgrounds, green spaces, as well as the Corniche and Abu Dhabi beaches.

Given the variety of attractions on offer, the Corniche is a hotspot in the city that caters to a diverse population and a wide range of activities. People of all ages can be seen walking, running, cycling, or scootering along the paths at almost all times of the day (except in summer when the heat is unbearable until the evening). Benches are also placed along the walkway, facing toward the sea, to allow pedestrians to sit, rest, or contemplate. In the park spaces, families can typically be seen relaxing, cooking, and picnicking while children explore the playgrounds. Of course, a key draw of the Corniche is the adjacent public beach area, where swathes of beach-goers swim, play volleyball, and lounge on the sand.

Much of the activity that takes place at and around the Corniche is thus of an active, movement-based nature. This fact, in conjunction with Abu Dhabi's hot climate and the lack of shade along the waterfront, necessitates adequate hydration when visiting the Corniche. We thus propose a design for a new drinking fountain that attempts to solve problem statements concerning hygiene while also taking into consideration the unique nature and context of the Corniche, its users, and the activities that take place at and around it. We focus primarily on pedestrian-heavy areas where there is a greater need for drinking water facilities.

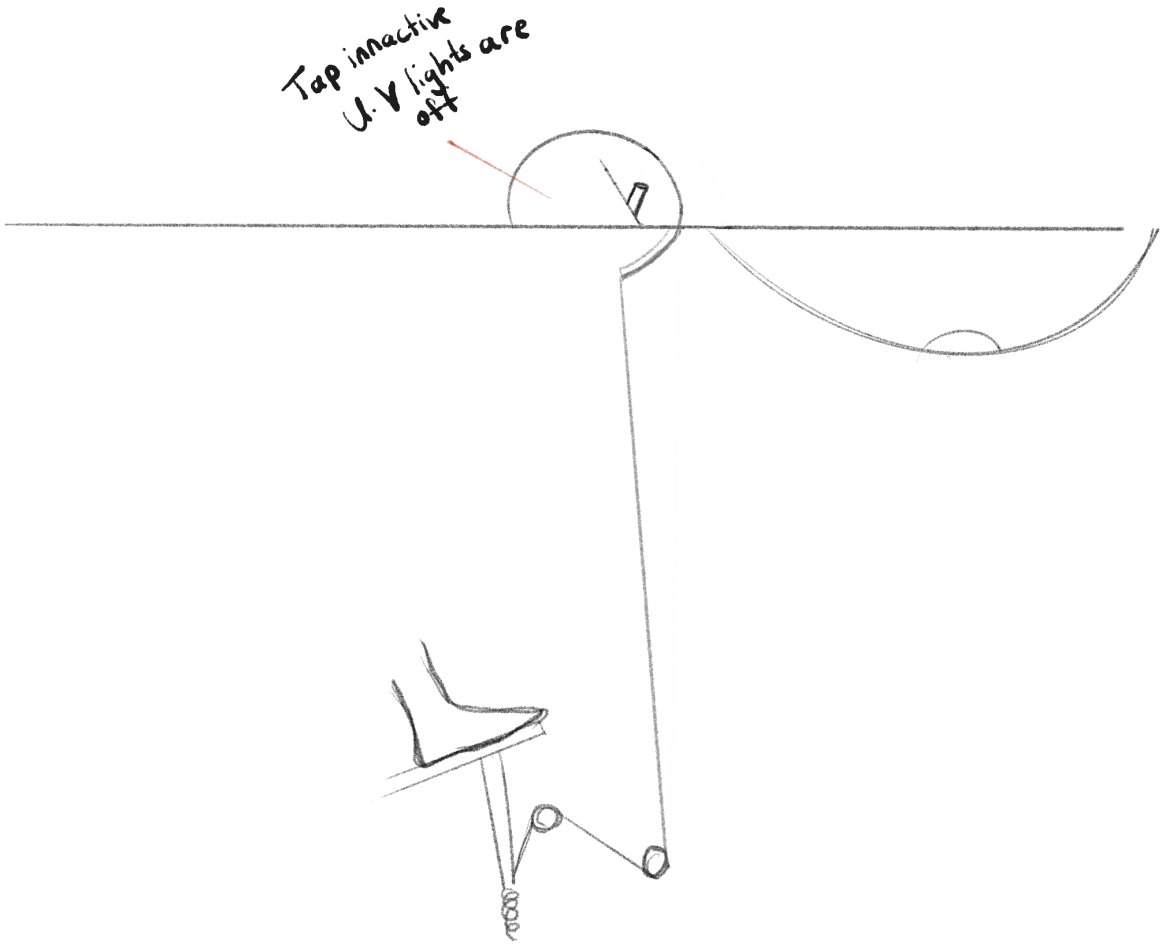
MVI / Mechanics of Operation

With the problem of hygiene in mind, the MVI of our design is the enclosure of the drinking tap nozzle inside a contained space with a closed-door on the side which only opens when the user drinks and closes again shortly afterward. This central design feature allows the nozzle to remain completely covered when not in use, therefore protected from the elements and minimizing the deposition of bacteria on its surface when users are drinking from it. In our design, this contained space takes the form of a semisphere.

The issue of hygiene is further addressed by the operation of a UV light system inside the semisphere. UV light operates within the structure to disinfect the nozzle between uses. This UV light is constantly on as long as the semisphere is fully closed. It only turns off when the door to the semisphere is opened; this is to avoid exposing the user to UV light when the fountain is in use. Once the door is fully closed again, the system will automatically turn back on.

The opening and closing mechanism of the door is operated by the mechanical use of a foot pedal situated on the floor. In our design, this foot pedal replaces the button on traditional drinking fountain designs which must be pressed to release water from the nozzle. The use of the foot pedal thus mitigates the issue of bacteria being transferred from user to user through touching the fountain's external surface.

When pressure is applied to the pedal, a series of pulleys put in motion cause the door to open as it retracts into a space of the same size in the drinking fountain structure. The opening of the door also activates the fountain's internal water system, prompting the nozzle to spray water at an angle through the opening created by the open door. The water begins flowing through the nozzle after a short delay only once the door is fully opened. For as long as the pressure on the pedal is sustained, the door will remain open and water will continue to flow from the nozzle. When pressure is released from the pedal, the door will close and water flow will cease accordingly.



Simple animation showing internal mechanical functioning of the fountain.

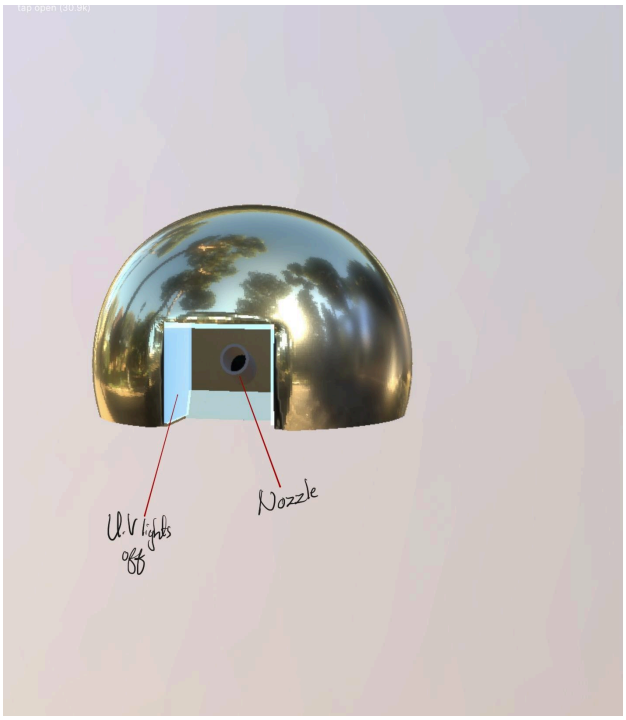
Specific Design Features & Considerations

<u>UV light system</u>

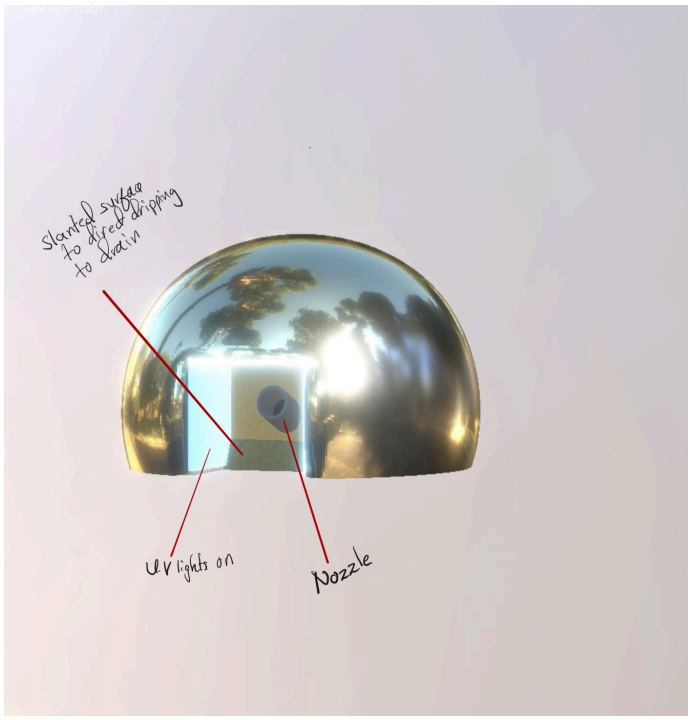
The efficacy of the UV cleaning system depends on the UV light levels being of sufficient strength to adequately disinfect the nozzle between uses. Research has shown that the optimal level required to eliminate E-coli cells is 265nm and we follow this industry standard. It

has also been established that this level of UV light exposure is not harmful to humans. However, despite this fact, users themselves may perceive the light to be dangerous, which would negatively impact their user experience. We have therefore designed the system to operate such that the light turns off as soon as the door begins to open (via pressure on the pedal), and only turns back on once the door is fully closed.

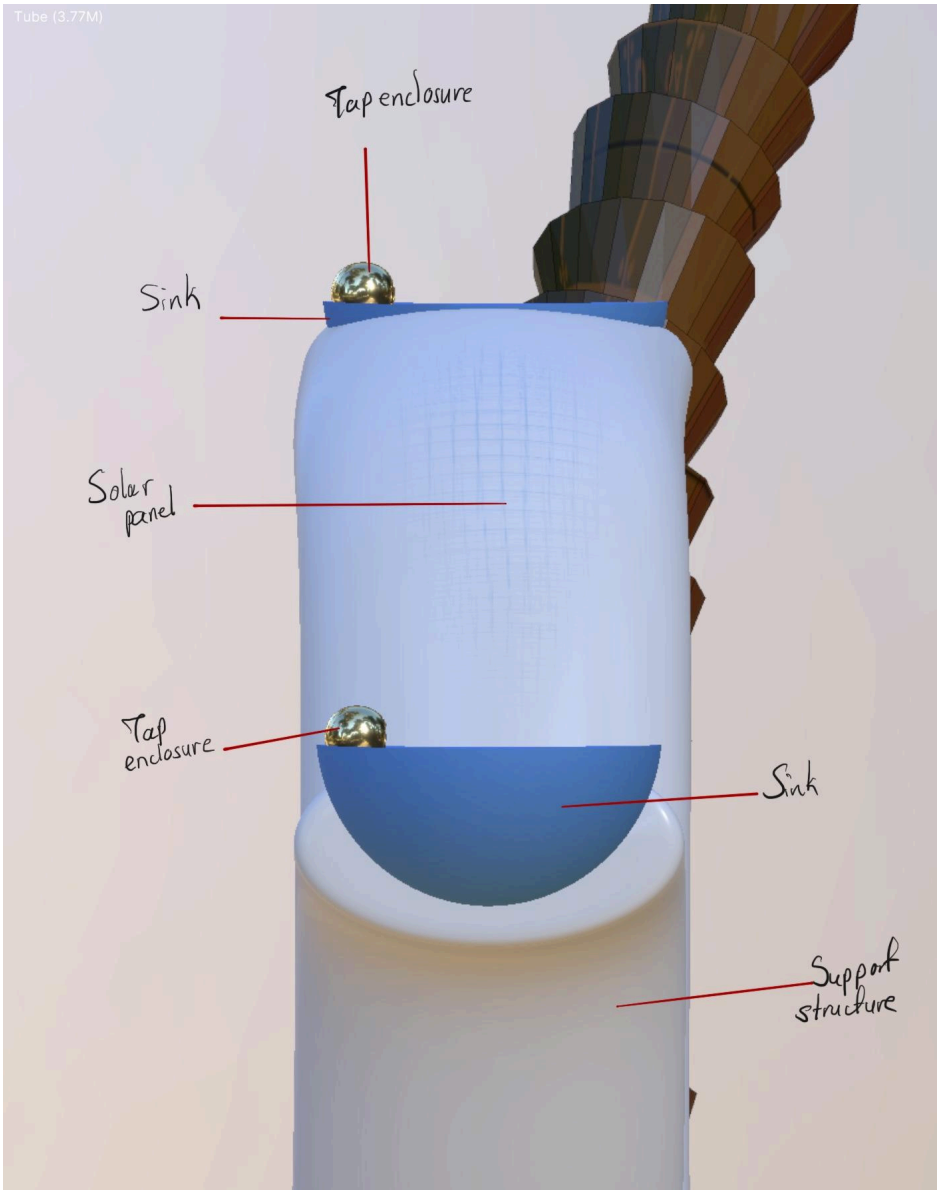
The UV light system also requires electrical energy for power. Battery power is clearly not a sustainable form of power for a drinking fountain that sees such frequent usage (the UV light system is constantly on except while the user is drinking). Our design instead capitalizes on our specific context to create the most economical approach: using solar panels positioned on the drinking fountain itself to power the UV light system. Situated directly next to the beach, the Corniche walkway is a prime location that receives a plentitude of sunshine throughout the day. There is little shade to be offered along the walkway, which further ensures that the fountain will receive a sufficient amount of sunlight to meet the system's energy needs. The fountain uses two solar panels embedded on the fountain's body at a slanted angle to optimize the capture of UV rays.



Tap enclosure internal view when UV lights are off.



Tap enclosure internal view when UV lights are on.

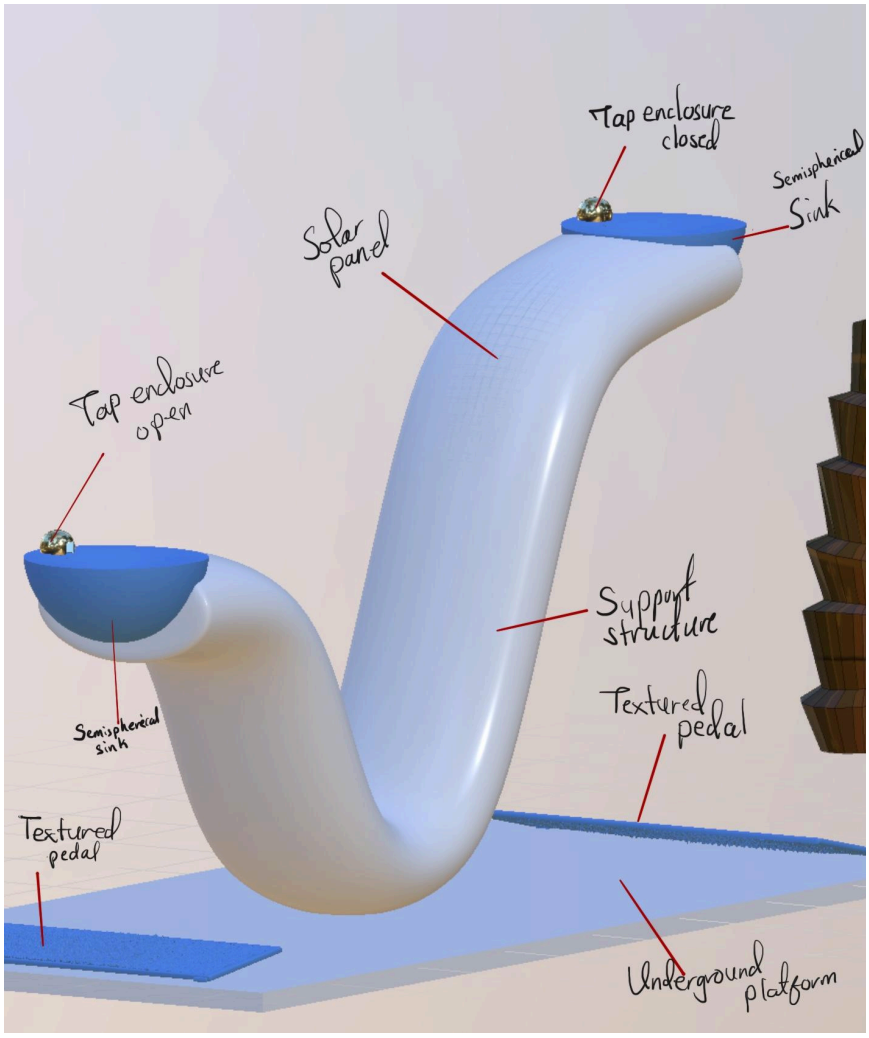


Side view of drinking fountain.

Pedal

The design for the pedal has been kept as simple as possible to maximize usability and accessibility, as well as to avoid drawing attention away from the main feature of the drinking fountain. The pedal's shape is a simple rectangle with dulled edges. Its width is just larger than the average width of a wheelchair (around 25 inches) to ensure that the wheelchair can be wheeled onto the pedal to activate it. The angle between the pedal and the ground when not pressed is 4.8 degrees, an angle that allows users using wheelchairs to be able to press on the pedals without rolling off according to recommendations by the Northeast Rehabilitation Health Network. To ensure the safety and comfort of users in wheelchairs, the amount of pressure

required to lower the pedal will be regulated in a way that makes it easy enough to press down on the pedal using a wheeled device but not too easy that it can be pushed down by non-human produced forces like wind and small animals. The specifics of the force required will be determined upon further research around the different weights the pedals will be frequently exposed to depending on specific locations along the corniche.



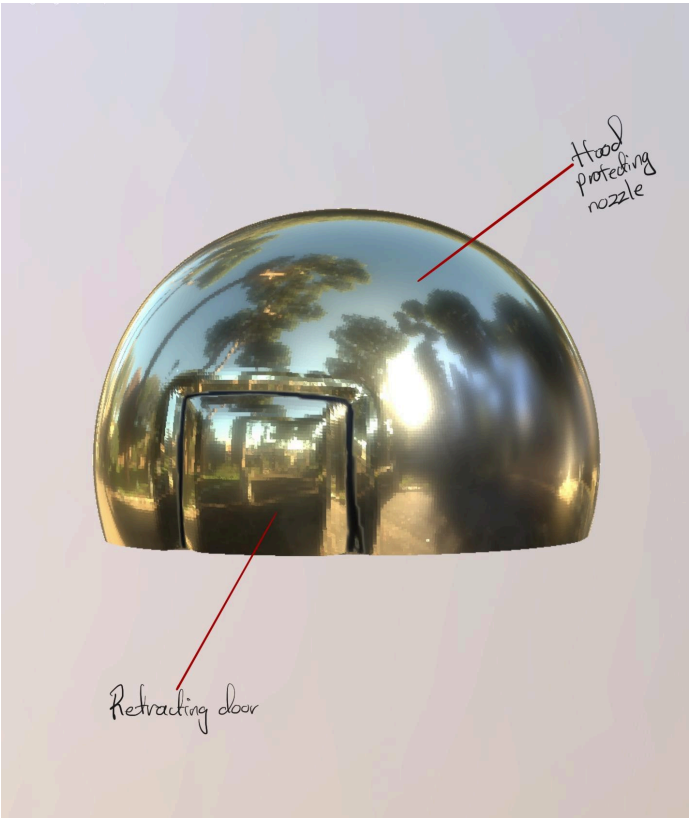
Door

While the opening and closing mechanism of the door through the use of the foot pedal is simple in concept, our design must also take into account the speed at which opening and closing happen.

The size of the door's opening is directly proportional to the amount of pressure applied to the pedal. However, a minimum level of pressure on the pedal is required to open the door to a sufficient level to allow the water to pass through the opening.

Regardless of how quickly pressure is removed from the pedal, the door will close at the same rate. This decision is made mainly with our specific context in mind; we anticipate that

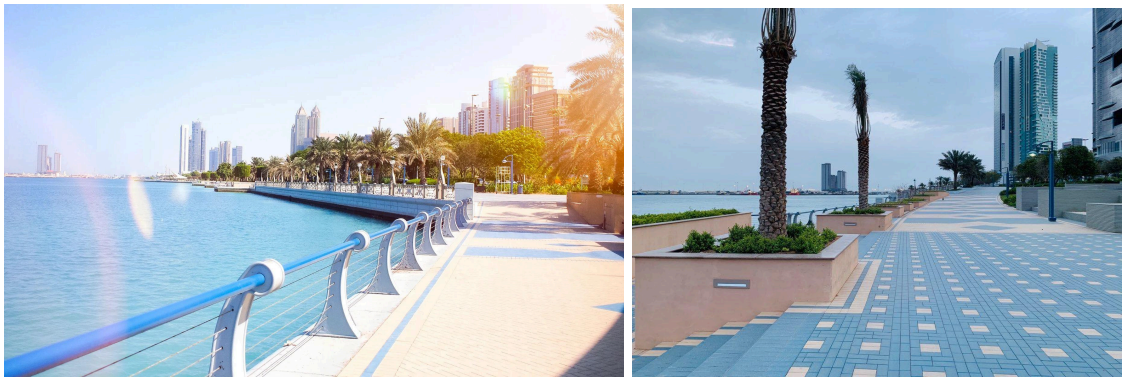
many children users – particularly excited and active ones – will want to be off on their way quickly after drinking and so would release the pedal almost immediately. With the standard rate of closure on the door, we can avoid unpleasant clanging noises that may shock the user when they take their foot off the pedal and prevent unnecessary stress on the fountain's structure from the excess force of closure.



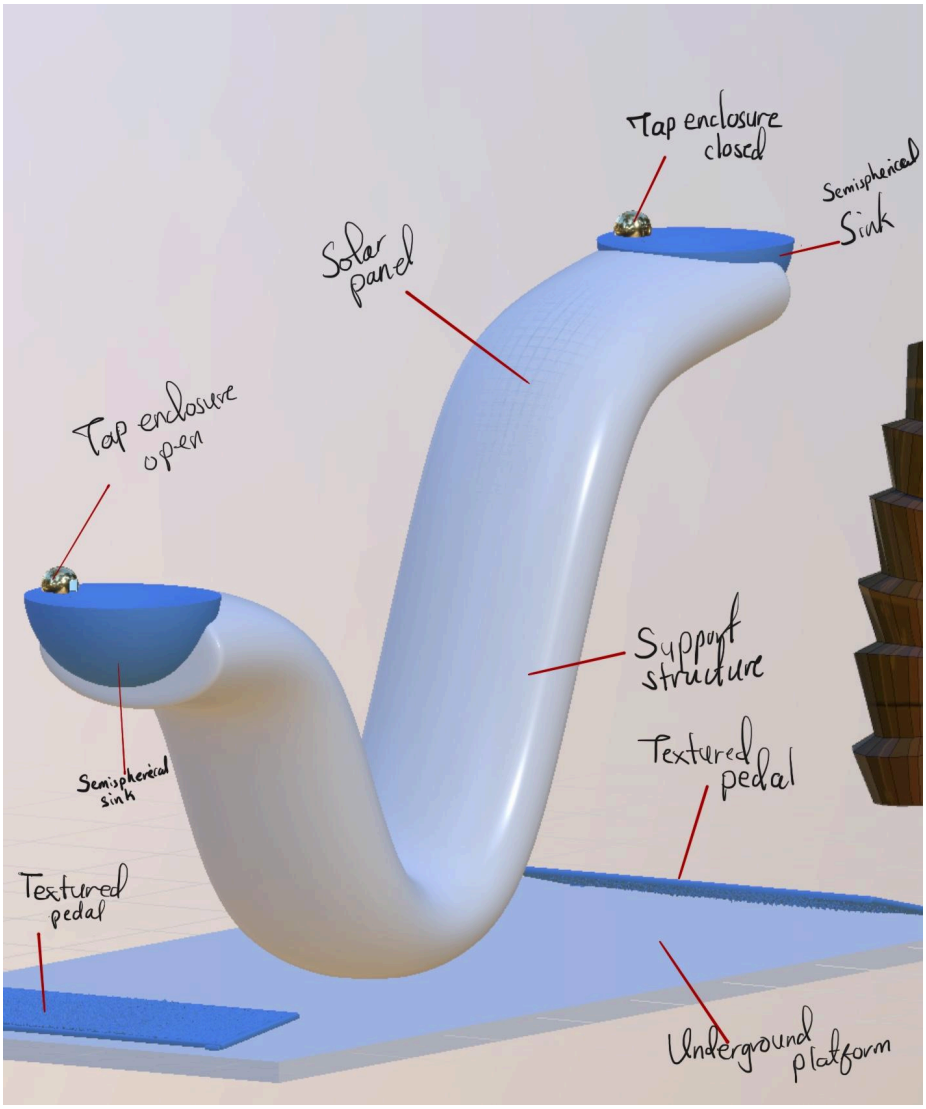
Close-up view of tap enclosure.

Aesthetics

The aesthetics of the drinking fountain take into consideration the different geometries present in the Corniche's design as well as the color scheme of the Corniche. This was done to ensure that the fountains merge seamlessly into the overall corniche aesthetic. Based on this, the fountain's body will have a curved structure while the sinks will have a semispherical shape to complement the structure of the railing along the corniche walkway. Additionally, it will use ocean blue and white colors similar to the colors of the corniche's tiling. The tap enclosures will be colored gold to make them distinguishable from the blue sinks while also complimenting the white and blue color schemes in a visually striking way.

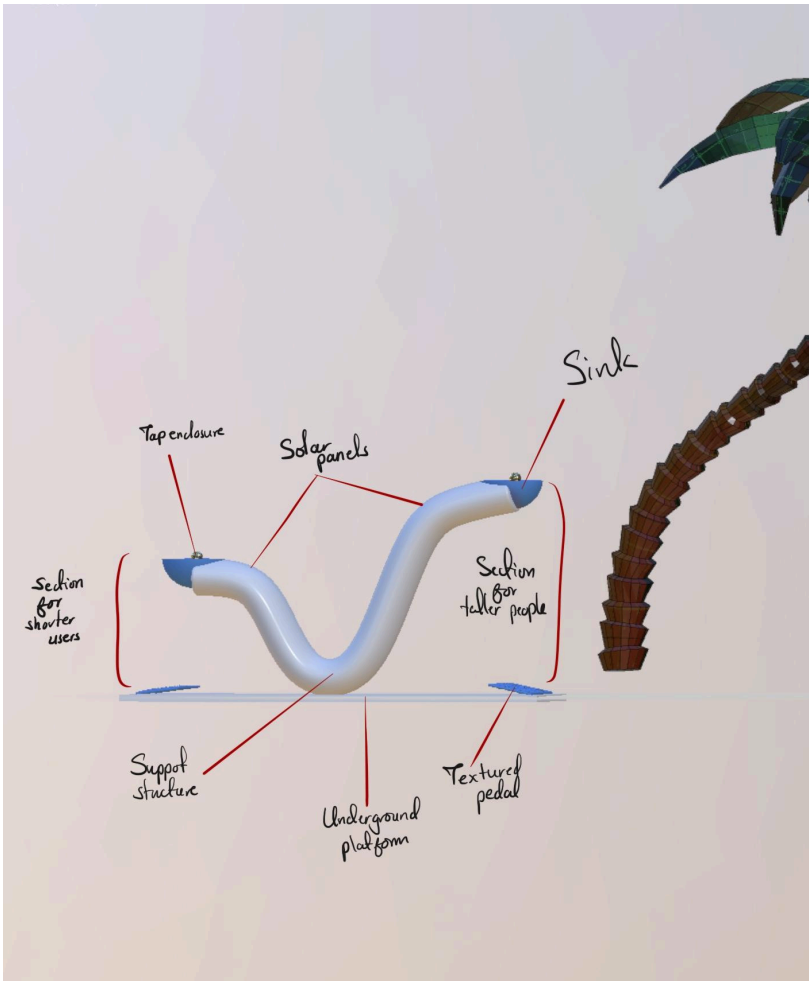


Reference photos of the Corniche used.



Final design of drinking fountain.

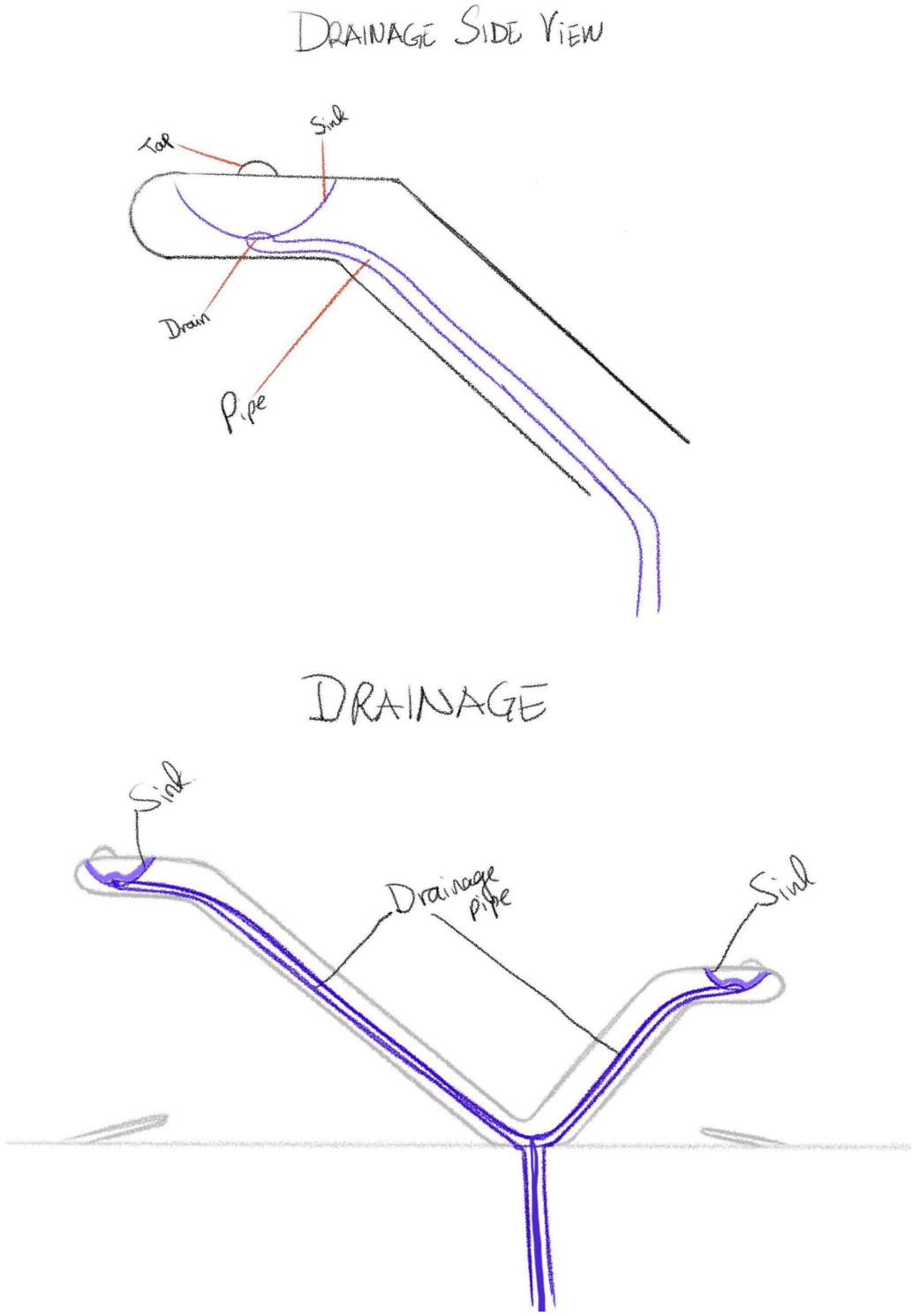
The fountain will also have two ends with one end taller than the other with the taller end meant to cater to taller users and the shorter end meant to cater to shorter users.



Front view of drinking fountain design to show taller and shorter fountain ends.

Draining and plumbing

The fountain will have two separate water drainage pipes coming from either sinks that take the water collected through the drain into the central Abu Dhabi water drainage system to undergo the standard water cycle as per official Abu Dhabi water drainage principles and practices.



Top- close up view of drainage system. Bottom- wider angle view of drainage system

Dimensions

The dimensions of the drinking fountain will be in compliance with the Americans with Disabilities Act (ADA) drinking fountain directives that are also suitable for the UAE context. Based on this, Water spouts will be located at the front of the water fountain on the sinks, and the water will flow out parallel to the front of the fountain.

The taller arm of the fountain will have its water tap located 36 inches from the floor while the shorter arm will have it 30 inches from the floor. For each arm, there will be a minimum of 48-inch by 30-inch open space on the floor under the sinks to allow for an easy approach for individuals with wheelchairs. Each pedal will be located within this designated open space under the sink with its exact positioning being dependent on additional research on drinking fountain use by wheelchair users. Additionally, the minimum knee space between the ground and the bottom of the fountain will be at least 27 inches. The space will also be at least 30 inches wide and 17 to 19 inches deep.

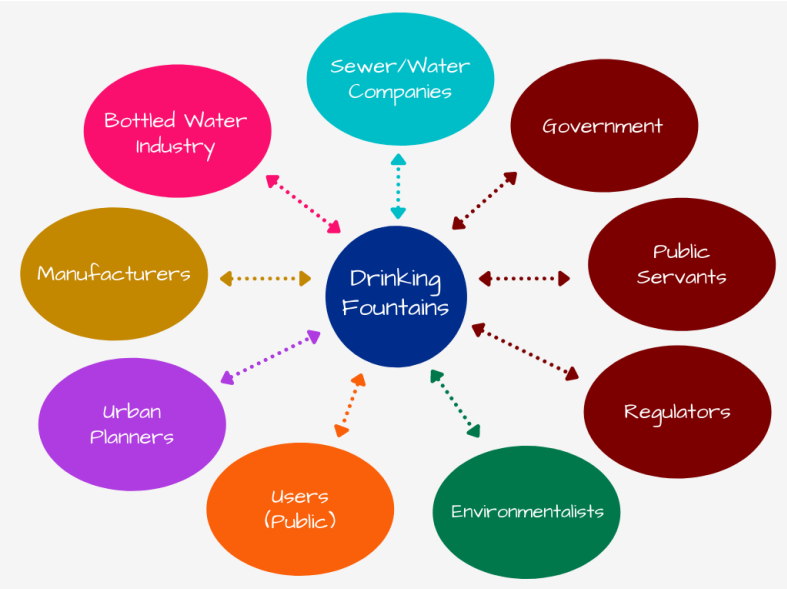
Materials

The drinking tap enclosure will be made out of stainless steel painted with anti-rust paint to prevent rust and make sure there is maximum reflectivity of U.V light inside the enclosure to allow more thorough sanitation. The sink and the rest of the fountain will be made of concrete because of its durability, affordability, and easy customization of shape. The pedals will be made of aluminum due to its lightweight and durability. The aluminum will be wrapped in anti-slip adhesive tape to prevent slipping of individuals using the pedals.

Stakeholders and Uptake

There is a wide variety of stakeholders to consider with regard to this innovation. In the specific context of the Corniche beach of Abu Dhabi, the largest party who might take interest in this fountain redesign is that of consumers: people who may use the drinking fountains as they travel along the Corniche. During the hotter times of year, the multitudes of people who frequent the beach and walkway will almost definitely benefit from having access to any drinking fountains (as there aren't currently many along the walkway). Additionally, the initiative to build fountains along the Corniche will likely be supported by people and organisations interested in fostering environmental sustainability, as access to clean drinking fountains is likely to promote the use of the fountains rather than the purchase of disposable water bottles. One such organisation, and likely the second largest stakeholder in this project, is the Abu Dhabi government. Across the UAE, the government has been approving campaigns like Dubai Can in order to encourage mindfulness with regards to one's carbon footprint, and an initiative to

increase the number and usage of public drinking fountains is a reasonable pursuit for the Abu Dhabi government to get behind and publicise. The implementation of drinking fountains in public would also help to combat the idea that the city of Abu Dhabi is 'unwalkable' in the heat. The government would also play a role in regulating the fountains: tasks like upholding safety standards and potentially implementing accessibility measures in the fountains. Going hand-in-hand with the government in this case are the parties who would be directly responsible for the implementation of the fountains: Urban planners who would construct the drinking fountains after ratifying their design and mechanism, as well as public servants or contracted agencies who would perform maintenance work and sanitary inspections on the fountains. The last stakeholder worth discussing is the competition: vendors of bottled water, whose sales stand to be impacted by the successful implementation of these drinking fountains.



Stakeholder Map

Future Development & Growth

The most immediate implementation of our innovation would concern installing the water fountains along the Corniche beach area. Our primary partner will be the Abu Dhabi government, as it is with most public projects in Abu Dhabi. We will naturally be working with state-owned or cooperating private agencies like Environment Agency Abu Dhabi (EAD), Abu Dhabi Distribution Co., Emirates Water & Electricity Co., and TAQA—who currently operate the city's water supply system—to sort out the logistical details such as how many fountains are installed, how far apart from each other, and how to hook them into the existing public water and electric system.

One prominent remaining obstacle to implementation is the prevalence of bottled water consumption. The bottled water industries as well as the public, who are the consumers, are

major stakeholders involved in this aspect. However, we believe this could be turned into an opportunity by embedding our innovation into a larger public water safety campaign across Abu Dhabi and even all emirates.

One of our problem statements was that the perception of public water as safe is not yet established. We observe that this is an existing interest of the Emirati government from initiatives like Dubai Can, as well as stated goals in the UAE Water Security Strategy 2036 (Ministry of Energy and Infrastructure 2017). We would therefore pitch a city-wide or nation-wide campaign to brand any kind of open, public source of water as clean and safe, letting the citizens know that all of these public water sources including tap water, water bottle filling fountains, and our new drinking fountains are all safely constructed and managed.

Note that such is a very common policy initiative across many countries. South Korea, for example, brands the public water source of their capital city Seoul with the name “Arisu” and conducted an expansive, successful campaign on branding it as generally safe (Seoul Waterworks Authority 2015). UAE’s case, is an especially favorable context because it is a known fact that most of its drinking water comes straight from the desalination plants and that is already a salient part of its national infrastructure. Thus, all the campaign needs is a very effective PSA to let people know how that connects to our various fountains and how this means safety is ensured. Here we would get environmental activists or NGOs and bottled water companies who are conscious of social responsibility involved, giving them some interest in our innovation and also getting the needed help to effectively get the PSA out. On top of the environmental initiative our innovation advances by nature, the active accessibility concerns in its design would give an extra stake for the government known for their previous emphasis on making UAE an inclusive country for people of determination, and thus private companies who follow this initiative as well.

With the right adaptations, our innovation can be taken into upscaled implementation, first to other emirates and then to a global scale. Across the UAE, our fountains could take the said public water brand into part of the national identity, expanding into indoor spaces and targeting all the large public spots including landmarks. We would consider enhancing the durability aspect, looking for alternative energy sources for indoor spaces where solar panels cannot be used, and even addressing potential water waste issues as the number of fountains increases.

This could potentially become a best practice and be imported to other countries, with a range of adaptations to local conditions and infrastructure. Contextual aspects, ranging from climate (again, for solar panels) to state regulations and water purification technologies in use in different parts of the world will be considered. Like our fountain is immediately reflecting the design themes of the corniche and the larger UAE public spaces, aesthetic concerns would rise with changing contexts, too.

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