Innovation Report

Group 2 – Lab 5

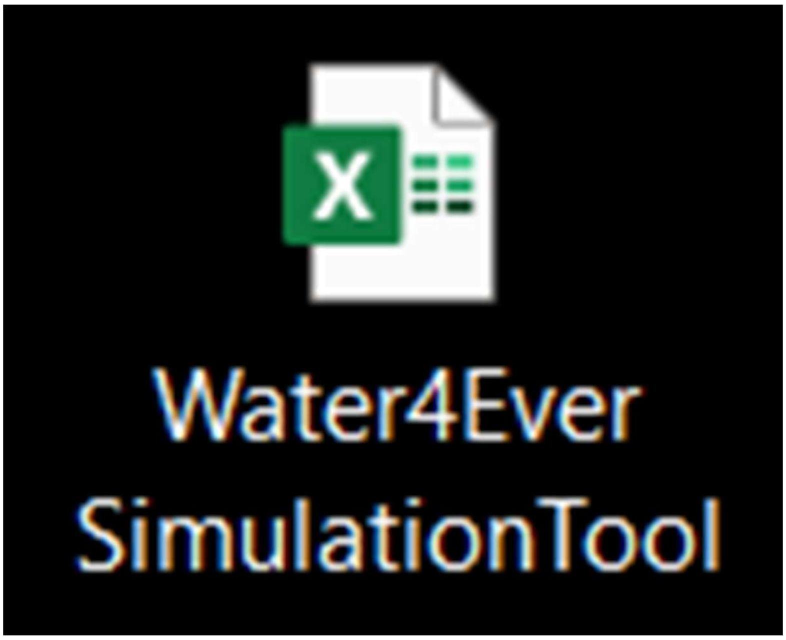


Table of contents

1 Introduction

Engineers Without Borders (EWB) has asked us to help them and their partner, Water4Ever (W4E), to explore how they can expand their current water supply system in Grafton, Sierra Leone. Grafton is a former compound that has never gone through any urban planning and has faced a growth in population that left the people living there with endless cues to the two public water pumps that could only be accessed by crossing dangerous roads. Clean, safe, accessible water supply has never been a greater problem than now.

W4E's system is a triple bottom line sustainable water supply system, that can accommodate around 4.000 people with locally purified groundwater. But as Grafton houses 21.000 inhabitants the current system is not able to meet the public demand for water. Moreover, according to W4E's assessments, Grafton is likely to face further growth in population as safe water is a nationwide challenge in Sierra Leone – making Grafton attractive for people to move to. So why don't they just expand their system to meet the demand? – a scarcity in economic resources, an exclusive focus on ensuring clean water supply today and a missing expansion strategy is preventing them from moving further. Thus, we saw arguments towards trying to support and guide decision making towards future development of the system. Hereby is our problem statement:

The current system is well proven, yet it is not future proof – how might we support W4E and Grafton to navigate a future system expansion and assist in raising the money needed?

In order to solve the problem, we have developed a solution for W4E to get the greatest use out of their data.

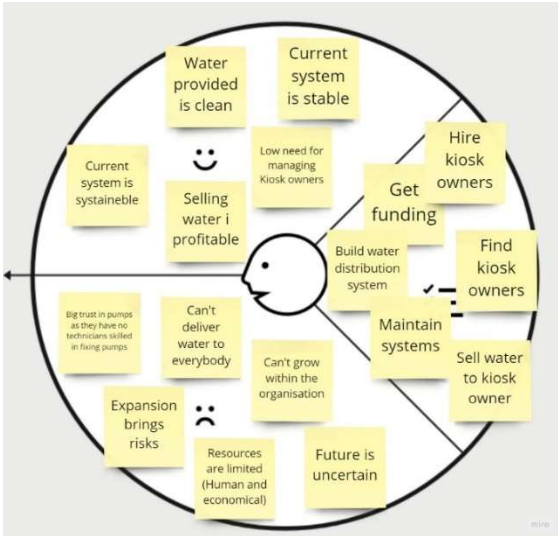
Through the report we will elaborate on the analysis and decisions that paved the way to the problem definition. We will describe our solution and the value that it – hopefully – will create for W4E and go through our prototype development. Lastly, we will try to introduce an implementation plan and next-steps.

2 Analysis and findings leading to decisions

Coming from a wealthy country as Denmark it isn't easy to design solutions for the worlds less fortunate people. What seems like a great and sustainable solution here, might interfere with deep social structures in another culture or simply isn't affordable. Through desk research and multiple interviews, we have gained the largest possible insight of the organization Water4Ever, Grafton and the overall culture in Sierra Leone. We have analyzed the collected data using different games and models such as 5 why's, question tree, business model canvas etc., which has led to the following main findings:

- *The established systems by Water4Ever runs great at the moment.*
- *Water4Evers largest lack of resource is money.*
- *Water4Ever will not make a business out of water. It's should always be as cheap as possible, because Sierra Leoneans are used to water being free.*
- *Water4Ever relies on external funding to grow.*
- *Data is very fragmented and contradictory depended on source.*
- *The pumps are solar powered and therefore will no water be pumped from sunset to sunrise.*

On behalf of the findings, we mapped a customer profile with the organization Water4Ever as the customer. One of the reasons we didn't focus on the end user as customer was the physical gap between us and them. With Alfred, Kenneth and Hassan available, we'd choose to focus on a problem that they could help us cast most light on. None of them were citizens of Grafton or users of W4E´s system. But they we're experts on the organizations structure, from the leaders to the kiosk owners, also on the inhabitants needs.



3 Our solution

Through dialogue we decided to work on something, that could be used straight away by Water4ever and Engineers without borders. We wanted to hand them something that they could keep working on and get good use out of. After a talk with water4ever we found out, that they have not thought about the future of the system very much. Or they have, but only the vision of keeping the system stable. They do not have a plan for how they system can expand itself by surplus.

We took a decision to move forward – based on our previous work.
After the talk with Water4Ever we decided to focus on investigating how long it will take before revenue comes from the system so that Water4Ever will be able to expand the

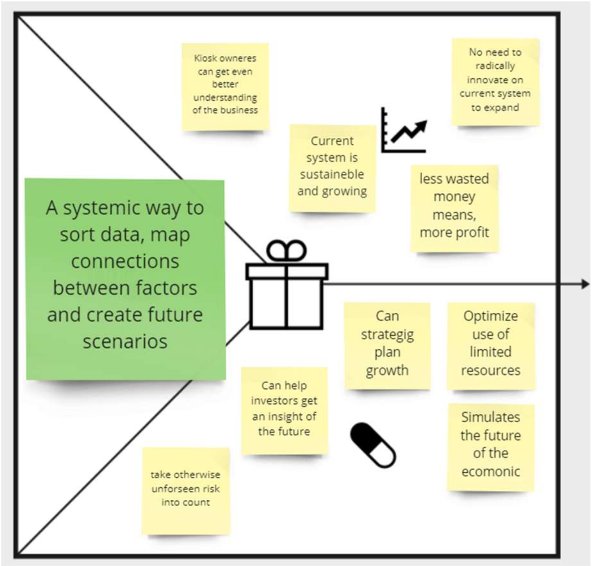
system by themself. This will, in the future, make Water4Ever able to expand their system and supply more people with clean water without needing a lot of funding.

The deliverable is an Excel-file (prototype) that shows all the important information and different scenarios for the upcoming 5-10 years. The scenarios are that Water4Ever should be able to expand their system, so the system can supply clean water to more inhabitants. Hopefully one day this can be without funding, but for now there is need of more funding to expand the system.

The purpose of this prototype is for Water4Ever to streamline their data within the organisation and use it to validate the effect of longsighted strategies. It will be a communication tool as well, that funds and investors can use to gain a deeper understanding of how funding will have a long-time impact. The goal is to make Water4Ever a growing organization without need for external investment, this prototype will help visualize the path, to make the system of clean water for everyone bigger and better.

The prototype allows one to insert factors that you can adjust, which gives an output in the form of a "gross model simulation". One can, for example, involve students in maintenance. The outputs that the simulator comes with, will tell the organisation how many days the organisation will save until they are profitable.

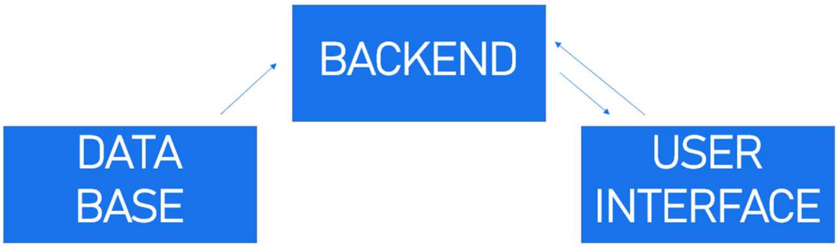
This prototype will hopefully have a great intervention for Water4Ever to look into the future of their system. The problem of the case in the first place was, that they could not supply all inhabitants in Grafton. With this tool, they can get a vision of when they will be able to expand their system of their surplus. This tool will also, as explained earlier, be a communication tool, so funds and investors can get a better understanding of how their funding can help the long-time impact of the organization. Therefore, this tool/product will have a big impact for the company, because they at the moment don't have an insight of how their future is looking, when they can make profit and how they will be able to expand their system.



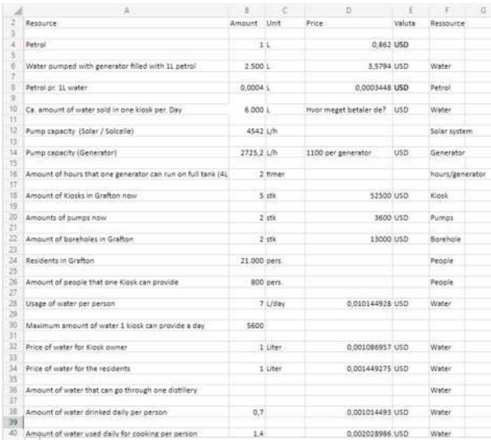
4 Prototype

Trying to put the solution into practice, we have developed a prototype to simulate how expansion scenarios can affect the future. E.g. how might W4E's revenue look if an extra water tower is implemented? Or how might a rise in demand result in more generator hours, and how will it affect the revenue as a result of increase in petrol use?

In order to develop the prototype a large selection of variables was needed as input, to create the simulation. These variables have been gained from desk research and interviews of the W4E team. The variables exists of water sale volume in kiosks, generator petrol usage, development of kiosk expenses and cost of general maintenance etc. By developing a program in Microsoft Excel, we can come up with future scenarios depending on different variables. The program is divided into 3 parts: Database, Backend and User interface



Database: The database is a central collection of data relevant to the water supply system.



Resource	Amount	Unit	Price	Valuta	Ressource
Petrol	1	L	0,862	USD	
Water pumped with generator filled with 1L petrol	2.500	L	3,5794	USD	Water
Petrol pr. 1L water	0,0004	L	0,0003448	USD	Petrol
Ca. amount of water sold in one kiosk per. Day	6.000	L	Hvor meget betaler de?	USD	Water
Pump capacity (Solar / Solcelle)	4542	L/h			Solar system
Pump capacity (Generator)	2725,2	L/h	1100 per generator	USD	Generator
Amount of hours that one generator can run on full tank (4L	2	timer			hours/generator
Amount of Kiosks in Grafton now	5	stk	52500	USD	Kiosk
Amounts of pumps now	2	stk	3600	USD	Pumps
Amount of boreholes in Grafton	2	stk	13000	USD	Borehole
Residents in Grafton	21.000	pers.			People
Amount of people that one Kiosk can provide	800	pers.			People
Usage of water per person	7	L/day	0,010144928	USD	Water
Maximum amount of water 1 kiosk can provide a day	5600				
Price of water for Kiosk owner	1	Liter	0,001086957	USD	Water
Price of water for the residents	1	Liter	0,001449275	USD	Water
Amount of water that can go through one distillery					Water
Amount of water drinked daily per person	0,7		0,001014493	USD	Water
Amount of water used daily for cooking per person	1,4		0,002028986	USD	Water

Figure 1 Shows the Database created in the Excel-file

BackEnd: Here all the data from the database is linked in various ways.

	Example of 1-day production as it is today										
	Overall system										
	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00
Expenses ($)	$0,88	$0,88	$0,88	$0,88	$0,88	$0,88	$0,88	$0,88	$0,88	$0,88	$0,88
Income kioskowner ($)	$0,00	$0,00	$0,00	$0,00	$3,38	$3,38	$3,38	$3,38	$3,38	$3,38	$3,38
Income W4E ($)	$0,00	$0,00	$0,00	$0,00	$2,54	$2,54	$2,54	$2,54	$2,54	$2,54	$2,54
Surplus W4E ($)	-$0,88	-$0,88	-$0,88	-$0,88	$1,66	$1,66	$1,66	$1,66	$1,66	$1,66	$1,66
Customers (ppl)	0	0	0	0	333	333	333	333	333	333	333
Production (L)	0,00	0,00	0,00	0,00	0,00	0,00	4.542,00	4.542,00	4.542,00	4.542,00	4.542,00
Usage (L)	0,00	0,00	0,00	0,00	2.333,33	2.333,33	2.333,33	2.333,33	2.333,33	2.333,33	2.333,33
Waste (L) (2%)	0,00	0,00	0,00	0,00	46,67	46,67	46,67	46,67	46,67	46,67	46,67
Storage (L)	20.000,00	20.000,00	20.000,00	20.000,00	17.620,00	15.240,00	17.402,00	19.564,00	21.726,00	23.888,00	26.050,00

Overall system	Running generator extra hours			Increasing amount of kiosks			Increasing number of water towers			Increasing number of p	
	Total	Effect	Explanation	Total	Effect	Explanation	Total	Effect	Explanation	Total	Effect
Expenses ($)	$25,70	$4,25		$30,03	$8,58						
Income kioskowner ($)	$72,41	$31,83		$56,81	$16,23						
Income W4E ($)	$54,31	$23,87		$42,61	$12,17						
Surplus W4E ($)	$28,61	$19,62		$12,58	$3,59						
Customers (ppl)	6.995	175%									
Production (L)	49.962	175%									
Usage (L)	48.963	175%									
Waste (L) (2%)	999	178%									
Project setup cost				$115.000,00	$21.000,00						

Figure 2 Shows the BackEnd in the Excel-file

UserInterface: Here any user can change different inputs in the current system and retrieve the effect such a change would have on the project.

SIM Factors	Input	Unit	Effect Surplus	Unit	Effect Project	Unit	Risk	Limitation	Activate state
Involving students	40	%	$8,58	USD/day	$0,00		4	Max. 100	0
Running generator for additional hours	5	hours	$0,00	USD/day	$0,00		2	Max. 10h	0
Increasing amount of kiosks	2	pcs	$3,59	USD/day	$21.000,00		1		1
Increasing number of water towers	1	pcs		USD/day					0
Increasing number of private tabs	0	pcs		USD/day					0
Increasing number of institutional tabs	0			USD/day					0
							2		0

SIM Results	value/factor
Project cost	$115.000,00 usd
Daily surplus	12,58 usd/day
Days before profit	9143 days
Years before profit	25,05 years
RISK-factor	1
Extra cost	$21.000,00 usd
Time saved	1320 days
	3,62 years

Figure 3 Shows the UserInterface

The screenshot above shows an example of how building 2 new water kiosk will approximately cost of 21.000USD, but the whole project including the two new kiosk will gain profit 3 ½ years earlier than before.

The prototype is currently able to predict future revenue and estimate time saved by running different scenarios. The current scenarios are:

- Involving students
- Running generator for additional hours
- Increasing amount of kiosks

- Increasing amount of water towers
- Increasing number of private tabs
- Increasing number of institutional tabs

For each of these scenarios we estimated a risk-factor from 1 to 10, with the purpose of making the calculations more reliable, and giving worst-case scenario. A risk-factor in our prototype, is supposed to be a number above 1, that you add to the estimated time. In the end, it is possible to compare the best case and worst-case scenario. A tool you can use in the decision-making.

After activating one or more of the scenarios and entering the needed input, our product also gives the user an example of 1-days production. Throughout a whole day it hourly plots amounts and quantities for:

- Expenses, Income, Surplus, Customers, Production, Usage, Waste, Storage

You can use this data to compare one scenario with another scenario, or to see if it fits the needs.

Currently the prototype is at the level of a *proof of principle prototype*. Meaning that it serves to provide overview of basic functionality but doesn't contain all the desired features of the finished product. Since the final product largely is a software solution and the current prototype is presented as "mock software" an actual software prototype would be preferable. This however takes a long time to implement compared to the added value to the prototype. It would however elevate the prototype to the level of a *user experience prototype,* and thus eliminate one of the current weaknesses. In general, the weakness of software-based solutions is the difficulty of implementation and uncertainty of integration. The actual user experience rarely relates to expectation. Right now, the prototype is likely to abstract for user testing as it needs a large amount of guidance to simulate the full solution experience. This could be overcome with use of an actual software-based prototype. Furthermore, the current prototype merely mimics the behavior of an integrated dynamic model were changing one parameter affects the entire model. This would be the core value of the final solution and should therefore be the focus point of further prototyping.

5 Plan for implementation

As described in the previous section of the rapport, the current prototype is insufficient for user testing. And thus, the next step should be further development of the prototype, preferably into something more resembling actual software. At the same time the focus should be the fine tuning of the dynamic model, not necessarily to the level of the final solution. Once this is achieved it takes priority to field test the prototype to determine user compatibility.

Or product is not a 100% failproof. There are certain risks attached using and relying on this tool. First of all, a false input could change the future scenario dramatically. A human error will always be a risk. Furthermore, a change in the political landscape can have a big impact in prices and accessibility. It is therefore important that we take this into consideration, in the further developing of this tool.

It is also important to keep updating the product, if the customers find flaws or need more information in the output. This will be a dynamic progress, and communication with the customer will be of importance. Once the solution has moved beyond the initial prototype phase, the solution becomes *open source*. Thus, actual development is backed by a community and is free of charge, while the validation/testing of new versions happens internally with the help of EWB. Because of this it is hard to predict the full timeline of development of new functionality, but the expenses are kept to a minimum.

It is our hope that the production cost of this product, will primarily be financed by free labor from students at the local university or from charities around the world.