The University Of Sheffield.

Global Engineering Challenge

Water Management

The water supply in Lobitos & Piedritas is only available for 2 to 3 hours for 3 days of the week. How could safe & healthy water supply be increased to 2 to 3 hours for 5 days of the week within the next year?

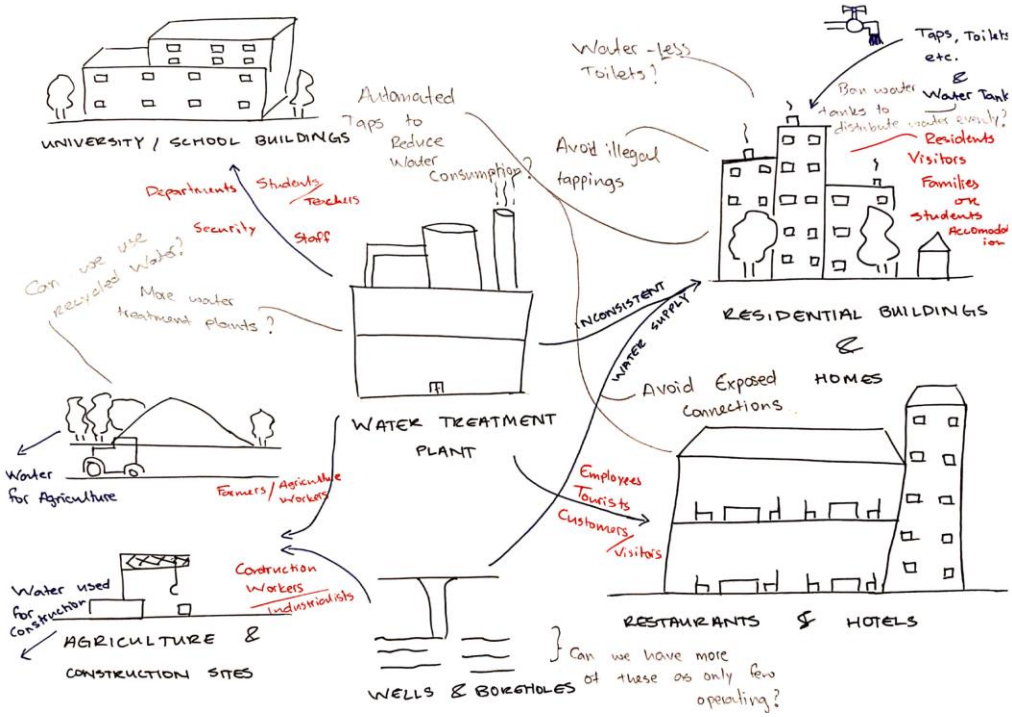
1-28-2021

Table of Contents

1. Introduction

1.1. Understanding the Context of the Problem

A rich picture has helped illustrate the main elements and relationships that should be considered to improve the water situation in Lobitos and Piedritas, therefore, highlight the complexity of the situation.



The rich picture above has helped define the current situation in Lobitos and Piedritas, therefore, will assist in finding a solution that is effective and can be affordably implemented. Similarly, for the solution to be effective, all stakeholders involved, and their interests should be considered. Therefore, a stakeholder analysis matrix (power/interest matrix) was constructed to assess the interests of stakeholders and to highlight the extent to which each stakeholder's interests/needs should be addressed in the project plan.

Power \ Interest	Low	High
High	**Understand & Satisfy** - Tourists - Visitors - Government - Council	**Engage & Influence** - Residents - Employees - University Staff
Low	**Monitor & Inform** - Construction Workers - Agriculture Workers	**Consider & Inform** - Hotel/Landowners

In terms of the current situation, we need to face a lot of questions to improve the water situation in Lobitos and Piedritas, so it is necessary to classify and analyze them in detail. Considering all stakeholders and their interests, we should treat their needs reasonably and maximize the benefits as far as possible when conditions permit.

In addition to meeting their requirements, we should also evaluate the project itself. From seasonal environmental impacts to local situation, from economic constraints to government initiatives, these are issues that we should consider carefully. Combining the above situation, we will start to carry out work, and continue to adjust and improve in the process, hoping to have very good result in the end.

1.2. STEEPLE Analysis

Social:

- There could be a potential effect on jobs as there may be additional jobs in relation to maintaining new equipment and developments made for having increased access to water.

Technological:

- There may be technology required, so need to think about what kind of resources need to be used.
- This technology must also be safe and up to date as to not cause indirect impacts on other aspects of the area.
- Need to think about what technology is available for certain budgets and ability to be set up and maintained as there needs to be manual labor to build certain things, as well as checkups to ensure safety.
- Linking to environmental, technology can also have a negative impact so need to think about if there are possibilities for technology that have least negative impact and whether it is possible to have access to it.
- For convenience it would be effective if the technology used is easy to maintain

Environmental:

- Resources should be sustainable as to not causes negative impacts on the environment.
- For disposal of any excess materials, they need to be sustainable so as not to create extra waste, ideally being able to recycle most of the materials.
- Need to think about energy required to firstly construct these solutions, and maintaining them, they need to be energy efficient.
- Ensure there is no negative impact on natural organisms, e.g., destroying the ecosystem to build something.

Economic:

- Needs to be affordable, should not cost too much so as not to make customers hesitant.
- Local suppliers could potentially be used to boost up the local economy.
- Income and expenditure ratio
- Need to look at future sustainability, will it be sustainable 5,10,15 etc. years from now?

Political:

- Need to consider that the solution can be used as a political stunt in effort to gain votes.
- What are the government initiatives? Must know everyone's intentions.

Legal:

- How do we control the issue with illegal tapping?
- Companies may be hesitant to invest due to heavy red tape (laws and regulations)

Ethical:

- The solution produced should not influence wildlife.
- Ensure safety of the water to avoid illness.

2. SMART Question

The water supply in Lobitos and Piedritas is only available for 2 to 3 hours for 3 days of the week. How could safe and healthy water supply be increased to 2 to 3 hours for 5 days of the week within the next year? (EcoSwell, 2021)

Specific: Increased days of week they have access to water from 3 to 5 days.

Measurable: Can easily be measured by people having access to water for 5 days.

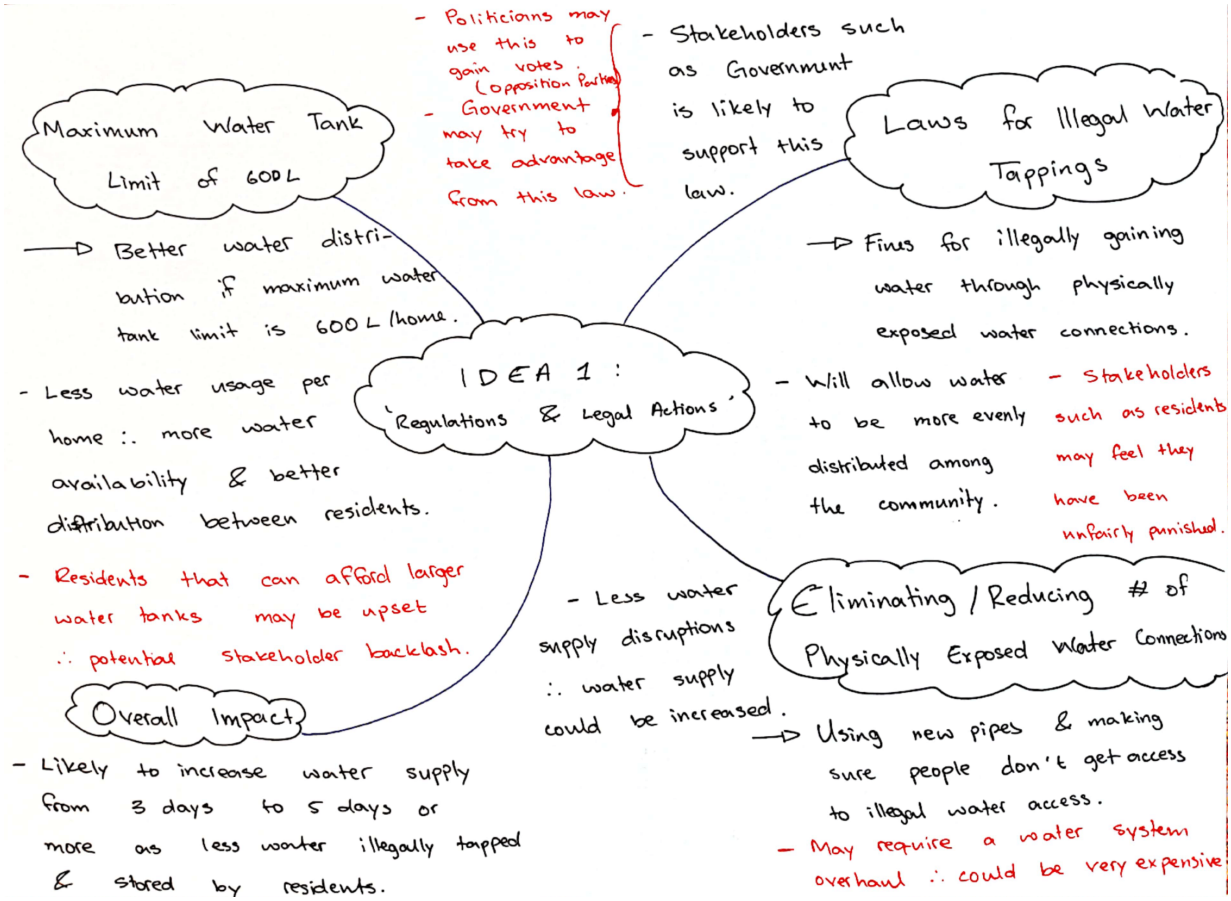
Achievable: They already have access to water 3 days a week, increasing to 5 is a goal that should be achievable.

Relevant: In Lobitos and Piedritas

Timebound: Within the next year - 1 year.

3. Designs

3.1. Design 1 – Creating Laws & Regulations

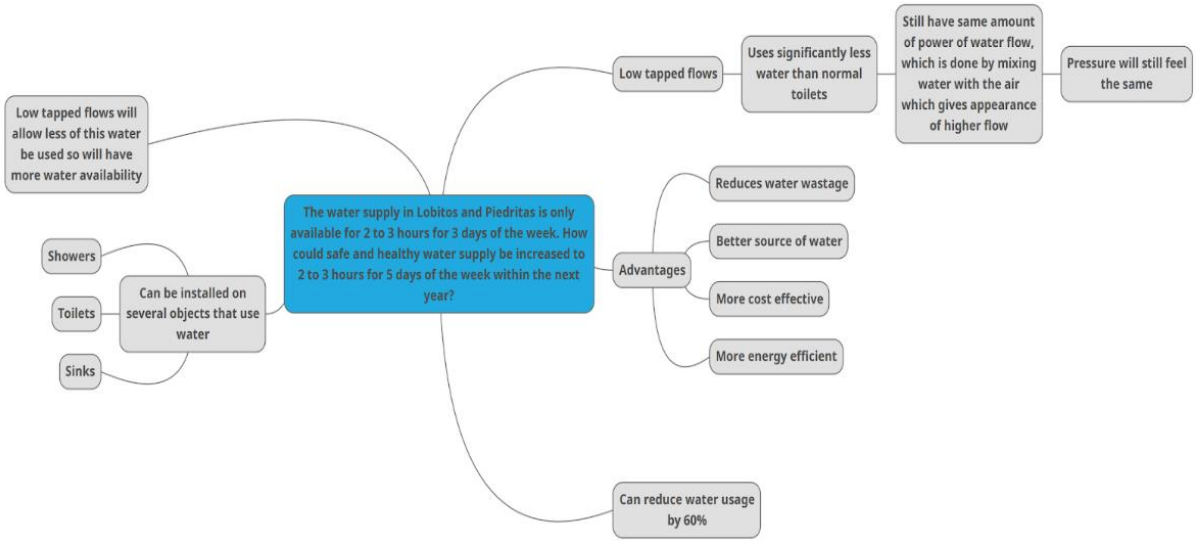


Design 1 mostly focuses on the legal side and creating limits for the maximum water tanks that could be stored on roofs of homes, along with eliminating/reducing physically exposed water connections. These three implementations combined will allow better distribution of water, less water wastage and illegal tapping, therefore, conserving the water supply. However, it could likely cause backlash from our stakeholders such as residents. On the other hand, some stakeholders such as the government may support laws and fines. (EPA, n.d.)

3.2. Design 2 – Reducing Water Usage/Wastage from Daily Activities

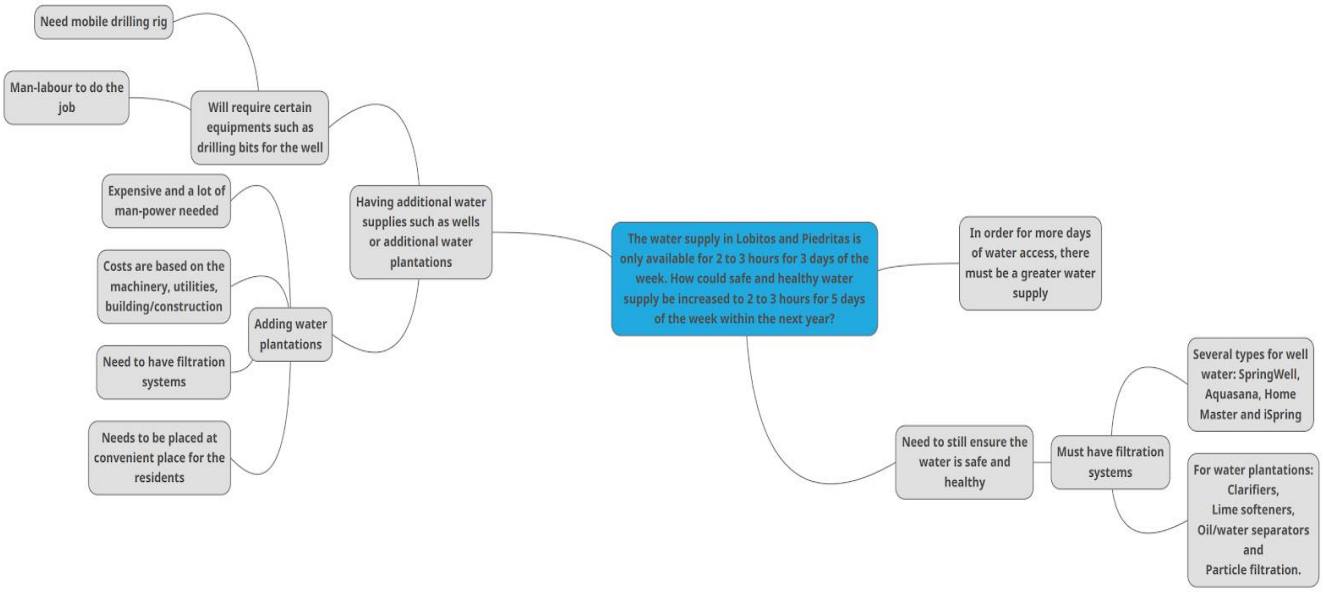
Design 2 focuses on using technology and a bit of automation to manage the current water supply through a more efficient and productive system. It focuses on reducing water wastage in areas where water is used most daily such as showers and taps. If all three solutions shown in Design 2 are implemented effectively, the water supply has a potential to more than double as there would be less water usage and wastage. However, this could be very expensive and stakeholders such as tourists could backlash. (EPA, n.d.) (Roberts, 2020) (savewater, n.d.)

3.3. Design 3 – Using Low Tapped Flows



This idea is mainly to reduce the usage of water by being more thoughtful about water management. It is an easy solution as it is not just reducing water wastage, but it is also cost and energy effective and is still a good source of water. As shown on the mind map, this design if used on all showers, taps and toilets can reduce water usage by 60% which allows the water to be saved so that there is more access to it for more days of the week. (Oneflare, 2021)

3.4. Design 4 – Idea of Having More Wells



This idea allows for more sources of water which will allow more people to have easier access to it and more water will be available. However, this idea does require things such as machinery and certain technologies to design, construct and maintain these water sources. In addition, there needs to be a filter system in all these sources to ensure safe and healthy water. A negative aspect of this idea is that it does require a high cost and a lot of manual labor, but if done effectively can allow for a lot more water access to residents as there will be more availability. (K, 2021) (Counts, 2021) (EcoSwell, 2021)

4. Design Selection

	Weighting	Raw Score				Weighted Score			
		Idea 1	Idea 2	Idea 3	Idea 4	Idea 1	Idea 2	Idea 3	Idea 4
Easy to Use	2.5	3	4.5	4	3	7.5	11.25	10	7.5
Safe to Use	5.5	4	4.5	5	2.5	22	24.75	27.5	13.75
Easy to Implement	5.5	2.5	2	3	1	13.75	11	16.5	5.5
Technical Requirements	6.5	1	5	4	1	6.5	32.5	26	6.5
Easy to Maintain	6.5	3	3.5	3.5	1.5	19.5	22.75	22.75	9.75
Low Cost	7.5	4	5	3	1	30	37.5	22.5	7.5
Low Environmental Impact/Sustainibility	8.5	5	4	5	2.5	42.5	34	42.5	21.25
Governmental Support	3.5	5	3	4	4.5	17.5	10.5	14	15.75
	Totals					159.25	184.2	181.75	87.5

The second and third ideas were quite similar in total weighted scores and the ideas themselves are also similar as they are both reducing water usage by using technological advancements such as automated water taps and aerators and low flow taps. We decided as a team that we would have one strong final idea if we combined the two ideas as they are both reducing water wastage by having a more efficient system.

5. Final Idea

6. Design Development

6.1. How the Chosen Design Meets the SMART Question?

Our chosen design meets all the requirements of our SMART question as the water supply is likely to increase from 3 days to more than 5 days. Similarly, we could implement our design within the next year in Piedritas and Lobitos.

6.2. Engineering Calculations

6.2.1. Efficiency

- Automated Water Taps & Aerators are 75% more efficient than traditional taps (reduce water usage by 60% & 15% more energy efficient). (Roberts, 2020) (Barnes, n.d.) (Rose, 2017)
- Water Efficient Shower Heads & Reducing Showers to 5 Minutes will save 75% water per each shower (25% less water consumption if water efficient shower heads used + 50% reduction in water consumption if showers are restricted to 5 minutes). (savewater, n.d.) (University, n.d.)
- 15 - 25% Reduction in water used in agriculture if Water Smart Landscaping & Irrigation used. (EPA, n.d.) (EPA, n.d.)

Therefore, a total of approximately 150% (average) reduction in water consumption.

6.2.2. Cost Savings

In the short term, this design is likely to be quite expensive due to installment and maintenance costs, however, as time goes on, this design will reduce costs in the shape of lower bills and reduced water wastage/usage.

6.2.3. Longevity Analysis

The design is likely to last a long time as it fulfills the basic needs of our key stakeholders (residents, tourists). Not only will it last long, but it is also likely to improve with time as the technology gets better, therefore, is likely to further minimize water wastage and improve the water supply.

6.3. Implementation of the Design

In relation to the shower aspect of our idea, reducing the time for showers in hotels to 5 minutes is a simple solution as the only installation is having a limitation on the water that can be used per day for every person. This will affect tourist attraction slightly as a lot of people will be used to having the accessibility to shower for longer periods of time. Another way of reducing water usage is to make the shower head more efficient, this can be costly to operate as these shower heads need to be bought and then installed around the area. However, this change can reduce water usage by 25%.

Another part of our idea is on automated water taps and aerators. This disperses the water, reducing the flow rate, allowing for water wastage to be minimized. The water coming out of the taps will still have the same pressure so as not to have a negative impact on people using the taps. Automated water taps can reduce water usage by 60% which is effective, as it is also energy efficient and has cleaner water. Installing these automated taps will be expensive and the maintenance of it may be expensive as well.

Our final part of our idea is promoting and using water smart landscaping and agriculture to reduce water wastage. Choosing specific plants that need less water and are easy to grow in that local area are good ways to reduce water wastage as a lot of the water used goes to agriculture. There are several advantages to this as it is a natural way of being water efficient and cleans out the environment so will be supported by environmental activists.

6.4. Risk Analysis

Risk ID	Risk Name	Description	Risk Category	Risk Type	Probability	Severity	Risk Score
001	Availability of Engineers	Qualified engineers & employees are required to install the equipment	Resource	Threat	3	4.5	13.5
002	Government Grants	Government may support the design as they may see that their interests is directly linked to our key stakeholder.	Resource	Opportunity	2.5	1	2.5
003	Backlash from Stakeholders	Some stakeholders such as tourists and residents may not support some components of the design.	Stakeholder Dissatisfaction	Threat	3.5	4.5	15.8
004	Need of Automation Software & Engineers	Automation software & engineers required for proper maintenance of the equipment.	Technical	Threat	3	4.5	13.5

005	Introduction of More Technology	This design may promote the importance of technology & automation, therefore, inviting more designs	Resource	Opportunity	3.5	1	3.5

6.4.1. Risk Mitigation Strategy

Risk ID	Risk Name	Risk Mitigation Strategy
001	Availability of Engineers	Start a training process from which employees could be hired
002	Government Grants	An opportunity, therefore, could try to convince government.
003	Backlash from Stakeholders	Promote/teach the benefits of saving water through adverts & promotions.
004	Need of Automation Software & Engineers	Maybe use automated water taps that do not require much maintenance.
005	Introduction of More Technology	This opportunity may help against risks 001 & 004 as employees for maintenance would be found easily.

6.5. Ethical Issues (Stakeholders' Issues & Plan to Mitigate)

Some stakeholders such as tourists and residents may not like some components of our design, i.e., they might backlash against the implementation of limiting showers to only 5 minutes. To mitigate this issue, we could carry out two proceedings:

- Charge residents and tourists with an extra price per minute if they choose to take showers longer than 5 minutes. However, this may upset our key stakeholders and is likely to damage our brand image.
- Promote/teach them the benefits of saving water through advertisements or promotions. This solution will likely not damage our brand image and will also promote education among the society regarding environmental issues.

7. Community – Led Design

7.1. Building on Existing Community Strengths & Local Enterprise

Our design will likely attract tourists as they may find automated water taps & efficient shower heads modern; this may also positively impact Lobitos and Piedritas image on a global scale, therefore, likely impacting their tourism industry and improving their economy. It is also likely to revolutionize the irrigation and agriculture industry as it would move towards automation, therefore, increasing productivity along with increasing the level of education among the society as more engineers will be required and low wage jobs would reduce.

7.2. Local Collaborations We Have Identified

We have identified two potential collaborations we could have:

1. Augusto, the owner Hotel Buenavista Lobitos, has a vision of environmental sustainability and shares his views on the challenges with water shortage and a lack of clean drinking water. (EWB, 2021)
2. Rafael, Surfer and Touristic Entrepreneur, discusses the tourism industry's need to gain access to a reliable supply of potable water. (EWB, 2021)

7.3. How the Design Empowers the Community for the Future?

Our design is effective for the future as it uses more modern technology, which is more sustainable and efficient, and is also a lot simpler to manage and use as it has been developed and improved from previous technologies. It allows for water usage to be reduced by a large amount as well as being sustainable and convenient for people living in the area.

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Appendix

1.1. Appendix 1 – Team Review

Monday:	
What went well?	We managed to meet all the objectives required in an efficient manner and had everyone in the group working on the tasks together. As a team we were able to split tasks up to be efficient but were also able to add to previous ideas from other team-mates to improve and consolidate ideas. We also made sure that everyone knew what they had to get done and who was doing what.
Any difficulties?	As it was just the 3 of us (2 of us for the first part), it was a little bit hard catching up to the work assigned, however, we still managed to complete all tasks appropriately. Similarly, it took some time to start working, yet we were still able to keep on par with all tasks for today.
Anything different that you want to do tomorrow?	Practice the "Bringing In" of quieter team members. If possible, the specific work of each person exceeds the directional completion. There are also times when we lack understanding of the form or specific implementation of the project. We hope that in the next few days, we can complete the task more completely and efficiently
Tuesday:	
What went well?	We were able to meet all objectives and were able to collaborate on the tasks. We were able to split up the tasks to be more productive and time efficient, along with improving each other's ideas.
Any difficulties?	Today was an improvement on yesterday since we were able to see what mistakes we made and how we could adjust. It was difficult to get a variety of ideas as we are still only 3 people. It is also difficult to adjust to group work in an online setting as it's not as easy to interact with each other.
Anything different that you want to do tomorrow?	We have a more systematic understanding of each of our tasks, so we hope that on Wednesday, each of our members can complete their tasks well, and discuss and share with other members in a timely manner, to achieve better results
Wednesday:	
What went well?	We have been improving our organisation skills a lot as we are able to keep more on track of things than at the start of the week. Our efficiency has also improved as we are communicating with each other better and setting out tasks for everyone to do so that everyone is engaged equally.
Any difficulties?	It was a little bit difficult for us to come up with many design ideas as we are just 3 members, therefore, each member had to come up with more than one design idea. This was a bit time consuming, but we were able to keep up and finish all out tasks for the day. Overall, an improvement from yesterday.
Anything different that you want to do tomorrow?	In terms of speeches, we have done fluently and smoothly. We hope that through more contact and cooperation with other members, we can do better. We have become more skilled in cooperation, and hope to work harder in the coming time
Thursday:	
What went well?	We were able to communicate well within our team and split tasks accordingly.

Any difficulties?	Even though there were 3 members in the group, most of the work was only done by 2 members, which is quite unfortunate.
Anything different that you want to do tomorrow?	Distribute the tasks more evenly so all 3 members contribute instead of just 2.