Climate Adaptation Smart Rainwater Buffering Campaign

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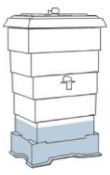


Abstract

The consequences of urbanization and climate change require the municipality of Enschede to find new approaches in communicating the importance of sustainable rainwater management. The Smart Rainwater Buffering system was envisioned and created as a feasible bottom up approach to actively involve the citizens in the process. Following several prototypes, the product is ready to be introduced to the citizens of Enschede. The goal of this project was to develop a campaign that promotes the Smart Rainwater Buffering System to the citizens. A literature research was conducted on social theory to extrapolate the characteristics and needs of the target group. Next to that, a state of the art was conducted, aimed at identifying common denominators amongst countries that successfully promoted rainwater buffering to the population. With an iterative user centered design process as the main method for obtaining requirements and specifications, several campaign concepts have been ideated. An animation was selected as the dominating campaign concept with the stakeholders from the municipality of Enschede. A cartoonesque 2D animation was realized and evaluated with the stakeholders. This animation answers the "What's in it for me?" question and highlights the importance of communicating individual gains to the viewer, particularly by addressing subsidization and use cases of the Smart Rainwater Buffering system. Furthermore, it aims to educate viewers about water management by making a comparison to antiquated water towers and their historical usage. Following the evaluation of the animation to the stakeholders, the client showed enthusiasm. The product has potential as a campaign tool; however, the client also expressed concerns about the pacing and conveyed information regarding usage and taxation, concluding that additional parties such as Vitens may be required to get involved in the process for clarification. Concluding, re-evaluation of requirements may demand for the partly or entire recreation of the animation.

Acknowledgement

I would like to thank my family, friends and loved ones for their support and belief in me. I would also like to thank my supervisor Kasia Zalewska and critical observer Richard Bults for their guidance and goodwill throughout both tricky and enjoyable phases of the graduation project. Lastly, this animation wouldn't have been possible without the dedication and feedback from the municipality, particularly Hendrik-Jan Teekens and Nicolette Hoogeveen as well as Jeroen Buitenweg from the Waterboard Vechstromen. Thank you for providing me with the opportunity to work on project that will hopefully make the future more sustainable.

Contents

1. Introduction

1.1. Situation

On an international scale, cities have recognized the need to deal with the repercussions of urbanization and climate change on their water management system. In the first place, increased migration into the cities puts a strain on older sewer systems. Second, an increase in excessive precipitation due to climate change further aggravates the problem caused by runoff. Additionally, following extended periods of drought, such in the summer 2018 in Europe, soil becomes incapable of absorbing water, multiplying the amount of runoff. Accordingly, problems such as flooding of streets and buildings, causing dangerous situations and damages for people, are increasingly likely (Water in Enschede, 2012).

In the same fashion, cities in the Netherlands must challenge these water management issues, especially regarding its geographically unique position. 26% of the Netherlands are below sea water, with 29% being susceptible to river flooding (IPCC, as cited in Ireland, 2010). However, historic events such as the North Sea flood of 1953 in Zeeland seem to have contributed to the awareness and knowledge of the nation regarding research and development of water systems that aim to prevent and control flooding.

Aside the aforementioned issues, the city of Enschede in the Netherlands has three aggravating factors that increase the risk of flooding. First, the city is built on top of a moraine, causing a height difference of 44m between the top (East) and bottom (West) of the slope, causing runoff to accumulate in 'hot spot' areas. Additionally, the ground water level runs parallelly to the moraine, creating further pressure (Water in Enschede, 2012). Second, the city centre, located at the bottom of the slope, consists mainly of flat areas with few green spaces, thus hindering runoff to pass over into the sewer system. Lastly, most of the flooding affected areas are connected to a combined sewerage system, funnelling both sewage and rainwater, thus further increasing the load on the system.

As a result, the municipality of Enschede and the waterboard Vechtstromen work together on a plan to keep water management in order and to improve it. The report "Watervisie Enschede 2013 - 2025 Water verbindt" highlights six goals, that function as a basis for several projects that since have been initiated. Water in Enschede, as cited in Defize, 2018) summarizes

1. Detach rainwater from sewage system to lower the load.
2. Improve the landscape by adding surface water.
3. Create water buffer areas to selectively store and release water.
4. Restrain increasing costs for water filtration.
5. Create awareness and participation in the water facilities amongst residents.
6. Combine efforts with other parties in a water agreement". (p. 6)

In collaboration with the University of Enschede, one of those projects, the DIY Smart Rainwater Buffer (SRB) was created as a bottom-up approach ("Slimme Regenton"). In contrast to other projects, such as the wadis, it is intended to actively engage the public and increase awareness for the problem the municipality and waterboard are trying to solve. Like other Rainwater Harvesting systems (RWH), the SRB retains runoff from flat roofs, stores them in a container and uses several sensors as well as

wireless connections to other SRBs and weather databases to release excess rainwater into the sewer system prior to heavy precipitation.

Considering a large-scale participation of enough households, the device likely functions as a decentralised water buffer, potentially alleviating stress on the sewer system during peak volume flow and therefore preventing flooding. Additionally, by repurposing rainwater for household purposes, it can create awareness for sustainable water usage.

1.2. Challenges & Objectives

However, adoption on a large scale depends on a multitude of socioeconomical factors such as cost, awareness, ease of use and usefulness of the device. Based on prior research conducted by Defize (2018), the SRB was constructed as a DIY-approach, which was identified to be the most affordable and accepted solution by participants of the study. Consequently, Tunc (2018) explored possible methods for communicating DIY information and identified that users responded well to a combination of an instruction manual consisting of text and illustrations as well as an expert opinion video.

With both DIY concept and instructions completed, a campaign must be developed aimed to promote the SRB to the citizens of Enschede. The goal of this paper is to get an insight on the sociological factors influencing behaviour towards and potential adaptation of the SRB. Concluding, these factors will be used to test and potentially identify the most effective design implementations for a campaign in Enschede.

1.3. Research Questions

To reach this goal regarding the aforementioned situation and objectives, a research question decomposed into three sub questions has been defined:

1. *How to develop a campaign for Enschede to promote a sustainable Smart Rainwater Buffering system?*

    (a) How to convey the message of usefulness to the citizens of Enschede?
    (b) How to create the critical mass of SRB users?
    (c) What is an effective design implementation for the campaign?

1.4. Outline

Chapter 2 of this thesis explores background research conducted on relevant topics. Separately, the first part of the chapter discusses previous literature from social theory, which more specifically delves into technology adoption models. Following that, a State of the Art explores the current international situation regarding successful RWH implementation and adoption and aims to identify and extract factors that led to the outcome in the leading countries.

Chapter 3 delves into methods and techniques for designing the campaign, more specifically by presenting the creative Technology design process.
The following chapters conclusively deal with the Creative Technology Design process and covers the four phases Ideation, Specification, Realization and Evaluation.
Following the Evaluation, a Conclusion summarizes key findings and lastly discusses suggestions for future work.

2. Background Research

To answer the research questions and subsequently creating a successful campaign, the SRB needs to be deployed and adopted on a large scale with the citizens of Enschede. To do so, literature for both individual and community-based technology adoption is discussed. This research builds on the previous work of Defize (2018) who found that technology adoption is a well-researched topic with vast amount of theories, citing a literature review that identifies the most prevalent theories by measuring their occurrence in 330 articles. He concludes that the two most dominant theories identifying individual and community factors are the Technology Acceptance Model (TAM) and Diffusion of Innovation (DOI) respectively. Those are briefly discussed, followed by a discussion of a concept combining these two and six other models into the Unified Theory of Acceptance and Use of Technology (UTAUT), which entails several factors and moderators, influencing behavioural intention and usage behaviour. It serves as the main social theory model to help identify key factors for creating a campaign that may change people's behaviour.

Afterwards, a State of the Art identifies challenges and approaches taken by leading countries having adopted RWH successfully. The focus hereby lies in governmental regulations and subsidization through funds, programmes and initiatives.

2.1. Literature Review

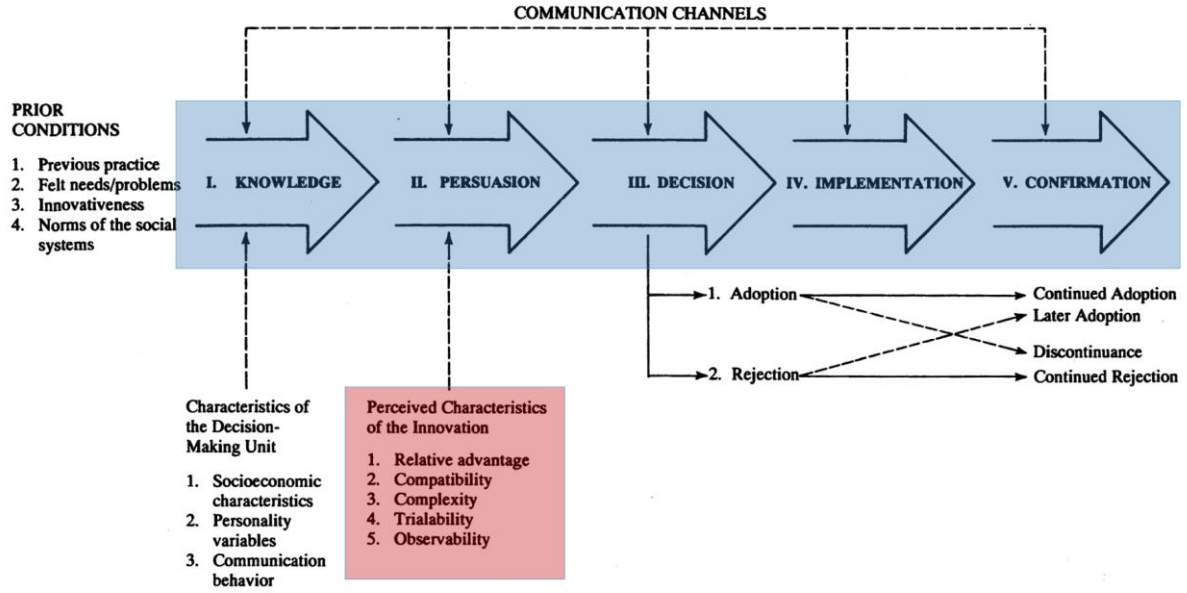
2.1.1. Technology Acceptance Model

The TAM model, introduced by Davis (1985) is an adaptation of the theory of reasoned action (TRA) which is an intention model, "designed to explain virtually any human behaviour" (Ajzen and Fishbein 1980, p. 4). It suggests that the key factors *perceived usefulness* (PU) and *perceived ease of use (EOU)* are of primary relevance for computer usage behaviour. Results of the initial study showed that PU strongly influenced user intentions while EOU had a significant but small effect that subsided over time. However, Davis, D., Bagozzi, P., Warshaw, R. (1989) further point out that subjective norms (the perceived social pressure to perform or not to perform certain behaviour (Ajzen ,1991)) have no effect on intentions while attitudes only partially mediated the effects on PU and EOU.

2.1.2. Diffusion of Innovation

Diffusion describes both the planned and spontaneous spread of new ideas. It is the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 1983). In addition, Rogers states that whether new innovations get adopted or rejected, social change occurs. The main difference to the TAM model is, that DOI focuses on the adoption within communities or societies as opposed to individuals.

The perceived characteristics of the innovation recycles the key beliefs of the TAM model such as *EOU,* here described as *Complexity,* while PU isn't clearly redefined but rather spread out among multiple factors. However, different from TAM, DOI sees change as being primarily about the evolution or "reinvention" of products and behaviours so they become better fits for the needs of individuals and groups. In Diffusion of Innovations it is not people who change, but the innovations themselves (Robinson, 2009).



The *innovation-decision process* is the process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision.

Fig. 2.1.2.1 A Model of Five Stages in the Innovation-Decision Process (Rogers, 2003)

However, in respect to adoption behaviour, Rogers (1983, p. 22) further states that "Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than the other members of a system." Accordingly, diffusion researchers describe a population by dividing them into five groups instead of using the term innovativeness, each defined by common characteristics and varying propensity towards technology adoption: Innovators, early adopters, early majority, late majority and laggards. Their distribution is highlighted in Figure 2.1.2.2. For this paper and resulting campaign, the focus lies on the first three groups of the technology adoption process to create critical mass: In the context of social theory, the term describes a sufficient number of adopters of an innovation in a social system so that the rate of adoption becomes self-sustaining and creates further growth.

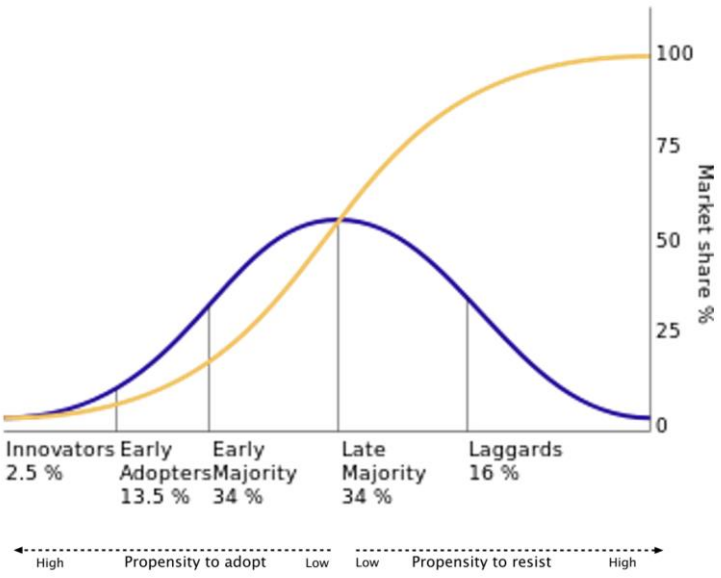


Fig. 2.1.2.2. Diffusion of Innovation adoption bell curve (Rogers, 2003)

Innovators are considered visionary and imaginative, willingly investing a lot of time, energy and commitment into new ideas and gadgets. They represent the first and smallest group of people to adopt a new technology and love to share their insights with other innovators (Rogers, 2003). However, Robinson (2009) summarizes that their one-eyed fixation on a new behaviour or gadget can make them seem dangerously idealistic to the pragmatic majority.

Robinson (2009) recaps that much like the innovators, early adopters have time and money to invest into a new venture, thus valuing risks lower. However, they are considered to make quick connections between clever innovations and their personal needs and differ in that they choose to adopt new technologies based on the hope to gain advantages over their peers. Early adopters are opinion leaders in their communities, having a strong effect on the latter groups, especially in regard to advice and information about the innovation (Rogers 1983). They are described to be particularly driven by social prestige; others watch to see whether they prosper or fail, and people start talking about the results. Additionally, early adopters like to talk about their successes (Rogers, as cited in Robinson, 2009). Concluding, he points out several suggestions for facilitating working conditions with early adopters:

- Offer strong face-to-face support for a limited number of early adopters to trial the new idea.
- Study the trials carefully to discover how to make the idea more convenient, low cost and marketable.
- Reward their egos e.g. with media coverage.
- Promote them as fashion leaders (beginning with the cultish end of the media market).
- Recruit and train some as peer educators.

• Maintain relationships with regular feedback. (p. 5)

The early majority contains approximately 34% of the population but is important surpassing critical mass. This is since the early majority vastly differs from both innovators and early adopters. Robinson (2009, p.5) writes, that they are cost sensitive and risk averse pragmatists, "[…] that are comfortable with moderately progressive ideas, but won't act without solid proof of benefits." He further summarizes Rogers (2003), saying that "they are looking for simple, proven, better ways of doing what they already do. They require guaranteed off-the-shelf performance, minimum disruption, minimum commitment of time, minimum learning, and either cost neutrality or rapid payback periods." Concluding, especially noteworthy and yet mostly disregarded in literature is the importance of cost as a factor for the successful campaigning and adopting of new technologies. Robinson (2009) summarizes the following guidelines for working with the early majority:

• Offer give-aways or competitions to stimulate buzz.

• Use mainstream advertising and media stories featuring endorsements from credible, respected, similar folks.

• Lower the entry cost and guarantee performance.

• Redesign to maximise ease and simplicity.

• Cut the red tape: simplify application forms and instructions.

• Provide strong customer service and support. (p.6)

2.1.3. Unified theory of acceptance and use of technology (UTAUT)

Venkatesh, Morris, Davis and Davis (2003) developed the UTAUT model following an empirically-based comparison of the eight dominant models, extracting similarities and subsequently theorizing four constructs, influenced by a set of key moderators that play a significant role as direct determinants of user acceptance and usage behaviour: performance expectancy, effort expectancy, social influence, and facilitating conditions.

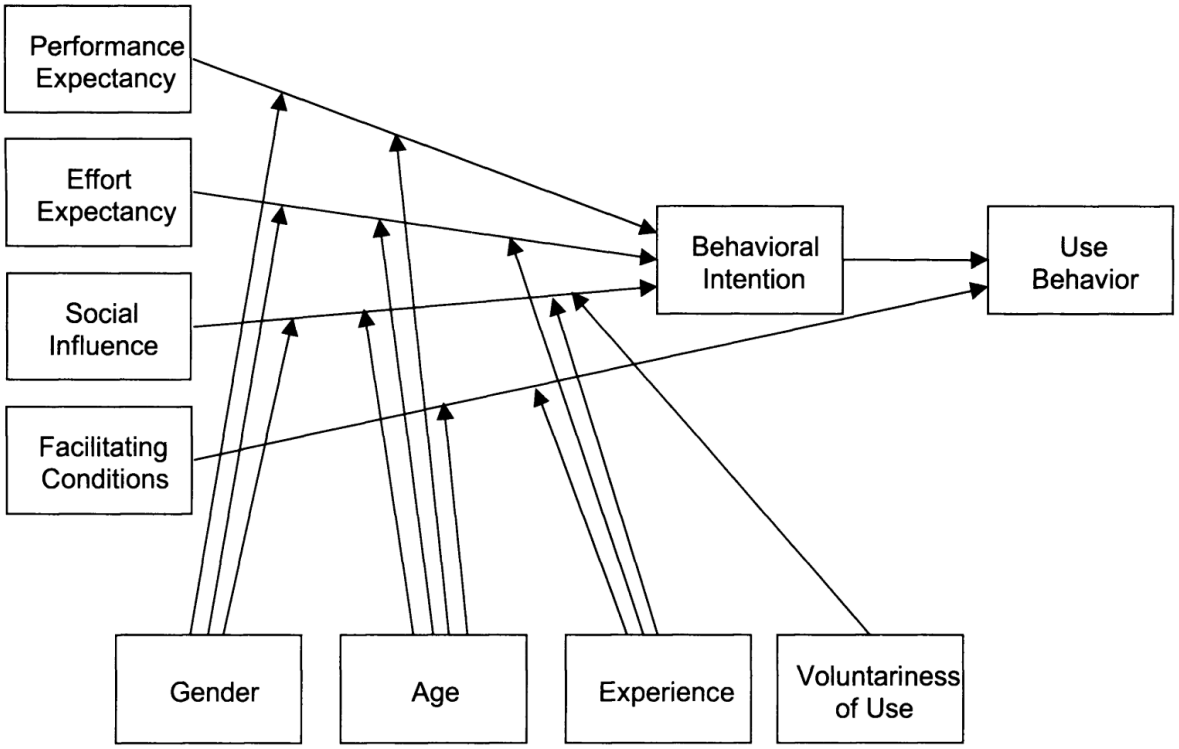


Fig. 2.1.3 Unified theory of acceptance and use of technology (Venkatesh et al., 2003)

Performance expectancy

Venkatesh et al. (2003, p.447) define performance expectancy "as the degree to which an individual believes that using the system will help him or her to attain gains in job performance" and pertains directly to the concepts such as perceived usefulness (TAM) amongst constructs coined in other models. They theorize that gender and age are the key moderating factors: Regarding gender, they state that males are highly task-oriented, while pointing out that gender schema theory suggests that such differences are not of biological nature but rather stem from gender roles and socialization processes (Bem 1981; Bem and Allen 1974; Kirchmeyer 1997; Lubinski et al. 1983; Lynott and McCandless 2000; Motowidlo 1982 as cited by Venkatesh et al. (2003). Regarding age, Hall and Mansfield (1975) suggest that in the context of job-related attitudes, younger workers may place more importance on extrinsic rewards.

Effort expectancy

Much like performance expectancy, this construct refers to the previously mentioned perceived ease of use as described in models such as TAM. Bem (as cited in Venkatesh et al., (2003, p.450), concludes that "the influence of effort expectancy on behavioural intention will be moderated by gender, age, and experience, such that the effect will be stronger for women, particularly younger women, and particularly at early stages of experience."

Social Influence

Social influence defines the degree to which an individual is affected by important others in using a new technology. Similarities can be drawn towards DOI in which the group of early adopters is found

to have an influence on the adoption process of people related to the early majority; however, Venkatesh et al. (2003) state that the individual's behaviour is influenced by the way in which they believe others will view them as a result of having used the technology. Its impact is measured through three mechanism: compliance, internalization, and identification (Venkatesh and Davis, 2000). Key moderators are gender, age, voluntariness, and experience such that the effect will be stronger for women (Miller, as cited in Venkatesh et al., 2003), particularly older women and particularly in mandatory settings in the early stages of experience (Morris and Venkatesh 2000).

Facilitating Conditions

"Facilitating conditions are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" (Venkatesh et al., 2003). While they show that facilitating conditions influence usage behaviour, the team concludes that there is no effect on usage intention, thus eliminating the importance of facilitating conditions for the purpose of this paper and the creation of a campaign.

2.2. State of the Art

The following chapter will highlight successful implementations of RWH across the globe with a focus on facilitating factors. Seeing how RWH share the closest relation to SRB, we can use research conducted on them to substitute the lack of scientific literature.

2.2.1. Germany

Ward (2010), identifying the leading countries in RWH implementation, states that Germany has been utilising RWH since the beginning of the early 1980s. Several factors such as compliance with the Urban Waste Water Treatment Directive by reducing combined sewer overflow releases (Butler and Ward as cited in Ward, 2010) have an effect on distribution. Nolde (2007) and Partzsch (2009) respectively, estimate that between 50,000 and 80,000 domestic systems are installed each year. Additionally, Ward summarizes that "Germany has an established standard (DIN 1989-1:2001-10), a contracting model (fig.2.2.1.2) and a building code entitled the German Sustainable Building Certificate (GSBC), which is administered by the German Sustainable Building Council (DGNB, as cited in Ward, 2010)." Moreover, Kellagher and Maneiro Franco (2005) point out that in some areas, subsidies are available for RWH systems: Hamburg endows up to 50% of the cost, while Bremen subsidises up to a third, or max. 2000€. Berlin's waterboard implemented a programme, aimed to provide monetary incentives for green roofs and sustainable drainage systems on private properties (Butler and Ward, as cited in Ward, 2010). Furthermore, Becker and Raasch (2001) state that the Emscher Region in North Rhine Westphalia is undertaking a large scale RWH infiltration project to tackle flooding, for which €4.5 million was provided for by the government. "The press reports regularly on the provisions implemented; various PR campaigns assist in disseminating the ideas – and the achievement – of longterm water management" (Becker and Raasch, 2001, p.162).

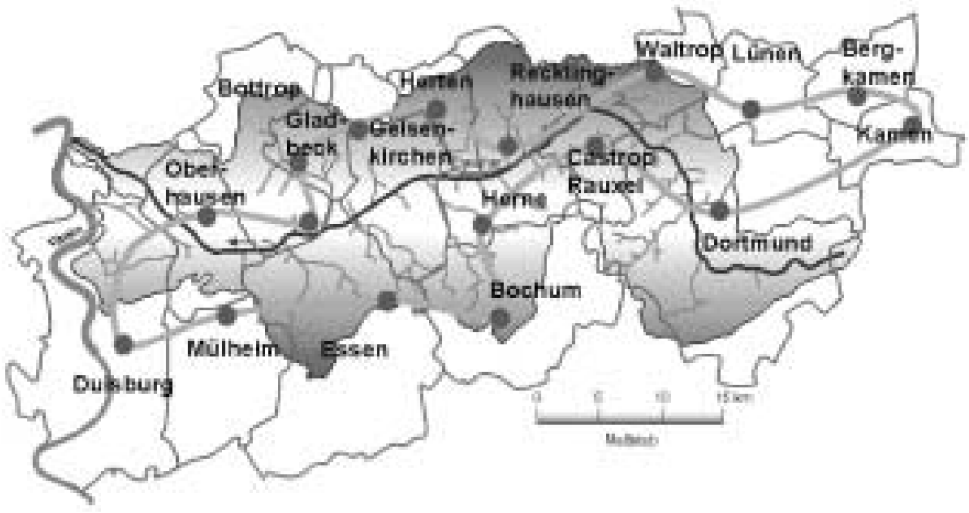


Fig. 2.2.1.1 The "rainwater route" (Becker and Raasch, 2001, p.165)

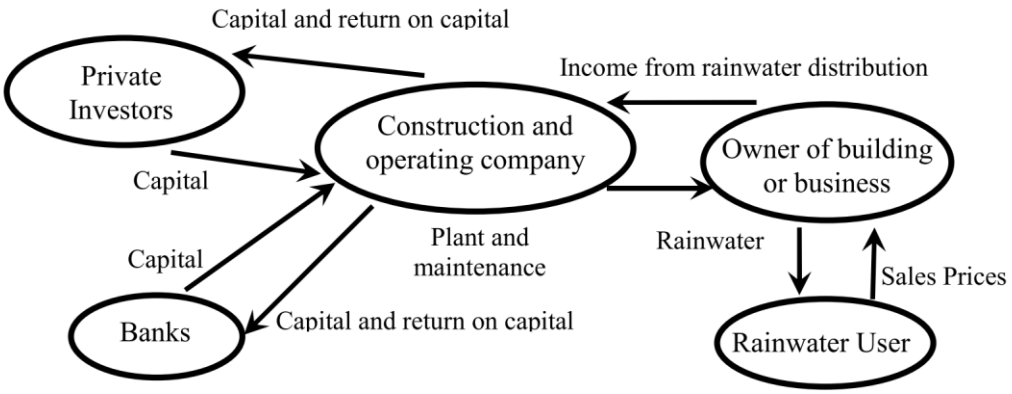


Fig. 2.2.1.2 RWH contracting model in Germany (Konig, as cited in Ward 2010)

Fig. 2.2.1.3 The official start of construction work on the "Hiberniaschule" project, in Herne (Becker and Raasch, 2001, p.162)

2.2.2. Japan

Yashima (as cited in Ward, 2010), Sakakibara (as cited in Ward, 2010) and Sugai (2009) all report on rainfall induced flooding of underground facilities and households in the Japanese cities Tokyo, Fukuoka and Kobe. In contrast De Graaf (2009) states that availability of water resources in Japan is a fifth of the world average due to a large proportion being lost during flooding events. Consequently, some municipalities in Japan have taken a combined approach to stormwater retention and reuse and have developed stormwater management plans that utilise both storm sewers and stormwater storage tanks receiving runoff from buildings (Ward, 2010) (Takeda, S., Tamada, A., Matsushima, O., Takase, Y., Miyahara, S., Miura, A., as cited in Ward, 2010) Yashima, as cited in Ward, 2010). Tokyo's Basic Policy for Intense Rainfall aims to create a flood resilient urban environment through individual, mutual and public action (Sugai, 2009). Murase, (as cited in Ward, 2010), mentions the Rainwater

Museum and the Rain Encyclopaedia as examples, run by passionate and dedicated local advocators of the practice who run campaigns for public awareness. Additionally, he mentions that the success of RWH in Japan is partially attributed to the creation of a network of municipalities, architects, manufacturers, plumbers and citizens, termed the 'Rain Network Japan'. Furthermore, corporate and income tax benefits, low interest loans and subsidies also exist for alternative water resource projects (De Graaf, 2009).

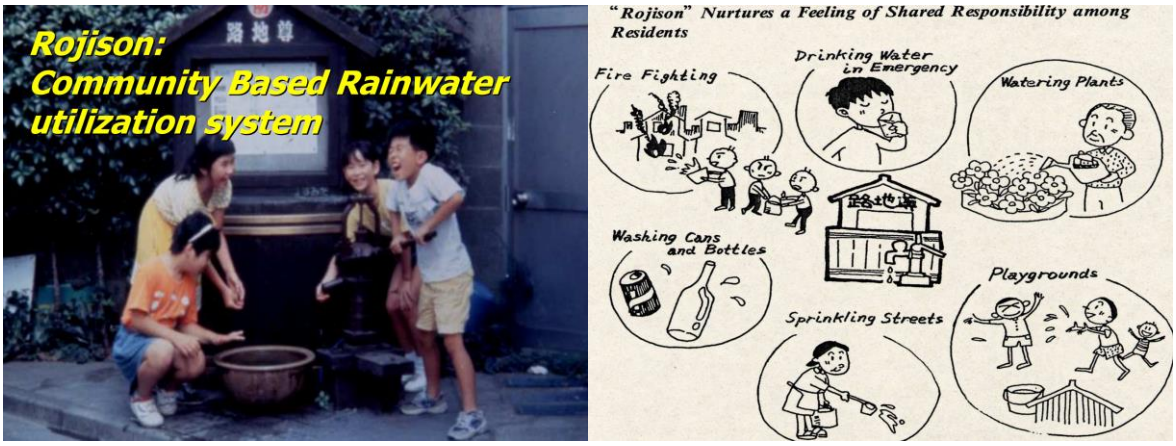


Fig. 2.2.2.1: Rojison sketches describing usefulness of community RWH (Murase, 2007)

Fig. 2.2.2.2: School Children learning about RWH (Murase, 2007)

2.2.3. Australia

Australia's drives for the implementation of RWH are based on low precipitation causing drought, unlike Germany and Japan, who mostly suffer from flooding induced damages to buildings and people. Ward (2010) writes, that "in 2004 the National Water Commission established the National Water Initiative in conjunction with the Council of Australia Governments" (NWC, 2009), aimed to encourage innovation in water supply, such as by using RWH and Greywater reuse to ensure the most effective combination of measures for water security (Marsden Jacob, 2007). On top of initialising a national Water Conservation and Reuse Research Program (Mitchell, as cited in Ward, 2010), installation of RWH has been made compulsory in some states. The National Rainwater and Greywater Initiative supports retrofitting RWH with subsidies; a fund of AUD $250 million, issued in 2009, allowed rebates

of AUD $500 for domestic installations while also providing guidance on the type of system to install and how to use it (DEWHA, as cited in Ward, 2010). A standard for installation entitled the National Rainwater Tank Design and Installation Handbook (NRTDIH) was published in 2006 (Standards Australia, as cited in Ward, 2010; Chapman et al., 2008). Lastly, Public awareness campaigns have been undertaken, such as that by the Smart Water Fund in the state of Victoria (Smart Water Fund, 2005), which took the following actions:

- Multimedia presentations
- School education packs
- Mass media advertising
- Radio campaigns
- Public exhibitions (generating a traffic of 290.000 people)

Key messages of the campaign were directed towards raising awareness of RWH for a range of uses other than just garden watering, its contribution to mains water consumption reduction and reduction of the impact of peak storm water events on sewers and that installation can be unobtrusive and cost-effective. It is estimated to have reached over 2 million residents by 2005 (Smart Water Fund, 2005)

While these successful campaigns can be used to ideate designs for a campaign in the Netherlands, Hofstede (1984) points out that differences between nations regarding their culture, may have an influence on their success. Based on his observations, the 3 countries shown here differ from another in multiple regards. However, comparing to the Netherlands, the biggest overlap in similarities can be found towards Germany, while Japan shows the highest deviations. This may indicate that a successful campaign working in Germany may have the same impact in the Netherlands. However, it is important to consider that his research is based on data from 1984 and is therefore outdated.

2.3. Conclusion

Several conclusions can be drawn from the social theory analysis as well as State of the Art, highlighting nations that successfully implemented RWH. In accordance with the goal of the literature review, the first two sub research questions predominantly aim at identifying and addressing individual factors that affect adoption behaviour while the State of the Art looks to identify examples for effective design implementations as stated in sub question 3.

2.3.1. Conclusion Social Theory

The UTAUT model shows, that three main factors are crucial for influencing behavioural intention which in turn leads to usage behaviour. Performance-, and Effort Expectancy as well as Social Influence. The first two factors can be effectively translated to perceived usefulness and perceived ease of use as encountered in TAM. Concluding, for possible campaigns and promotional efforts it is crucial to highlight use cases and functions of the system in order to satisfy possible users' expectations. Social influence on the other hand highlights the susceptibility of individuals towards

social pressure or more specifically how people influence and perceive each other's individual behaviour.

Furthermore, the Diffusion of Innovation theory is particularly crucial in this regard, considering that one group has an influence on the other. It also highlights a problematic issue: While innovators and early adopters share similar characteristics such as a tendency to downgrade risk factors, the early majority tends to prefer proven systems with low failure rate and characteristics such as low maintenance and low cost. Addressing these three groups simultaneously through promotional efforts is challenging.

Venkatesh et al., (2003) conclude that facilitating conditions, such as the implementation of support systems show to have no influence on behavioural intention and can thus be disregarded for the purpose of the campaign design. Additionally, Tunc (2018) conducted research into the development of DIY manual solutions and reported positive results for her two-way approach, using both written and video material.

2.3.2. Conclusion State of the Art

Summarizing the State of the Art of countries having implemented RWH, government regulation alongside subsidization play an essential role in the success of the endeavour. For this purpose, several funds, programmes and initiatives, subsidizing for example the retrofitting of systems into existing facilities have been implemented. Furthermore, public awareness campaigns are either dependent on passionate and dedicated local advocators, being knowledgeable in the field (Innovators, Early Adopters) or are initiated by groups that target channels such as multi & mass media, school education and public exhibitions. Again, the government's willingness to fund such endeavours is essential for their success.

3. Methods & Techniques

The following chapter describes the methods and techniques used during the graduation project connected to this thesis. The intention is to facilitate the development process and structuring of the accompanying report. The main method is the Creative Technology Design Process (CTDP) acting as a frame for the entire endeavour. Furthermore, user related methods facilitate and organize the acquisition of data and structure thereof.

3.1. *Creative Technology Design Process*

The Creative Technology Design Process as introduced by Mader and Eggink (2014) provides the product development framework necessary to answer the research question stated in the previous chapter. It was specifically developed for the study by the same name due to the overarching content taught in its curriculum, covering fields such as Information and Communication Technology, Engineering as well as Industrial, Interaction and Graphic Design. It aims to ground creativity and idea generation on lateral thinking techniques rather than “the kiss of the muse”. The goal of the process, consisting of the four phases *ideation, specification, realization* and *evaluation* is the structured development and subsequent analysis of a product prototype with and through the constant involvement of stakeholders in mind. Furthermore, at the core of each phase is an iterative approach supported by a combination of classical creative design models, such as divergence & convergence and the use of spiral models. A visual summary of the process can be found in figure 3.1. and the following paragraphs elaborate on the distinction between each phase and highlight the importance of user involvement.

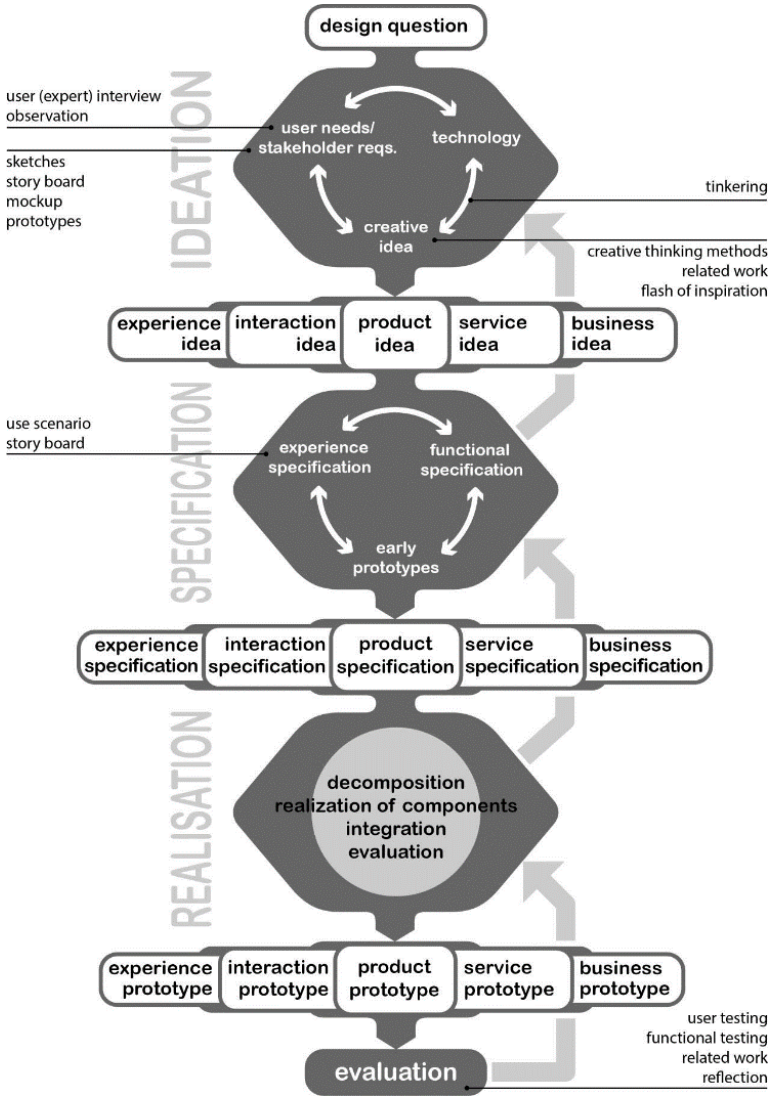


Fig. 3.1: The Create Technology Design Process (Mader and Eggink, 2014)

3.1.1. Ideation

The main goal for the first phase is the envisioning of a more elaborated project idea in accord to the stakeholder's preliminary requirements through the application of user centred design techniques. In User Centred Design, all "development proceeds with the user as the centre of focus" (Rubin and Chisnell, 2008). At the start is the design question, which may come "in form of a product idea, an order from a client, or a creative inspiration" (Mader and Eggink, 2014) and is rooted in the research question(s) that arose from the background research and State of the Art. After iteratively creating multiple lo-fi concept prototypes, using mock-ups, sketches, user scenarios or story boards, early ideas are then evaluated with the help of clients, experts and/or users. Conclusively, interviews help to determine needs, describe problems and provide requirements.

3.1.2. Specification

The specification phase aims to diverge the elaborated product idea, explore the design space and evaluate the interplay of functionality and user experience using prototypes. Said lo-fi prototypes may be elaborate enough to address the whole concept of the product or could alternatively only test the functionality of a single aspect. Unlike the Engineering Design approach, prototypes are quickly created, evaluated and conclusively either improved, merged or discarded. With user experience at the centre, the communication between designers and clients & users is paramount in this iterative approach and may even lead to new functional specifications between prototypes.

3.1.3. Realization

Once the product specification is given, the realization phase shifts to a more linear rather than an iterative approach for the creation of the final prototype. First, the product specification is decomposed into separate, manageable elements. Second, possibly using the method of divergence to find the best solution, these individual components are then realized and ultimately integrated and evaluated.

3.1.4. Evaluation

The goals of the evaluation phase are to verify the original requirements identified in the first phase by conducting a set of tests and ultimately to answer the research question(s). First, functional testing, though likely partially included during realization, is conducted to address the incorporation of the most important functional requirements of the prototype. Second, user testing is intended to verify whether the users' needs and a facilitation of the intended experience with the prototype are fulfilled. Concluding, a personal reflection of the graduation project process aims to explore the experiences in the decision-making process and turn implicit decisions into explicit ones, allowing for a clearer insight into the individuals thought process.

3.2. Stakeholder Identification Analysis

The correct identification and subsequent analysis of the stakeholders during a project are paramount to its failure or success. The term stakeholder can refer to an "individual, group, or organization, who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project" (PMBOK 2013, p.563). Furthermore, arguing that involving stakeholders is crucial to problem solving, Bryson (2004, p.23) concludes that "many individuals, groups and organizations are involved or affected or have some partial responsibility to act". The importance of the correct identification is further enforced when considering the level of influence each stakeholder has on the development and outcome of a project. Using the method by Sharp, H., Finkelstein, A., & Galal, G. (1999), stakeholders can be divided into four groups. In order to better classify their importance and subsequently extract an ordered list of their requirements, a stakeholder matrix can then be used to place them on both influence-, and interest-axis' (fig.: 3.2).

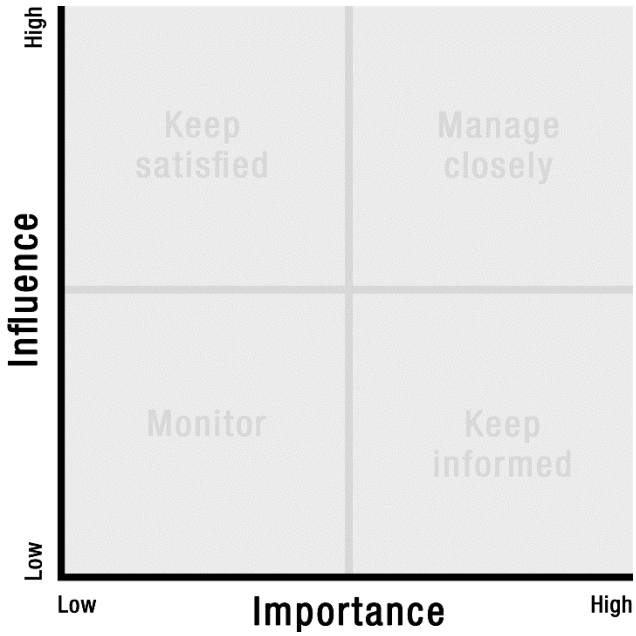


Fig. 3.2: A stakeholder matrix plotting "Importance" against "Influence"

3.3. Requirement Elicitation

Following the stakeholder identification and analysis comes the elicitation of requirements necessary to realize the envisioned project by adhering to the client's needs and wishes. These may differ or overlap between stakeholders; thus, the identification helps in prioritizing their demands. The requirements are obtained during the iterative process of interviewing the clients and creating storyboards which are evaluated with their help.

Stakeholder Interviews

For the duration of this project most of the information coming from interviews leading to requirements was conveyed during non-, and semi-structured interview sessions. Due to relative freedom regarding the approach for the development of the campaign concept, there was no need for structured interviews, focussing on answering questions aimed to extract specific details.

During semi-structured interviews, the interviewer refers to a prepared list of topics which are somewhat openly discussed with the interviewee; however, the interviewer loosely guides through the conversation, ensuring every important talking point is considered. This form of interview is less restricted than a structured one and allows the interviewee to express his thoughts. However, this concept may lead to the lack of detailed answers and is less beneficial when applied in large groups due to the wide range of responses.

A non-structured interview focuses on undiluted open discussion, which may lead to otherwise unconsidered topics. However, it may also lead to the diversion from the important topics entirely; i.e. the extraction of requirements. This interview is likely most efficient in a 1on1 interview situation.

The decision for semi-, and non-structured interviewing methods adheres to the unrestricted approach to the development of the campaign. Without a pre-conceived campaign concept in place,

the preliminary restrictions and requirements coined by the stakeholders do not entail content related remarks and allow for the exploration of a wider range of possibilities for the envisioned campaign concept.

3.4. Requirement Categorisation

Following the acquisition of requirements, they are separated into two groups, functional and non-functional requirements. This is done to facilitate the design process and evaluate stakeholder requirements. Functional requirements are relatively easy to verify, since they describe what a product should do, whereas non-functional requirements address how a product performs a certain function, which is a less palpable aspect, not to be simply answered with “yes” or “no”.

Following the separation of requirements into functional and non-functional requirements, the MoSCoW method, as introduced by Clegg and Barker (1994), is used to categorize and order them in a list by their priority further facilitating the development process. MoSCoW is an abbreviation for the four types by magnitude of importance: Must, Should, Could, Would. “Must” contains requirements that are necessary for the project to succeed. “Should” entails requirements that are favourable over others, yet don’t jeopardize the success if not implemented. “Could” describes requirements that could be nice to have yet shouldn’t be implemented if preventing “Must” or “Should” requirements. Lastly, “Would” (have) or sometimes referred to as “Won’t” (have) requirements are out of the scope of the project and not to be implemented.

3.5. User Scenario & PACT Analysis

Scenarios are created during the specification phase. The intention is to envision realistic use cases for the envisioned product with the user in mind. The goal is to align the design of the product with the user’s needs and wishes. The PACT framework is a design tool aimed to understand the user’s perspective by analysing with whom, what and where a user interacts with a product/solution (Benyon, D., Macaulay, C., 2002). PACT stands for “People”, “Activities”, “Context” and “Technology”, whereas each part is systemically represented in a scenario. The “user” and “people” as referred to in the scenario and PACT analysis respectively, refer to the main stakeholder, the municipality.

People: Describes the user in regard to their skills, physical and cognitive characteristics

Activities: Describes the user’s actions and frequencies thereof, their goals and tasks.

Context: Describes the physical and social environment of the scenario

Technology: Tools such as devices and interfaces thereof used.

The goal of the scenario is to elicit requirements and discover interesting insights by placing the user (municipality) into a fictious situation that is supposed to resemble the intended usage of the product as close as possible. Using PACT, the fidelity of the context and situation may be approached to a plausible degree.

4. Ideation

The ideation phase is aimed to develop a project idea and gather requirements for the product from the stakeholders involved in the development. Due to the involvement of several stakeholders, an analysis, differentiating them by their importance, is executed first. It is intended to describe, categorize and identify stakeholders based on power and interest. Then a first round of interviews and early visualization concepts follows, aimed to extract preliminary requirements.

4.1. *Stakeholder Identification Analysis*

As part of the analysis the main stakeholders need to be identified and listed. Seeing as the product (SRB), which lead to the development of a campaign, is a joint effort between three parties, they form the basis for the analysis: The municipality (consisting of three sub groups), waterboard and University of Twente. They are represented by individual people and each group comes with their own motivations and needs regarding the final product. While the citizens of Enschede are the target group for the campaign, their inclusion during this phase has been disregarded, particularly because the municipality acts as a proxy to their needs and wishes. It is essential to treat and evaluate the stakeholders on a basis such that it facilitates the decision-making process during production. A resulting prioritization is crucial for example in case of contradicting needs between stakeholders. Table 4.1. summarizes the stakeholders, their importance and briefly mentions relevant individuals whereas figure 4.1.3. plots the stakeholders on a matrix focussing on importance vs influence.

Stakeholder	Contact Person	Role	Participation
Municipality of Enschede	Hendrik-Jan Teekens	Decision-Maker	Manage closely
University of Twente	Richard Bults & Kasia Zalewska	Decision-Maker	Manage closely
Waterboard Vechtstromen	Jeroen Buitenweg	Consultant & Sponsor	Monitor

Table 4.1.: Stakeholder analysis list

4.1.1. Municipality of Enschede – Hendrik-Jan Teekens

Looking at the influence-importance matrix, the municipality of Enschede represents the main client for the project and is thus regarded as a main decision-maker. The highest placement on both power and importance is further justified seeing as they are actively investing funds into in the idea for the campaign. The motivation and support for the Smart Rainwater Buffer development project is a continuous effort in collaboration with the University of Twente over multiple iterations and stems from the increasing and cost-intensive rainwater related damages to buildings and persons throughout the city. Requirements by the municipality are summarized into one set; however, given the crucial involvement during each phase, this stakeholder is decomposed into four groups, each representing a field focusing on specific requirements: Policy developers, policy executives, communications staff and water specialists. The main representative of the municipality is the water landscape designer Hendrik-Jan Teekens, who formerly worked with the Waterboard Vechtstromen and is now responsible for a multitude of water management related projects throughout Enschede.

4.1.2. Waterboard Vechtstromen – Jeroen Buitenweg

The waterboard Vechtstromen is a consultant and sponsor for the project and collaborates with the municipality on issues regarding the sewer system. They are represented by Jeroen Buitenweg, who is ensuring the functionality of the sewer system and climate in Enschede in collaboration with the municipality. They mostly share the same requirements for the production of the campaign as the municipality and hope to raise awareness for the unique situation Enschede faces geographically, which in turn cause many of the water management related issues.

4.1.3. University of Twente – Richard Bults & Kasia Zalewska

The University of Twente represents another decision-maker but unlike the municipality and waterboard, they do not represent a client for the campaign project. However, the critical observer of this graduation project, Richard Bults, also acts as a mediator between the municipality and the SRB project. His continued involvement in SRB related projects at the UT provides much expertise. Additionally, Kasia Zalewska in her role as supervisor ensures university-based requirements are met. Together they share their opinions towards the other clients and provide useful feedback throughout the development process.

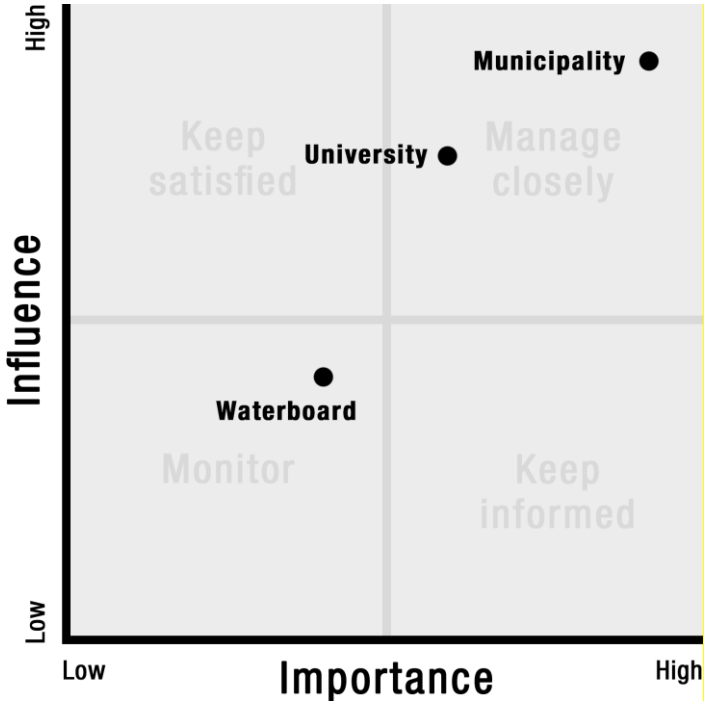


Figure 4.1.3: Stakeholder analysis matrix

4.2. Requirement Elicitation

Following the identification and analysis of stakeholders, the next step consists of the elicitation of preliminary requirements. This is achieved by holding interviews with the aforementioned stakeholders to gather insights on their wishes while also using the opportunity to present first concepts.

4.2.1. Interviews

Throughout the Ideation phase, multiple rounds of stakeholder interviews have been conducted in order to elicit the requirements for the SRB campaign, subsequently leading to a clearer idea regarding needs of the concept. Specifically, during the ideation phase, interviews with the university stakeholders, which also acted as mediators to the municipality and waterboard, were conducted in a semi-structured fashion in order to retrieve information about the campaign requirements. An essential part during this first phase, backed up by research into comparable international projects, was to convey the factors of user adoption of rainwater buffering systems to the municipality in order to ensure the address of user needs in the campaign would be actively facilitated by the decision-makers, generating requirements. Conclusively, a list of preliminary requirements for the campaign was conceived, with the municipalities' focus being the addressing of the largest number of inhabitants possible, while remaining neutral regarding sociodemographic differences in the population and the creation of promises in regard to what the SRB is capable of (flood prevention, tax cuts etc). Additionally, conveying the message of community activism was considered favourable. Last, with research implying the importance of cost communication, there must be an inclusion of this matter as well.

A crucial request that would help with idea generation during the ideation phase was mentioned and approved during the early stages of interviews with the stakeholder: The name Smart Rainwater Buffer at this point was only a placeholder intended to be the working title for project work. In order to give the product a marketable identity it was concluded to rebrand the product, including the creation of a new name and accompanying logo.

4.2.2. Preliminary Campaign Concepts

Earliest ideas for the campaign include a distinction between physical and digital concepts, whereas some include aspects from both realms. These were presented to the university as stakeholder and mediator to the opinions of the municipality.

Website

Creating a website was one of the initial ideas for the campaign as it can not only be used as a landing page containing information about SRB acquisition but also for educational purposes regarding water consumption, flooding, drought and use case scenarios. Aside from this, the inclusion of a user forum would also facilitate the growth of a community, spreading awareness of the product and topic. Visualization examples of the concept are compiled in Figure 4.2.2a.

Figure 4.2.2a: Website campaign concept

Virtual and/or Augmented Reality Experience

Using VR and/or AR, it would be possible to convey the message of flood prevention and its consequences. Possible applications are explored in figure 4.2.2b. Creating an environment in which the user could experience and control the effects of flooding, raises awareness, especially when including visualizations conveying damage related costs. However, due to the rather negative message, the focus on the experience shifts towards manipulation through fear and was therefore quickly abandoned. Additionally, VR is expensive and cannot be experienced by many people at a time.

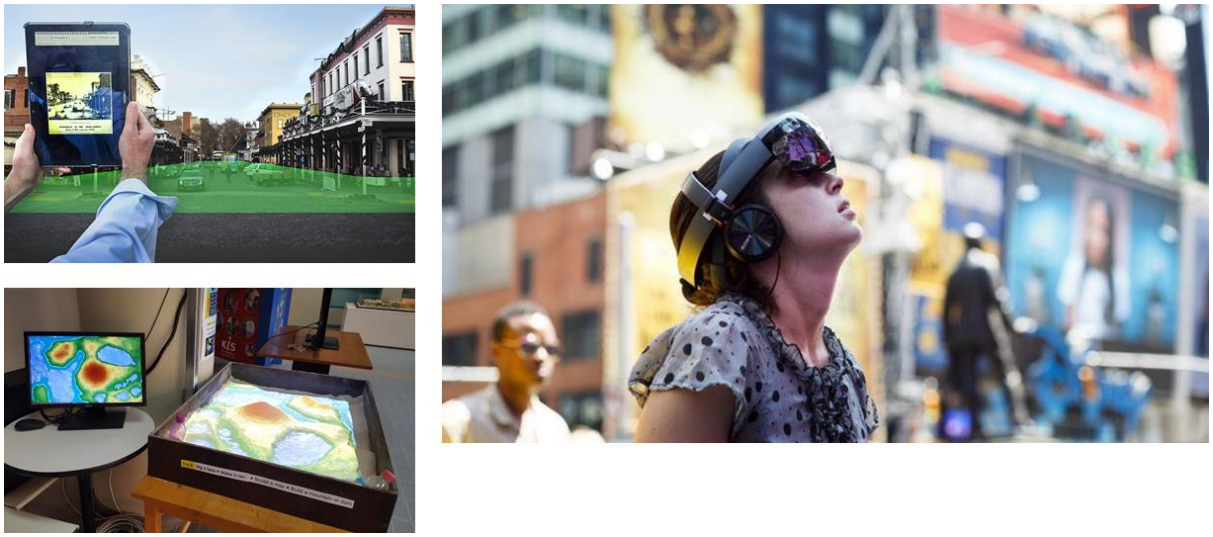


Figure 4.2.2b: Virtual Reality campaign concept

Animation

Given the popularity of YouTube, publishing an animation would not only allow to reach vast amounts of people with relative ease but also gives relative freedom regarding the storytelling involved (inclusion of educational material such as history etc). Additionally, an animation has a wide range of applicable styles allowing to create a unique visual. Furthermore, an animation is favourable due its entertaining value, relative simplicity and popularity with younger generations; further expanding outreach. An excerpt to an animation is shown in figure 4.2.2c.

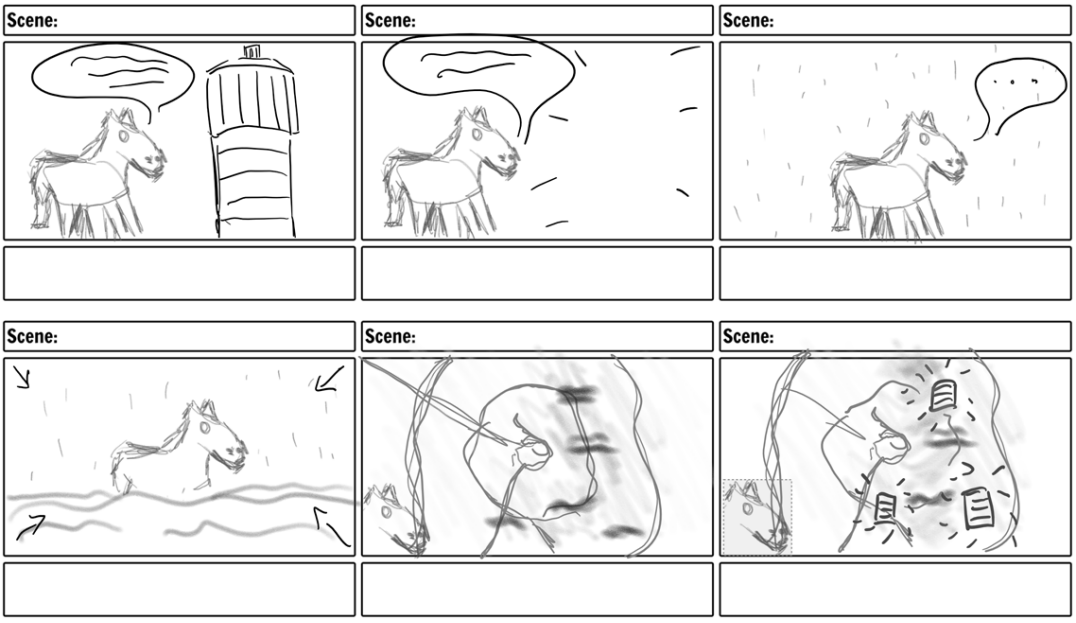


Figure 4.2.2c: Animation campaign concept

Exhibitions

Physical installations using SRBs in so called hot spot areas or during neighbourhood gatherings would allow the inhabitants to get up close and experience the product and its functions for themselves. Providing informational material (posters, pamphlets), an eye-catching design or even dedicated events (local artists using it as canvas) would gather the attention of people. However, such promotional events require the attendance of many people and are thus dependent on factors such as weather and temperature. Figure 4.2.2d shows an exhibition example and enticing designs related to water management.

Figure 4.2.2d: Exhibition campaign concept

4.2.2.1. Preliminary Campaign Concept Conclusion

The results of this first round of concepts was that the campaign would benefit most from an animation, given the many benefits from addressing the user base over the internet and through audio visual media. The stakeholders agree, that many of the preliminary requirements can be addressed with the visual medium, while addressing the most amount of people in a neutral fashion is regarded the driving factor.

4.2.3. Preliminary Visualization Concepts

In order to explore the possibilities of the visualization concept further, a set of different stories was then developed and presented to the stakeholders. Initially there was not a restriction as to the content that needed to be included, apart from the initial needs and wishes set by the stakeholders and a time restriction put into place to prevent loss of attention within the user base. Referring to prior research on cognitive load theory, stakeholders decided that three minutes were considered ideal not to stress the boundaries of the general attention span when conveying information (Mayer, R. E., Moreno, R., 2003). In order to not overload each animation concept with information, three distinct scenarios with their own themes were created: “What is in it for me?”, “What is in it for the community?” and What is in it for the municipality?”

In order to communicate the visualization ideas to the stakeholders, lo-fi storyboards were created, that, without the usage of detailed information, such as a script, represented a great opportunity to convey an idea and start a dialogue about the importance of content. The focus lay on the qualitative information each concept represents and the goal was to extract the most important aspects that needed to be communicated with each story. In the end one main concept remained that could then be refined by combining or merging it with (fragments of) the other stories.

4.2.3.1. "Me" Scenario

The first storyline (figure 4.2.3.1) focuses entirely on conveying what the acquisition of an SRB would mean for the individual, particularly financial gain, as well as scenarios regarding water retention and water usage ("What's in it for me?"). It put two neighbours central to the storyline, that get into a discussion about their water consumption, leading to an explanation about the historical usage of water towers in the city. This is concluded by showing the SRB, which is introduced by drawing comparisons to the water tower. Lastly, following examples of utilization, details about some sort of subsidization through the municipality are given.

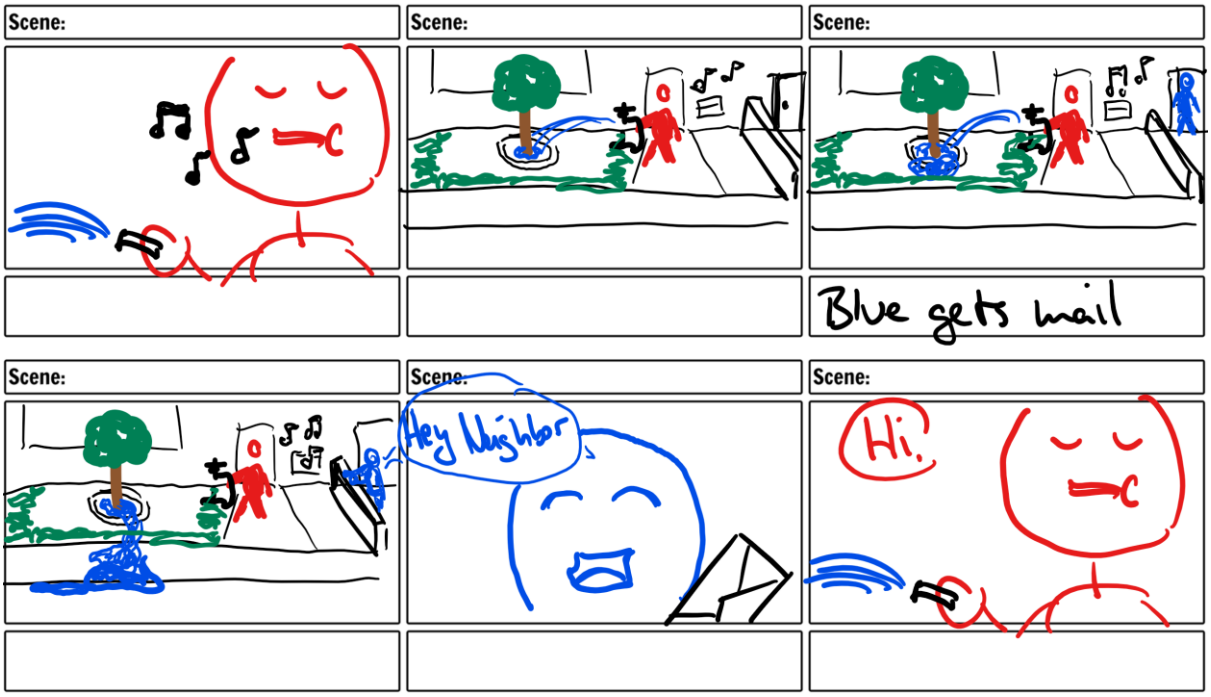


Figure 4.2.3.1: Excerpt from the "Me" Scenario

4.2.3.2. "Community" Scenario

The community storyline (figure 4.2.3.2) focuses on neighbourhoods, that share public space as a garden, where not everyone would benefit from the acquisition of a Smart Rainwater Buffering system. Here, the SRB is used to convey the idea that water is a shared resource and that in the same sense a garden can be treated the equally. People would come and work together on a flourishing vegetable and flour garden.

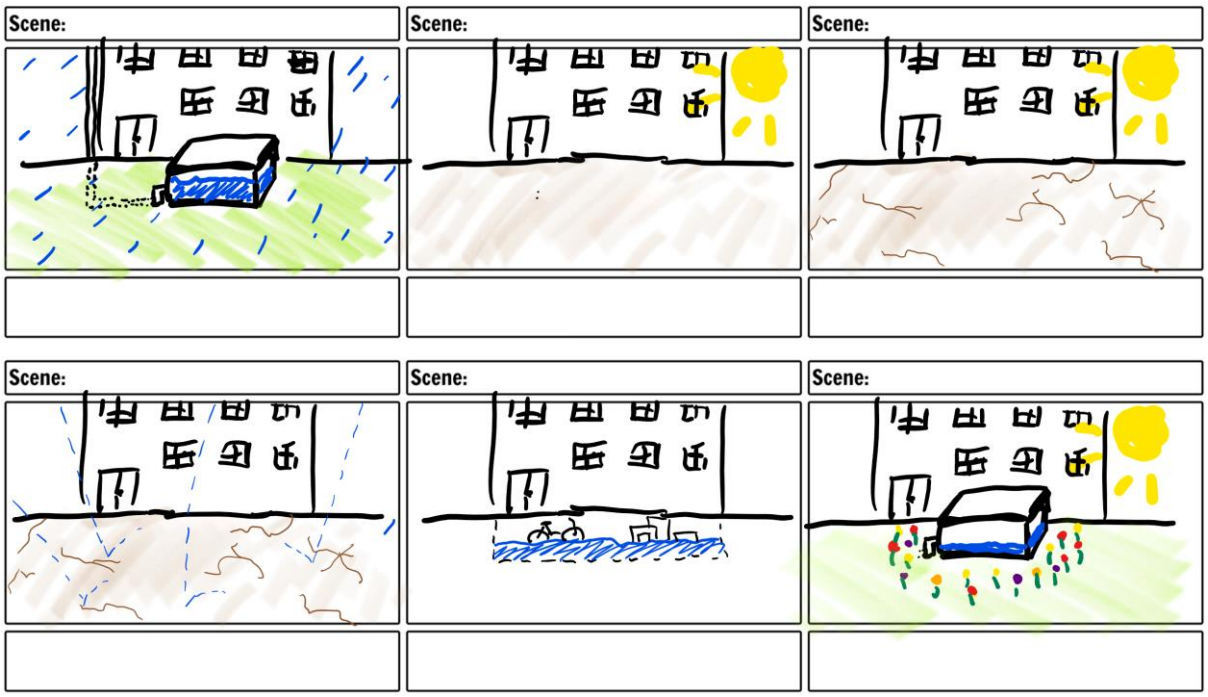


Figure 4.2.3.2: Excerpt from the "Community" Scenario

4.2.3.3. "Municipality" Scenario

The municipality story (figure 4.2.3.3) aims to communicate the efforts the municipality has and continues to put into water management projects. It is created to represent a very contemporary and popular approach to storytelling: superheroes. The municipality is represented by a hero, in an eternal struggle against the villain, climate change, who is causing severe weather conditions, subsequently causing flooding. In an attempt to tackle the villain, several projects would be quickly introduced to the viewer; however, climate change prevails, and the hero is seen failing. At this point, people, representing the inhabitants of Enschede gather to aid the hero and the concept of the SRB is introduced.

Figure 4.2.3.3: Excerpt from the "Municipality" Scenario

4.2.3.4. Preliminary Visualization Concept Conclusion

The ensuing discussion from the presentation of the three storyboards led to import insights about what the animation needs to be focusing on. Even though communicating the importance of creating the sense of community within the viewers was a favoured endeavour, it was too likely to sound "preachy", something that needed to be avoided, considering the less interested group of adopters, the early majority. For this reason, the stakeholders decided to shift the focus on what the individual can get from adopting the product first, followed by the implication that a community effort has additional benefits. Second, educating about and creating a connection to water towers was restated as useful, making the animation more personal and creating a sense of relatability to the viewer. Concluding, the "(What's in it for) Me" scenario was considered the most promising animation and to be further iterated.

4.3. PACT Analysis & Scenario

According to the framework introduced in chapter three a user scenario based on the PACT analysis is created to better align product design with user needs and wishes. It is based on the visualization concept conveying information about the SRB targeted at individuals while also including educational material about water towers. While the campaign will ultimately reach citizens of Enschede, the municipality entails a role as "proxies" to the end user in the following scenario; their needs and wishes are communicated through the municipality representatives as stakeholder.

PACT

People: A spokesperson of the municipality who, together with a dedicated team create educational material to be presented during a neighbourhood gathering.

Activities: Participates in an informational event organized by the municipality and waterboard with the goal to teach about more sustainable water usage. The goal is to influence citizens' behaviour and preferably encourage them to acquire an SRB and share their knowledge to their friends and families.

Context: Townhall with beamer.

Technology: Internet connected laptop or multi-media presentation with incorporated animation video

Scenario

Anna is a representative employee by the municipality and works together in collaboration with the waterboard Vechtstromen on several projects, promoting sustainable water usage to the inhabitants of Enschede. She has already worked on several projects before and thus has a lot of experience on the topic. Following the recent development of a DIY Smart Rainwater Buffering system in collaboration with the university, intended to be deployed in household gardens, the municipality has asked to create a neighbourhood campaign to convey the message of usefulness to the inhabitants of the city, without enforcing it as an agenda, nor discriminating between age or socio-economic status. Anna enjoys the idea of explaining the topic to a broad range of people, using simplistic animations as visual medium, seeing how it conveys complex processes and information in a fun and enticing way.

She arrives at the neighbourhood gathering and is welcomed by one of the more dedicated and active neighbours, Niek. She sets up her presentation by plugging her laptop into a beamer and awaits the arrival of more participants. After the people have settled down, she introduces herself to the people and shortly after starts her presentation by telling them a story related to water management at home. She then continues to tell them about her job with the municipality and projects they have been conducting in order to tackle the geographical problems that make water management especially in Enschede so difficult, while being specific about the neighbourhood they're currently in. She then says that the municipality is trying a lot but is not capable of solving the issues by itself and concludes that it is very important that everyone is more conscious where the water problems arise and how to use it more efficiently. She continues by saying that their newest project may hopefully help to raise awareness within all people of Enschede even looking further into the future. Lastly, her presentation slides show the animation, which she starts.

It starts in a fun way by showing a sunbathing ladybug on a hot summers day that gets surprised by sudden rain. It then turns out to be a garden hose wielded by a person watering the flowers. The focus shifts now onto the person (A) in his front yard, who shortly after gets interrupted by his neighbour (B) inviting him to a beverage at his place. He refuses and while the water is still running, a conversation about the mail ensues that regards the sewer tax bill. The neighbour proudly announces the low amount he has to pay, which causes the person with the hose to ask how he has to pay so

much less than him. An explanation about the water towers in Enschede follows, only to be interrupted by A, wondering what this has to do with the tax. B then goes on to explain the concept and use cases of the SRB and its connection to what the water towers used to represent in the city. B closes by explaining the importance of the project to the municipality by mentioning a form of subsidization early adopters can bestow upon friends and family. This causes A to close the tap and shyly reconsider the invitation to the beverage at B's place.

Following the presentation of the animation, Anna goes on to talk about the capabilities of the SRB by given some relatable examples (outside cleaning, watering potted plants etc) and goes on by answering questions from the audience. Lastly, she concludes by explaining how they can find the video on YouTube and to show it to their friends and children, whom she encourages to write comments and leave "likes".

4.4. Preliminary Ideation Requirements

With the initial round of stakeholder interviews and campaign concept presentations, a preliminary list of functional and non-functional requirements has been created. Following the focus on animations and the further exploration of visualization concepts and their subsequent discussion, these requirements have been tested and updated accordingly. Using the MoSCoW technique, the current lists of requirements (figure 4.4a & 4.4b) has been prioritized and is finalized during the specification phase.

MoSCoW	Preliminary Functional Requirements
Must	Voice-Over in Dutch language
Must	Make no promises about flood prevention
Must	Only one message per video
Must	Use some sort of animation
Should	Mention some form of subsidization
Should	Credit scene with stakeholder Logos
Should	Be Educational
Should	Contain SFX for immersion & dramatic effect (Water, Summer etc)

Table 4.4a: Preliminary Functional Requirements

MoSCoW	Preliminary Non-Functional Requirements
Must	Mustn't be too long
Must	Do not discriminate between users based on social status
Must	Storytelling must be neutral
Should	Rebrand SRB and include new name & logo
Should	Dialogues & expressions should be funny
Should	Address sense of community: incentives
Could	Contain a mix of realistic images and animation styles (Real water tower transitioning animation)
Could	Visual style: Paper or felt texture on all assets
Won't	Mostly contain smooth animations

Table 4.4b: Preliminary Non-functional Requirements

5. Specification

The goal of this chapter is to further elaborate on the final concept of the product idea by creating a set of prototypes supported by a storyboard aimed to further explore functional and experience specifications through small feedback and evaluation loops. First, the process for finalizing the storyline based on the requirements is elaborated on. Then the storyboard is created as a visual representation for the storyline, additionally adding remarks that indicate the usage and placements of sound effects and voice-over for dramatic purposes. At the end of this chapter, based on the evaluations by the stakeholders on the continuously updated prototype, the previously enumerated functional and non-functional requirements are refined to their final state by adhering to the clients' additional inputs and remarks. Consequently, the process of creating a lo-fi animation prototype based on the combined storyline and storyboard is explored. Based on stakeholder feedback, it is then refined and changed until requirements and animation are coordinated accordingly.

5.1. Storyline

As discussed in the previous section 4.2.3.1, the storyline answering the message "What's in it for me?", focussing on the requirements entailing information targeted at the individual and the gains for acquiring a Smart Rainwater Buffering system was selected for the animation: Making water cost, subsidization through the municipality and use cases for retained water the most crucial requirements to be included. While there were no requirements on the exact progression of the storyline, cost and subsidization were given highest priority and were therefore placed at the beginning and end of the story respectively, making water cost the problem, and subsidization part of the solution (aside the SRB itself). To stress this message further, the protagonists themselves represented both problem and solution respectively reflected in their behaviour and actions. Additionally, another preliminary requirement was the implementation of an educational aspect. Combined with the opportunity to rebrand the Smart Rainwater Buffer, as was confirmed during early Interviews (4.2.1), an aspect of the storyline addresses antiquated water towers and their historical usage. Conclusively, "De Regentoren" was envisioned as a new name for the Smart Rainwater Buffering system, using water towers as a namesake while conveying the idea of water retention. Following the explanation about water towers, use cases for retained water are explored after introducing the Smart Rainwater Buffer as the solution to the reduction of water cost. Having the most crucial components of the story envisioned allowed for the creation of an introduction. This was unrelated to the preliminary requirements yet served a purpose by visualizing excessive water consumption/usage and its effects on nature. Given the visual deficiency of the storyline limited the stakeholder feedback to remarks about requirement communication. Comparing the neighbours was to be approached carefully: While they may differ regarding SRB ownership, they should not be distinguished based on their socio-economic status. An approximation of the storyline contents are seen in figure 5.1.

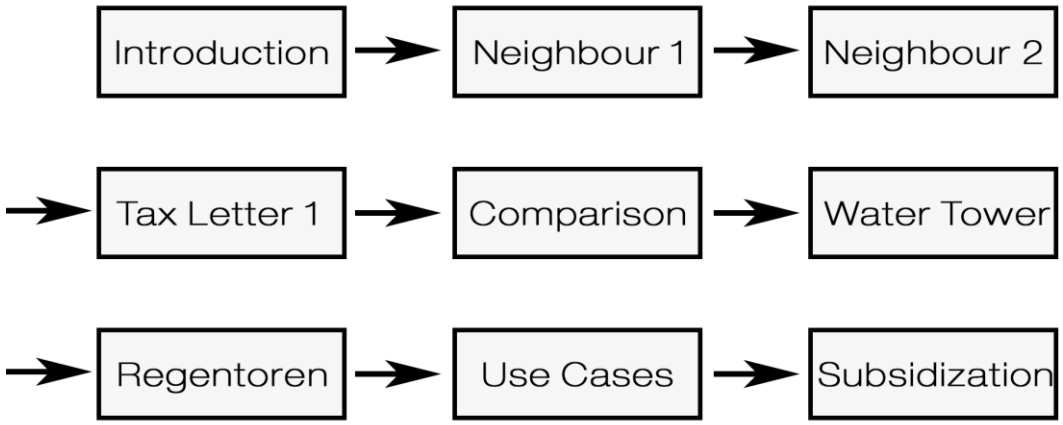


Figure 5.1: Storyline Components

5.2. Storyboard

With the implementation and verification of requirements into the final storyline, a final version of the storyboard was made, however, due to the interconnected influence between story and visuals (storyline and storyboard), several changes were made in an iterative fashion, further refining the storyline in the process.

The storyboard was created by using simplified drawings in square panels representing a simplified visualization style for the animation while encapsulating the storyline. By including bits of text under each panel, additional information was conveyed to the viewer. Such information included description of scenes, inclusion of sound effects, ideas for the movement of the camera for dramatic purposes and simplified versions of dialogue script in order to facilitate understandability. An excerpt of the storyboard can be seen in Figure 5.2, while the entire storyboard can be viewed in Appendix D. Having the storyboard in place helped to distinguish subsections of the storyline as self-contained parts, making it possible to test their structural integrity regarding the storyline. The “visual placement” of the storyline was influenced by the nature of the SRB, being an “outside product” and requirements such as prevention of communicating social discrimination. The protagonists meet outside in their respective gardens on a sunny day, not only conveying a positive mood but also giving the opportunity to justify the implementation of water usage in the animation, implying the topic (water & its cost) of the conversation. Last, as previously mentioned, the storyboard also contains early stage ideas for the selection and placement of sound effects and voice-over content facilitating the workflow going into lo-fi prototype creation followed by the final realization. Evaluating the storyboard with the stakeholders helped clarify requirements and allowed to test visual concepts not communicated solely through the storyline. The protagonists’ expressions were regarded as specifically important since they convey emotional responses to crucial points such as taxation and subsidization. Additionally, ideas for transitions between “De Regentoren” and water towers, conveying a “replacement” of one with the other in the city’s landscape, received valuable feedback and led to iterations in how they appear and disappear.

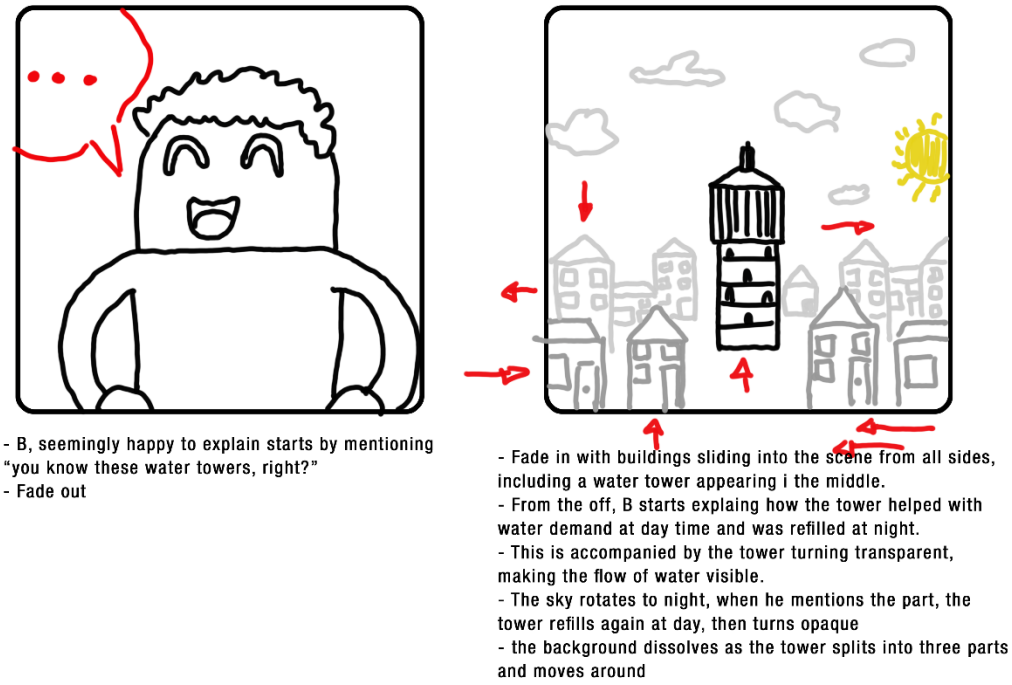


Figure 5.2: Excerpt from the final storyboard

5.3. Lo-Fi Prototype

A lo-fi prototype is an imperfect and incomplete low-cost version of the target product, that contains some characteristics of the final version but is otherwise simplified. Its intention is to be quickly produced, tested, evaluated and eventually discarded or improved upon. Regarding an animation, the simplicity is intended to be reflected by a lack of detail, however it still contains the relevant information, such as storyline and requirements and thus allows for it to be evaluated on general feasibility.

Due to a higher focus on iteration during the campaign concept, storyline and storyboard creation, the development of the animation required to be progressing at a faster pace, leading to the decision to overgo lo-fi versions and create hi-fi assets and early stage animations in order to alleviate the workload during the Realization phase of the project. This meant that many aspects discussed in the following chapter 6, such as the selection of tools and the general process were already explored. Visuals aside, the prototype lacked fidelity regarding audio. Both voice-over and sound effects were either poorly recorded without much focus on accentuation and placement or lacked entirely. A still from the early prototype is shown in Figure 5.3.

During evaluation, the stakeholders were highly satisfied with the progression; feedback included suggestions for the changing of use cases. The first iteration consisted of a set of four cases: Drinkable water for pets, washing the car, watering plants and flushing the toilet. Besides watering plants, the others were omitted. Washing the car is against the law, flushing the toilet is problematic since it most likely requires mixing grey with clean water pipes and feeding pets was not applicable enough.

Consequently, the new set focused on cleaning and thus replaced cars with bikes, mouldy tiles, and windows. Lastly, feedback also regarded slow pacing and suggestions included a subsequent reduction in lenght

Figure 5.3: Still from the lo-fi prototype

5.4. Final Functional & Non-Functional Requirements

Following the final evaluations of storyline, storyboards and lo-fi prototypes, again using the MoSCoW technique to create a prioritized order within the list, a definitive version of functional and non-functional requirements is conceived, facilitating the realization of the animation during the upcoming phase (Figures 5.3a & 5.3b).

MoSCoW	**Functional Requirements**
Must	Final Version in English
Must	No longer than 3 minutes
Must	Include use case scenarios that are not against regional and national legislation (ie. washing the car)
Must	Include comparison of sewer tax letter
Must	Include spoken text (Voice-over)
Must	Storytelling must be neutral and refrain from including ideologies such as political party affiliation
Must	Make no promises about flood prevention

Must	Only one message
Should	Use cartoonesque 2D animations
Should	Mention some form of “De Regentoren” subsidization
Should	Credit scene with stakeholder Logos
Should	Communicate water tower “revival” through SRB usage (Community incentive)
Should	Contain educational material but kept simple
Should	Contain SFX for immersion & dramatic effect (Water, Summer etc)
Should	Rebrand SRB and include new name & logo

Table 5.3a: Functional Requirements

MoSCoW	**Non-Functional Requirements**
Must	Storytelling must not discriminate between users based on social status
Should	Dialogues & expressions should be funny
Could	Type of look: Paper or felt on all assets
Won’t	Contain a mix of realistic images and animation styles (Real water tower transitioning to cartoonesque animation)
Won’t	Mostly contain smooth animations

Table 5.3b: Non-Functional Requirements

6. Realization

During the realization phase, the insights, requirements and ideas gathered about the envisioned product during the previous chapters are all summarized and incorporated in a final prototype that is subsequently used for an evaluation by the most important/influential stakeholders. To achieve this, the necessary tools for the creation of the animation are first determined. Secondly, the visualization concept is decomposed into manageable parts, facilitating the realization process. Lastly, the individual components will be incorporated in the final design.

6.1. Tools

In order to ensure the creation of a satisfying product that covers the acquired requirements it is essential to determine the right tools for the task. Considering the visualization is aimed to be created on a computer, the term "tools" refers entirely on the usage of software. Important factors to consider during selection are whether the software incorporates the functionality to create the envisioned product and whether the author possesses the necessary experience with the software to translate the concepts into components that actually reflect the initial idea.

6.1.1. Adobe Creative Cloud

The adobe creative cloud (Adobe Creative Cloud Version 4.7.0.400 2018) is a set of applications from Adobe Systems that is very common amongst professional working with audio visual media. It gives access to a collection of software and services used for graphic design, video and image editing, web development, photography and animation creation. Unlike its predecessor, Creative Suite, the Creative Cloud allows for easier sharing, cloud saving management and facilitated workflow integration of files between software.

Photoshop

Adobe Photoshop CC (Knoll, T., Knoll, K., 2018) is a raster-based graphics program that is regarded the industry standard in raster graphics editing. It can edit and compose raster images in multiple layers and supports masks, alpha compositing and several colour models including RGB, CMYK etc. In addition to raster graphics, it has limited abilities to edit or render text, vector graphics (especially through clipping path), 3D graphics and video ("Adobe Photoshop," n.d.). During the Realization it is barely used by the author, serving only to clean up and adjust the logos of the stakeholders for the credits.

Illustrator

Illustrator (Adobe Inc., 2018) is a vector-based graphics editing software that uses a layer interface with a multitude of options and is highly regarded amongst professionals ("Adobe Illustrator," n.d.). Unlike regular graphics editing applications such as Photoshop, Illustrator uses vectors for the creation of images. Regular images consist of pixels and thus share disadvantages such as the reduction of quality when resizing the image. Additionally, the file size of pixel-based images increases dramatically the higher the resolution. Vector files are not affected by either of these issues. The author uses

Illustrator to create all the different backgrounds and individual components of the animation, including characters. In case rigging[1] and animating required their independence from other components in the scene, they are saved individually. Additionally, it is used to create a logo for the rebranded device “regentoren”, formerly known as SRB.

After Effects

After Effects (Adobe Systems, 2018) is a visual effect, motion graphics, and compositing application that is used in the post-production process of film making and television production and can also be used for keying, tracking, compositing and animation (“Adobe After Effects,” n.d.). The author uses it to rig and animate the previously in Illustrator created scenes and characters. Using keyframes in combination with scaling, rotation and opacity effects to name a few, individual layers can be manipulated. The entirety of the animation was created in individually saved scenes using After Effects.

Premiere Pro

Premiere Pro (Adobe Systems, 2018) is a timeline-based video edition software that allows editing of video clips, audio and image into compositions. Additionally, it is possible to apply a range of effects, create title cards and colour correct footage. It is considered one of the industry standards for video editing and has been used to edit many high-grossing Hollywood movies (“Adobe Premiere Pro,” n.d.). The author used Premiere Pro to finalize the animation by combining the individual pre-created components into a cohesive product, add the voice over, sound effects and generally adjust the flow of the composition by speeding up or extending parts of the animation.

6.1.2. Audacity

Audacity (Version 2.3.0 2018) is a free and open-source digital audio editor and recording application software that is available on multiple platforms. Apart from being capable of multi-source recording, it can be used for several post-processing tasks such as normalization, trimming, and fading in and out. Additional to its editing features, it entails a large array of digital effects and plug-ins such as noise and/or vocal reduction and isolation. Audacity was used to record all required audio for the final voice-over of the visualization.

6.1.3. Freesound.org

Freesound.org is a collaborative database of Creative Commons Licensed sounds. It allows to browse, download and share sounds amongst its users. When browsing for sounds, sorting based on multiple parameters such as rating and specific tags helps facilitate the inquiry. Additionally, sounds can be sampled and skipped through online without requiring prior download of the file, further easing the process. The website was used to acquire the necessary background sound effects aimed to enrich the immersion and credibility of the visualization by an aural component.

[1] The process of creating a skeleton for a model so it can move

6.2. Decomposition

In order to facilitate the workflow during the realization of the final visualization, individual components are identified and broken down. The decomposition is based on the chronological approach in the creation of the animation. The first three components entirely cover visual components, starting with the Illustration, followed by the animation and concluded with the editing. However, during and before editing, audio was a vital part: Even though the animation was created following the final script, the pace of audio required an adjustment of both animation to the audio and vice versa. An illustration approximating the workflow is shown in figure 6.2.

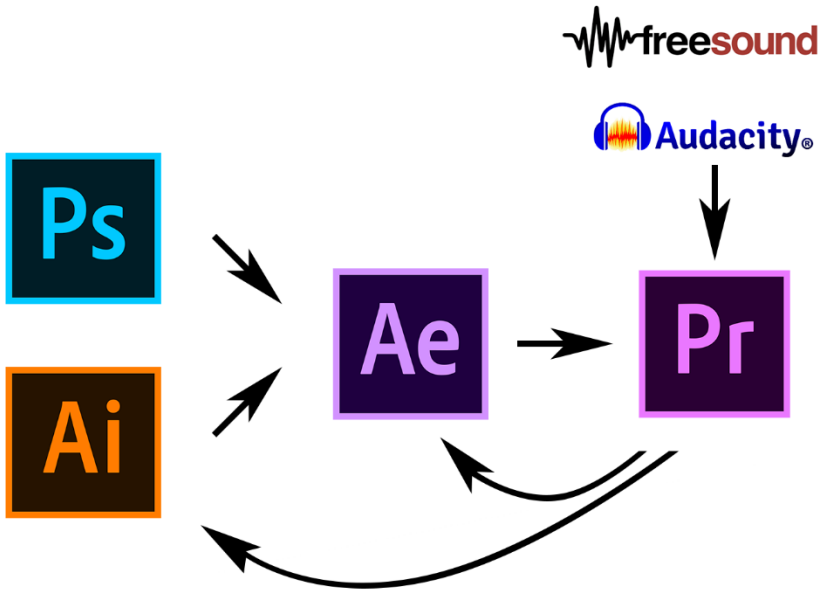


Figure 6.2: Software workflow depiction

6.2.1. Illustration

Following the creation of the refined storyboard and the lo-fi prototype, the illustrations were the first phase in the creation of the final visualization and are considered the most important. The visuals created at this point would entail the entirety of the storyboard and thus the bare visual aspects of the complete storyline. Consequently, this step is not only the most important regarding a range of functional and non-functional requirements, such as the creation of 2D visuals, but is also the most difficult, seeing as any mistake made would cause a ripple effect requiring having to redo some of the following steps such as animation and editing up to even the adjustment of audio material. With the final animation in mind, it is crucial to envision which parts need to be moveable and consequently order and name the corresponding elements that require rigging. This included buildings, expressions and other moving parts such as backgrounds and water levels.

As a result, the storyboard was broken down into a set of large scenes, containing all the components that were needed for the following animation, such as houses, persons etcetera. An important factor and benefit in this regard is the usage of vector-based graphics. The size of the scene was not a

constraining factor on the final visualization seeing as camera movement and zooms don't have an impact on the graphics' quality based on their infinity & scalability.

In order to allow for a smooth transition between scenes it was essential to include some sort of visual similarity between scenes, ultimately solved by using a background layer across multiple scenes with the same shade of blue.

6.2.2. Animation

Making use of the cross compatibility of the Adobe Creative Cloud, the Adobe Illustrator files containing scenes were then individually imported and edited within After Effects. This entailed the manipulation of individual layers to create a sense of movement in characters, buildings etcetera. Additionally, by moving and zooming into groups of layers, camera movements could be emulated. While After Effects allows the use of a timeline with keyframes for the animation, effectively making it possible to create the entirety of the animation within its' boundaries, it was only used as an approximation, with a focus on zooms, pans, and animated layers, not motion in-between. Additionally, by consciously refraining from the inclusion of audio within the After Effects workflow, the final pace of the visualization was created during editing.

6.2.3. Audio

The audio component consisted of two parts: voice-over and sound effects. The voice-over was crucial because it conveyed the story to the viewer which was ultimately backed up by the accompanying visuals. It was the driving factor in addressing most of the functional and non-functional requirements. Any change to the voice-over translated to the animation and vice versa. However, seeing how the voice-over is the essential medium to convey the messages contained in the visualization, its' flow was the guideline to how the animations needed to be placed and cut in accordance to each other.

With both storyline and storyboard in place a final script was written containing all the sentences needed for the visualization, including alternative versions differing in emphasis or length, to provide more options in case of last-minute changes. The voice-over recording was conducted in a one-day session and aside from the aforementioned alternatives, included multiple takes of each sentence to facilitate the editing process.

The sound effects aim to entice the viewer and made the animation more believable and immersive. The inclusion of water and summer sounds were in line with the story and are conveyed by the chirping of birds and splashes.

6.2.4. Editing

Adobe Premiere was used to fuse the animated results from After Effects together with the recorded voice-over and downloaded sound effects. Most of the finetuning of the visualization was done within this software, including the final cut and audio level and placement adjustments.

Regarding visuals, due to the simplistic nature of the animation, not having any camera movement for example during dialogue scenes, it was possible to elongate or shorten stretches of the animation due

to the lack of change between frames. Additionally, using the functionality of duration/speed on individual animation pieces, it was possible to change the pacing, improving the flow of the animation and facilitating the synchronisation with the voice-over.

6.3. Conclusion

Using the aforementioned tools within a roughly linear, yet slightly iterative workflow, the final visualization was ultimately finished. The individual components of which it consists were created without any set-backs, while heavily relying on the Adobe applications' cross-over user interface similarities and compatibility, specifically regarding output files. Furthermore, the success in creating the components was positively affected by a structured approach and prior experience with some of the applications listed above. The user interface and functional similarities helped level the lack of knowledge specifically during the usage of After Effects. Furthermore, online resources, such as instructional videos and tutorials were consulted to make up the required experience necessary for the creation of animations.

Recording of the voice-over resulted in some hardware related issues along the way. None of the microphones that were provided for the specific purpose worked as intended in combination with a laptop. This unfortunately resulted in subpar quality of the audio. Additionally, the workflow between audio and video was heavily influenced by one another, making it necessary to jump back and forth. For the scope of this project, the importance of the message is paramount, thus suggesting that first creating a script followed by the animation would've been beneficial.

Following the realization and integration of the individual components into the final animation, the realization phase is concluded. Consequently, the last step in the Creative Technology Design Process entails the evaluation of the resulted product. By presenting the visualization to the representatives of the municipality and receiving feedback regarding the fulfilment of requirements and input about the general quality, its' success will be measured.

7. Evaluation

The last step of the design process, following the realization of a prototype aiming to entail all previously elaborated requirements, is the evaluation phase. The goal of this phase is to present the results in form of a product to person(s) of interest, such as the stakeholders or intended users. With their help it will be evaluated whether the product is a success, by evaluating if both functional and non-functional requirements have been met. First a method for the evaluation must be worked out which will be followed by a discussion of the evaluation and its results.

Though the final goal is to evaluate the effectiveness of the animation video as a campaign tool with the citizens of Enschede in mind, the aim of the thesis and this prototype is to elicit and evaluate the requirements the main stakeholders set upon the animation as a proof of concept. Therefore the evaluation session was solely focused on officials from the municipality ranging from different fields: Policy developers, policy executives, communications staff, and water specialists.

7.1. Evaluation Method

The evaluation session was held in a presentation room consisting of a large screen used to show the animation to the attendees. Several representatives of the four stakeholder groups were present. The session began with an introduction into the topic followed by the disclosure of the procedure. Consent forms and 3-part questionnaires were handed out and signed by all participants. Both can be found in Appendix A & B. Consequently, the animation was shown a first time. The participants then filled out the first two parts individually, an open question about immediate remarks and three sets of closed questions based on the five-point Likert scale to evaluate the functional and non-functional requirements. The animation was watched again before a semi-structured discussion was initiated; the featured questions are mentioned in Appendix F. Concluding, the attendees were given another chance to write down additional remarks in the last part of the questionnaire before thanking them for their help in evaluating the concept.

7.2. Evaluation Results

Considering the inclusion of both functional and non-functional requirements in the evaluation questionnaire for the purpose of receiving more qualitative insights on the animation approach and content, it is crucial to recall the MoSCoW method for ordering requirements based on their importance. Fulfilling “Must” requirements is the bare minimum regarding the success of a product. The tables 7.2.1 and 7.2.2 summarizes the results and adds upon the aforementioned functional and non-functional requirements another column and row; the column to the right gives an insight on the average response as taken from the 5-point Likert scale analysis, ranging from “very bad”, “bad”, “undecided” to “good” and “very good”. Whether a requirement is fulfilled is highlighted with the use of green (fulfilled) and red (unfulfilled) boxes respectively. Specific repetitive remarks and outliers are summarized in the row below each requirement and will be further elaborated on in the following section 7.3.. The entire results of the 5-point Likert scale evaluation can be found in Appendix C. The additionally open question comments in Appendix G.

MoSCoW	Functional Requirements	Average response
Must	Final Version in English language	Very Good
No remarks on the quality of English		
Must	No longer than 3 minutes	Very Good
Being roughly 3:30 long, multiple remarks were made about drag and the possibility to shorten the introduction by taking another approach to the neighbour dialogue, possibly shortening the length of the clip significantly. However, evaluation suggested general content with length		
Must	Include use case scenarios that are not against the regional and national legislation (i.e. washing the car)	Good
Fulfilled, however during the discussion there was disagreement among participants what kind of use cases should be mentioned to the public and whether they seem reasonable on a day to day basis.		
Must	Include comparison of sewer tax letter	Undecided/Good
While the topic was sufficiently addressed on a functional basis, the discussion revealed that the conveyed information was wrong. This resulted from a prior miscommunication between the UT acting as mediator and the municipality: The GBLT, which is used to address the topic of taxation in the animation is not actually connected to the water tax. This would require the participation of another party, Vitens		
Must	Include spoken text (Voice-over)	Good
General agreement on the usefulness of the voice-over		
Must	Storytelling must be neutral and refrain from including ideologies such as political party affiliation	Good
The questionnaire reveals overall agreement that there is no ideological bias contained with the animation.		
Must	Make no promises about flood prevention	Good
No further remarks.		
Must	Only one message	Undecided/Good
While the message is indeed restricted to the “me” scenario and individual use cases/gains, the consensus is that the content of the animation is partly convoluted and there is undecidedness on whether it is easy to follow. This also refers to the prior discussion about the sewer tax communication.		

Should	Use cartoonesque 2D animation	Very Good
The questionnaire reveals agreement among participants on the appeal of the visuals		
Should	Mention some form of “De Regentoren” subsidization	Good
Overall agreement, yet two respondents disagree and voice concerns to be more specific about the subsidization, however correct communication of the subsidization is dependent on stakeholder involvement/regulation.		
Should	Credit scene with stakeholder Logos	Good
No remarks		
Should	Communicate water tower “revival” through SRB usage (Community incentive)	Good
With a focus on the water tower and education about its historical usage there was general agreement. There was however concern about the different uses of water towers (regentoren = grey water vs water tower = clean water)		
Should	Contain educational material but kept simple	Good
Overall agreement with a few exceptions being undecided		
Should	Contain SFX for immersion & dramatic effect (Water, Summer etc)	Very Good
Agreement on the usage of SFX		
Should	Rebrand SRB and include new name & logo	Undecided/Good
Undecidedness about the appeal of the name and logo. Equal amounts of “undecided” and “agreements”		

Table 7.2.1: Functional Requirement Evaluation Results

MoSCoW	**Non-Functional Requirements**	**Average Response**
Must	Storytelling should not discriminate between users based on social status	Undecided/Good
Overall high agreement that there is no discrimination happening.		
Should	Dialogues & expressions should be funny	Very Good
The animation was generally conceived as funny		
Could	Type of look: Paper or felt on all assets	[not included]
-		

Won't	Contain a mix of realistic images and animation styles (Real water tower transitioning to animation)	[not included]
-		
Won't	Mostly contain smooth animations	[not included]
-		

Table 7.2.2: Non-Functional Requirement Evaluation Results

7.3. Evaluation Discussion

While the most crucial functional and non-functional requirements were altogether addressed and satisfyingly fulfilled, there were many specific remarks and critical comments falling outside of the consensus in some cases even creating longer discussions. This however did not necessarily mean failure to fulfil a requirement; they were mostly intended as suggestions regarding content and visualization approach. This section aims to address the most important requirements that resulted in diverse feedback.

Use Cases

Regarding the functional requirement to address usage for the regentoren owner, there was a suggestion to be more explicit about the use cases and eventually address them earlier on in the animation. This ensued a discussion amongst participants about which use cases seem reasonable to users, followed by a statement about previous storyline iterations addressing another set of use cases (such as drinking water for pets) and why they were ultimately abandoned in correspondence with the stakeholder. While some considered regentoren water usage for cleaning purposes reasonable, others disagreed. This was a mixed signal since it showcased the diversity of opinion between stakeholders and raises the question whether there even is an ideal set of use cases that could appeal to the general public. Conclusively, this topic needs to be further explored in order to ensure conveying the right message.

Taxation

While the comparison of letters was addressed within the video, it still highlighted one of the biggest issues with the animation. Evaluation participants related closely to the taxation regulation (water specialists) raised the point that the involvement of the "Waterschapsbelastingen en gemeentelijke Belastingen" (GBLT) was wrongly included in the animation. Instead, they referred to "Vitens" as the correct agency for such matters, which to this point was not yet involved in the regentoren campaign. This information however was initially wrongly communicated between University and municipality.

Clarity of the message

A very small number of participants responded that the message was confusing and the animation not easy to understand. This directly reflects onto one of the main functional requirements, having one message per campaign video. This project focuses on the "Me" scenario, highlighting the benefits for the individual, including cost reduction for regentoren acquisition (subsidization) and actual water use cases. Referring to the results from Chapter 2, social theory and state of the art both suggest the importance of communicating expenses (and the reduction thereof) to the potential end user. If this

is not properly conveyed, there is a high chance of the campaign failing its purpose. Suggestions to make the message more explicit included the shortening of the introduction and restructuring the conflict between neighbours, so that the regentoren is introduced early on.

Subsidization

Another functional requirement closely related to the aforementioned feedback was the importance of subsidization conveyance. Two participants voiced concerns about the explicitness of the topic and suggested to highlight it more.

Rebranding

Part of the rebranding effort included creating a connection between the regentoren and its' name sake, water tower. This translated to an educational message about water towers, using them to explain the concept of the regentoren on a grand scale. While this message did indeed work, the water specialists implied concern about the different use cases: water towers supplying potable water whereas regentoren retaining rainwater. Furthermore the questionnaire revealed a slight discrepancy between the appeal of both logo and name, a non-functional requirement, where some people really enjoyed it an others suggested rethinking it. However, this was not further elaborated on during the open discussion.

Length

Lastly, the video was aimed to be around 3 minutes long. Many of the comments suggested it was "slow". This was furthermore in line with other open remarks about shortening the introduction and getting to the point quicker, possibly alleviating other issues in succession.

Ultimately, many of the open remarks included the light-heartedness of the animation and that it was overall funny and enjoyable, further facilitated by the use of voice-over and sound effects. Stakeholders and participants agreed that it serves as a proof of concept with potential that should be further developed into a polished product to be released to the citizens of Enschede.

8. Conclusion

Following the completion of the Creative Technology Design Process, resulting in the creation and evaluation of the envisioned product, this conclusion aims to reflect on the previous chapters and ultimately address whether the Research Question stated in section 1.3. has been answered accordingly and whether the project reached its goal. Furthermore, recommendations for future work are elaborated on.

The goal of this graduation project dealt with the development of a rainwater buffering campaign for Enschede which was administered by the local municipality. Its' aim is to affect sustainability awareness of the citizens of Enschede by promoting the adoption of a rainwater buffering system. As such, the research question was "***How to develop a campaign for Enschede to promote a sustainable Smart Rainwater Buffering system?"***.

The development of the campaign resulted from the municipalities' need to promote the Smart Rainwater Buffering system, previously envisioned and created in collaboration with the waterboard Vechtstromen and the University of Twente. The goal of the campaign aims to reflect and communicate the messages intended by the device itself: Education about and awareness for rainwater management to the citizens on an individual level. A cartoonesque 2D animation using voice-over to communicate the messages of usefulness and subsidization to the viewer was created in the realization phase with the use of dedicated software.

Following ongoing communication with the municipality the final animation was ultimately presented to and evaluated by a group of stakeholder representatives from different fields within the municipality. Concluding, the client expressed overall satisfaction with the result, regarding it as concept with a lot of potential as a campaigning tool, however demanding further exploration into the details regarding the communicated messages and localization thereof. This includes the recreation of the voice-over into Dutch, adhering to the needs of the intended viewership, the citizens of Enschede. Major plot changes aside, this would cause a ripple effect regarding the flow of the animation. With audio shifting in tone and length, the visuals need to be adjusted accordingly. Additionally, some sentences may not translate directly and require restructuring of the script.

8.1. Future Work

The last part of the conclusion entails a reflection including the experiences made during the creation process of the product and the collaboration with the stakeholders. It builds upon the feedback given during the evaluation and provides an outlook on possible improvements that could be made to the product as a result. Additionally, some suggestions about the workflow and software is provided.

Given the expressed support of the stakeholders for the animation as a viable campaign concept, the extended collaboration will focus on re-evaluating some requirements. This has especially emerged during the evaluation discussion, which resulted in a diversity of opinions. The disagreement between stakeholders during the evaluation inferred that some of the topics conveyed in the animation need more work or a different approach, i.e. communicating use cases and financial details. Additionally, this may even require the inclusion of other parties to the list of stakeholders, which in turn may lead

to the extension of requirements. Conclusively, this is the most important issue going further as it may even require the recreation of entire scenes or even the entire story.

Seeing as most of the issues regarding requirements resulted from diverse stakeholder opinions, a first step towards an improved animation entails the reconsideration of all influential parties regarding the communicated messages. Specifically details on how to address taxation and subsidization need to be worked out before the script and storyline can be refined. Furthermore, surveying the possible use cases among users of conventional rainwater harvesting systems may help to pinpoint the most frequent and therefore valuable use cases amongst citizens without bias from stakeholders.

Aside from the individual gains (“What’s in it for me?”) communicated through the animation created in the time frame of this graduation project, the campaign ideation resulted in the conception of two additional animations with distinct messages. Re-evaluating the requirements and thorough research into the corresponding themes (“community” and “municipality”), while ensuring a closer feedback loop with stakeholders becomes especially crucial to ensure there is no overlap of content or miscommunication of details.

Regarding the other animations, a suggestion would be to forgo the exact recreation of the visual style to not just ensure distinction between messages but also encourage the developer the creation of a unique product. However, considering the positive evaluation results, a cartoonesque 2D animation is the preferred visualization regarding complexity within the given time frame.

Another suggestion includes creating the script in Dutch, however, this is depending on the creator’s proficiency in the language. This will help facilitate the communication about the product and its effectiveness with stakeholders during feedback loops. While not specifically requested by stakeholders nor tested for its effectiveness during the evaluation, a humorous audio-visual style influenced the viewers positively; resulting in many comments suggesting viewers were entertained. Conclusively, pursuing to mix content with humour is beneficial.

Given the effectiveness and importance of voice-over in communicating the message of the animation it is essential to ensure a high-quality sound. Reflecting on some critical feedback during the evaluation, ensuring a professional setup, such as recording in a dedicated studio with quality hardware, will likely benefit the animation in terms of credibility and entertainment.

Lastly, while there are many freeware solutions that can fulfil each individual task separately, the overarching UI similarities given in the Adobe Creative Cloud software package helped facilitate the workflow and creation process. Additionally, the lack of experience with After Effects was levelled due to the prior experience with Premiere Pro, Illustrator and Photoshop. Disregarding the choice of software, however, in order to facilitate a smooth workflow, it is essential to establish a well sorted folder system with sub folders and proper naming of individual files, which is especially crucial during editing (Premiere Pro), as moving files from a project between folders will result in error messages and workflow disruption.

9. References

Title of Software version x.y year, computer program, publisher, place.

Adobe Creative Cloud. Version 4.7.0.400 (2018) computer program, Adobe Inc., San Jose, California, USA

Adobe Illustrator. (n.d.). In Wikipedia. Retrieved January 5, 2019, from https://en.wikipedia.org/wiki/Adobe_After_Effects

Adobe Illustrator. (n.d.). In Wikipedia. Retrieved January 5, 2019, from https://en.wikipedia.org/wiki/Adobe_Illustrator

Adobe Inc. (2018) Adobe Illustrator, computer program, Adobe Inc., San Jose, California, USA

Adobe Photoshop. (n.d.). In Wikipedia. Retrieved January 5, 2019, from https://en.wikipedia.org/wiki/Adobe_Photoshop

Adobe Premiere Pro. (n.d.). In Wikipedia. Retrieved January 5, 2019, from https://en.wikipedia.org/wiki/Adobe_Premiere_Pro

Adobe Systems (2018) Adobe After Effects, computer program, Adobe Inc., San Jose, California, USA

Adobe Systems (2018) Adobe Premiere Pro, computer program, Adobe Inc., San Jose, California, USA

Adobe Creative Cloud Version 4.7.0.400 2018, computer program, Adobe Inc., San Jose, California, USA

Ajzen, I. (1985) From intentions to actions: A theory of planned behaviour. Retrieved from https://www.d.umn.edu/~kgilbert/educ5165-731/Readings/Theory%20of%20Planned%20Behavior-%20Azjen.pdf

Ajzen I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), ISSN 0749-5978, https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I., Fishbein, M. (1980) The Prediction of Behavior from Attitudinal and Normative Variables. https://doi.org/10.1016/0022-1031(70)90057-0

Audacity. Version 2.3.0 (2018), computer program, The Audacity Team, Carnegie Mellon University

Becker, M., Raasch, U. (2001) Sustainable rainwater management in the Emscher river catchment area. *Water Science and Technology, 45 (3)*, pp. 159-166. https://doi.org/10.2166/wst.2002.0075

Benyon, D., Barker, R., (2002) Scenarios and the HCI-SE design problem. Interacting with Computers, 14 (4), pp. 397-405. DOI: 10.1016/S0953-5438(02)00007-3

Bryson, J. M. (2004) What to do when Stakeholders matter. Public Management Review, 6 (1), pp. 21-53. https://doi.org/10.1080/14719030410001675722

Chapman, H., Cartwright, T. & Tripodi, N. (2008) Guidance Manual for the Design and Installation of Urban Roofwater Harvesting Systems in Australia (Edition 1), Research Report 39. Cooperative Research Centre for Water Quality and Treatment. ISBN 18766 16644 https://www.researchgate.net/profile/Neil_Tripodi/publication/272419233_Guidance_Manual_for_the_Design_and_Installation_of_Urban_Roofwater_Harvesting_Systems_in_Australia_Edition_1/links/54e3d2d20cf2dbf606947c55/Guidance-Manual-for-the-Design-and-Installation-of-Urban-Roofwater-Harvesting-Systems-in-Australia-Edition-1.pdf Accessed 9 November 2018

Clegg, D. and Barker, R. (1994) Case Method Fast-Track: A RAD Approach. (1st ed.) Addison-Wesley.

Davis (1985) A Technology Acceptance Model for empirically testing new end-user information systems: Theory and results. Retrieved from https://dspace.mit.edu/bitstream/handle/1721.1/15192/14927137-MIT.pdf

Davis, D., Bagozzi, P., Warshaw, R. (1989) User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. https://doi.org/10.1287/mnsc.35.8.982

De Graaf, R. E. (2009) Innovations in urban water management to reduce the vulnerability of cities. (Doctoral Thesis). TU Delft. Retrieved from https://repository.tudelft.nl/islandora/object/uuid%3A817c33c6-f716-44ca-bb17-80d20ef2100e

Defize, D. (2018). Climate Active City Enschede. Retrieved from http://essay.utwente.nl/74526/1/Defize_BA_EEMCS.pdf

DIN (1989) Rainwater harvesting systems — Part 1: Planning, installation, operation and maintenance. Translated from the German DIN by Kern GmbH, Frankfurt, Germany. Retrieved from https://pdhonline.com/courses/c611/Rainwater%20Harvesting%20EN_1989-1_(en).pdf

Gemeente Enschede. (2012, June). Water in Enschede: feiten, cijfers en trends. Retrieved, 2018, October 18, from https://www.ruimtelijkeplannen.enschede.nl/

Hall, D. T., and Mansfield, R. (1975) Relationships of age and seniority with career variables of engineers and scientists. Journal of Applied Psychology, 60(2), pp. 201-210. http://dx.doi.org/10.1037/h0076549

Hofstede, G. (1984) Cultural Dimensions In Management And Planning. *Asia Pacific Journal of Management*, 1(2), pp. 81–99

Ireland, L. (2010, February 10). U.N. climate panel admits Dutch sea level flaw. *Reuters*. Retrieved from https://www.reuters.com

Kellagher, R., & Maneiro Franco, E. (2005). *Rainfall collection and use in developments*; benefits for yield and stormwater control. WaND Briefing Note 19.

Knoll, T., Knoll, K., (2018) Adobe Photoshop CC, computer program, Adobe Inc., San Jose, California, USA

Mader, A., and Eggink, W. (20014) A design process for creative technology. International conference on engineering and product design education, The Netherlands.

Marsen Jacob Associates (2007) The cost-effectiveness of rainwater tanks in urban Australia. National Water Commission, Australian Government. http://webarchive.nla.gov.au/gov/20070829173658/http://www.nwc.gov.au/index.cfm Accessed 9 November 2018

Mayer, R. E., & Moreno, R. (2003). Nine Ways to Reduce Cognitive Load in Multimedia Learning. Educational Psychologist, 38(1), 43–52. doi:10.1207/s15326985ep3801_6

Morris, M. G. and Venkatesh, V. (2000) Age Differences in Technology Adoption Decisions: Implications for a Changing Workforce. Personnel Psychology 53(2), 2000, pp. 375-403. https://doi.org/10.1111/j.1744-6570.2000.tb00206.x

Murase, M. (2007) Innovative Rainwater Management in Urban Areas: Challenges and Successful Examples from Japan. *Proceedings of the Conference Water Problems in Urban Areas – II. International Water Conference (IWC) Berlin, Germany* Retrieved from https://bgz-berlin.de/projekte-und-produkte/projektuebersicht/ii-internationale-wasserkonferenz.html Accessed 9 November 2018

Nolde, E. (2007) Possibilities of rainwater utilisation in densely populated areas including precipitation runoffs from traffic surfaces. Desalination. 215(1–3), pp. 1-11. https://doi.org/10.1016/j.desal.2006.10.033

NWC (2009) National Water Initiative. http://webarchive.nla.gov.au/gov/20080718231031/http://www.nwc.gov.au/nwi/index.cfm Accessed 9 November 2018

Partzsch, L. (2009) Smart regulation for water innovation – the case of decentralized rainwater technology. Journal of Cleaner Production, 17(11), pp. 985-991. https://doi.org/10.1016/j.jclepro.2009.01.009

PMBOK (2013) A Guide to the Project Management Body of Knowledge (5th ed.). Project Management Institute, Inc.

Robinson, L. (2009) A summary of Diffusion of Innovations. Retrieved from https://www.enablingchange.com.au/Summary_Diffusion_Theory.pdf

Rogers, E. (1983) Diffusion of Innovations (3rd ed.). The Free Press.

Rogers, E. (2003). Diffusion of Innovations (5th ed.). Simon and Schuster.

Rubin, J. and Chisnell, D. (2008) Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests (2nd ed.) Wiley Publishing, Inc.

Sharp, H., Finkelstein, A., & Galal, G. (1999). Stakeholder identification in the requirements engineering process. Tenth International Workshop on Database and Expert Systems Applications. DEXA 99. DOI:10.1109/dexa.1999.795198

Slimme regenton. Retrieved 2018, November 9, from https://www.enschede.nl/duurzame-daad/slimme-regenton

Smart Water Fund (2005) Rainwater Tank Public Awareness Campaign. https://waterportal.com.au/swf/images/swf-files/1088-combined-doc.pdf Accessed 9 November 2018

Sugai, M. (2009) Stormwater Control Measures for Tokyo. Retrieved from http://www.gesui.metro.tokyo.jp/english/pdf/tp0902.pdf

Tunc, S. (2018). Smart Rainwater Buffer DIY Instructions. Retrieved from http://essay.utwente.nl/75753/1/Tunc_BA_EEMCS.pdf

Venkatesh, V. and Davis, F. D. (2000) A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. Management Science, 46(2), February 2000, pp. 169-332. https://doi.org/10.1287/mnsc.46.2.186.11926

Venkatesh, V., Morris, M., Davis, G., Davis, D. (2003) User Acceptance of Information Technology: Toward a Unified View. MIS Quarterly Vol. 27, No. 3, 2003, pp. 425-478, doi: 10.2307/30036540

Ward, S. L. (2010) Rainwater harvesting in the UK: a strategic framework to enable transition from novel to mainstream. (Doctoral Thesis). University of Exeter. Retrieved from https://ore.exeter.ac.uk/repository/handle/10036/106575

10. Appendices

A: Informed Consent Form

Informed consent form

Title research: **Regentoren Campaign Prototype Evaluation**

Responsible researcher: **Alexandros Charizanis**

To be completed by the participant

I declare in a manner obvious to me, to be informed about the nature, method, target and the risks and load of the investigation.

I know that the data and results of the study will only be published anonymously and confidentially to third parties. My questions have been answered satisfactorily.

I understand that audio content or operation thereof will be used only for analysis and / or scientific presentations.

I voluntarily agree to take part in this study. While I reserve the right to terminate my participation in

this study without giving a reason at any time.

Name participant:

……

Date: …… Signature participant: ……

To be completed by the executive researcher

I have given a spoken and written explanation of the study. I will answer remaining questions about the

investigation into power. The participant will not suffer any adverse consequences in case of any early

termination of participation in this study.

Name researcher:

……

Date: …… Signature researcher:……

UNIVERSITY OF TWENTE.

B: 3-Part Questionnaire incl. 5-point Likert scale

Participant Number: ☐

Affiliation: (Municipality / Waterboard / University: ☐

Part 1

Please write down your immediate reaction to watching the animation

☐

Part 2

Please answer the following questions by ticking one of the boxes

CONTENT	1 Strongly Disagree	2 Disagree	3 Undecided	4 Agree	5 Strongly Agree
The animation…					
Q1: …does not discriminate between potential users based on social status	○	○	○	○	○
Q2: …is neutral: It does not promote a politically charged message	○	○	○	○	○
Q3: …sufficiently addresses the topic of regentoren-subsidization	○	○	○	○	○
Q4: …educates the viewer about water towers and their relation to regentoren	○	○	○	○	○

QUALITY

	1 Strongly Disagree	2 Disagree	3 Undecided	4 Agree	5 Strongly Agree
The animation…					
Q5: …is funny	○	○	○	○	○
Q6: …is visually appealing	○	○	○	○	○
Q7: …makes good use of sound effects	○	○	○	○	○
Q8: …makes good use of the voice over	○	○	○	○	○
Q9: …is easy to follow	○	○	○	○	○
Q10: …is overall enjoyable	○	○	○	○	○

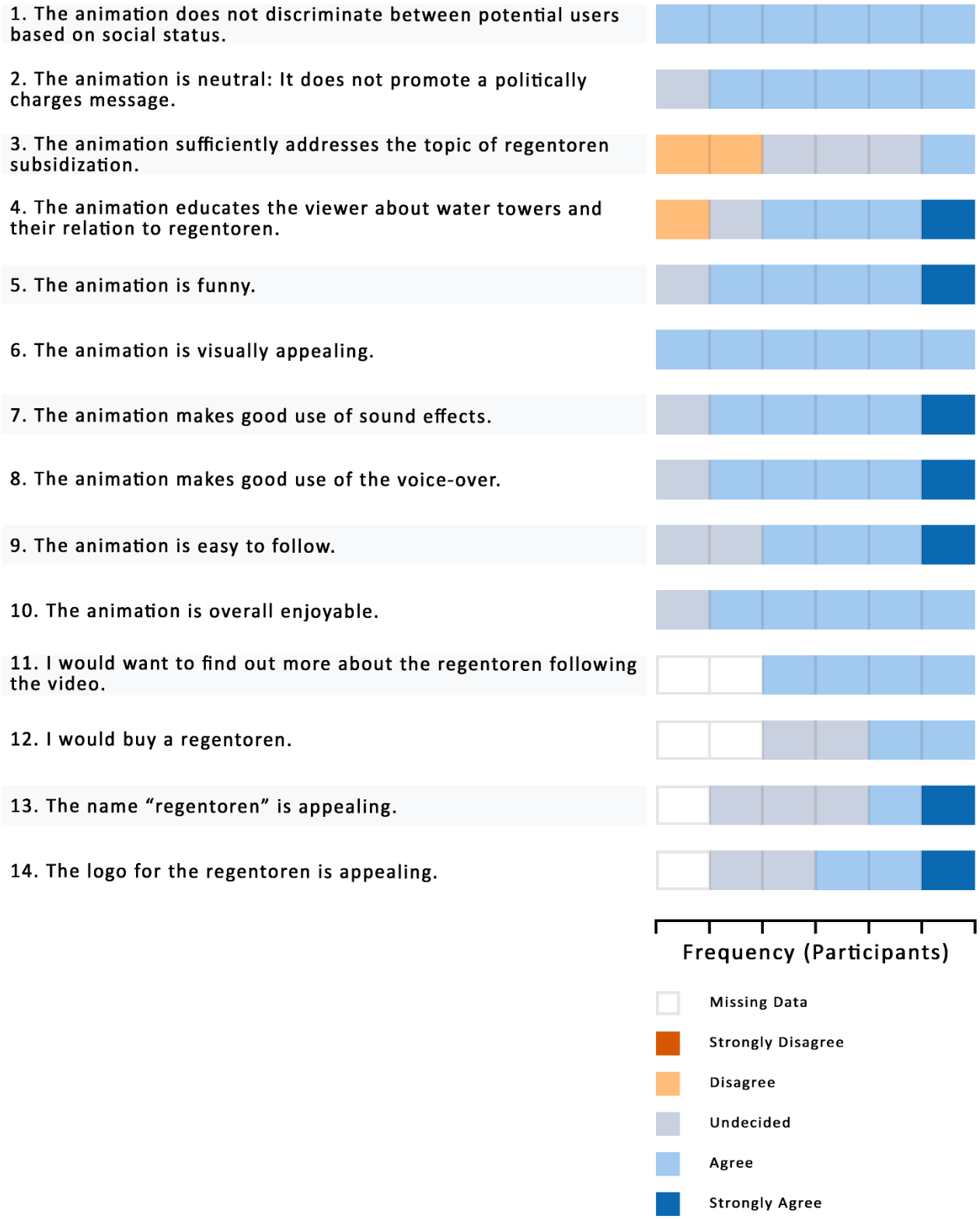
GENERAL	1 Strongly Disagree	2 Disagree	3 Undecided	4 Agree	5 Strongly Agree
Q11: I would want to find out more about the regentoren following the video	○	○	○	○	○
Q12: I would buy a regentoren	○	○	○	○	○
Q13: The name "regentoren" is appealing	○	○	○	○	○
Q14: The logo for the regentoren is appealing	○	○	○	○	○

Part 3

If you have any further remarks please note them here

Thank you for your participation!

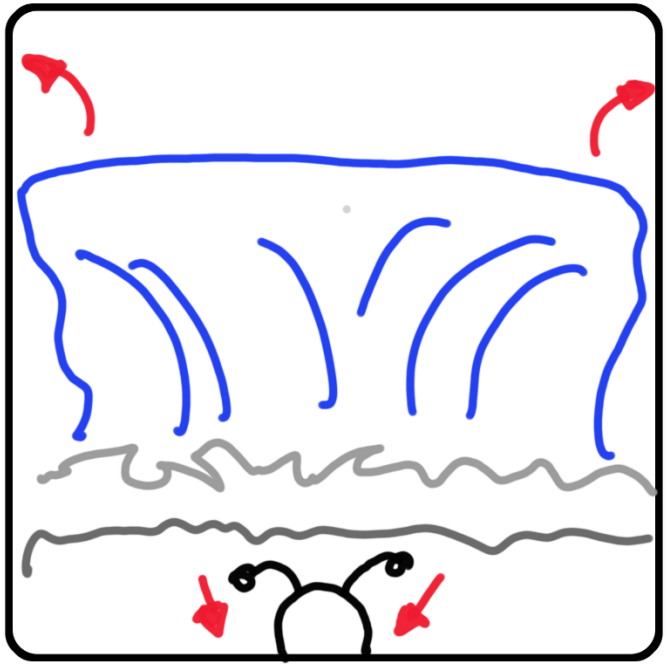
C: 5-point Likert scale evaluation



D: Final Storyboard incl. notes

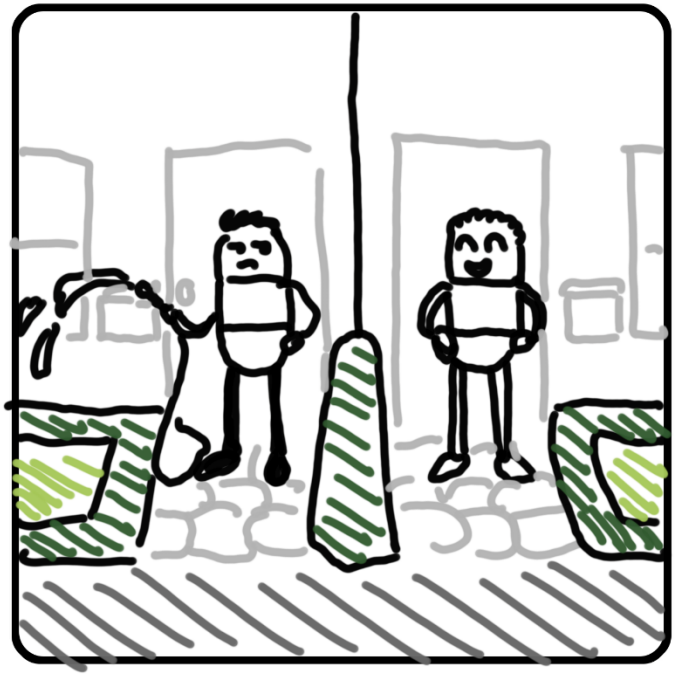
-Zoom into ladybug laying in a field of grass.
- Sighs of relief, comment about the beautiful day
-SFX bird chirping, summer
-Drips start filling the screen as the ladybug calls out in surprise.
- Thundering sound fades in and gets louder

- Sound gets unbearable
- Shadow in the background crawls upwards
- ladybug pulls down shades from head, eyes twitch in terror
- Starts screaming and immediately cut away from the scene

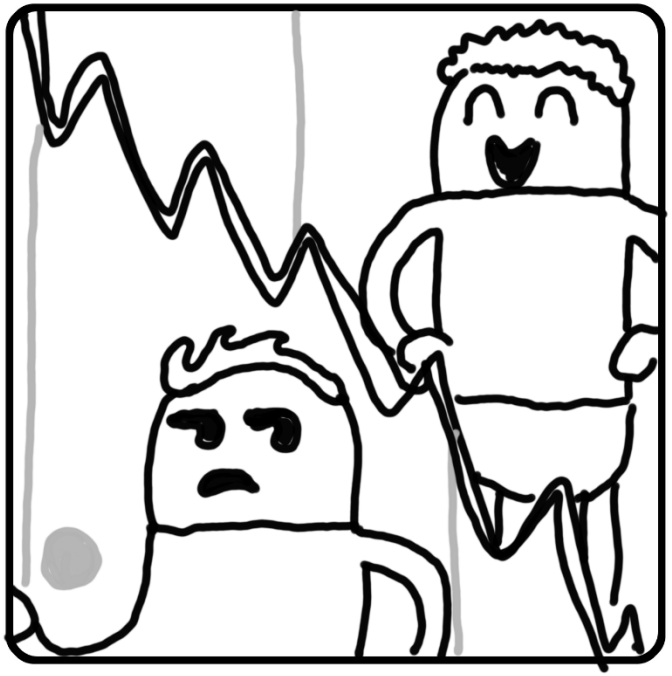


- Ladybug screams as sound is now clearly destinguishable as approaching water
- Zoom out of ladybug while zooming into growing wave.
Cut

-A is whistling lighty, while we hear the smooth and quiet sound of water gushing out of the hose.
- some seconds pass, all of a sudden a voice interrupts the whistle.
- B greets his neighbour



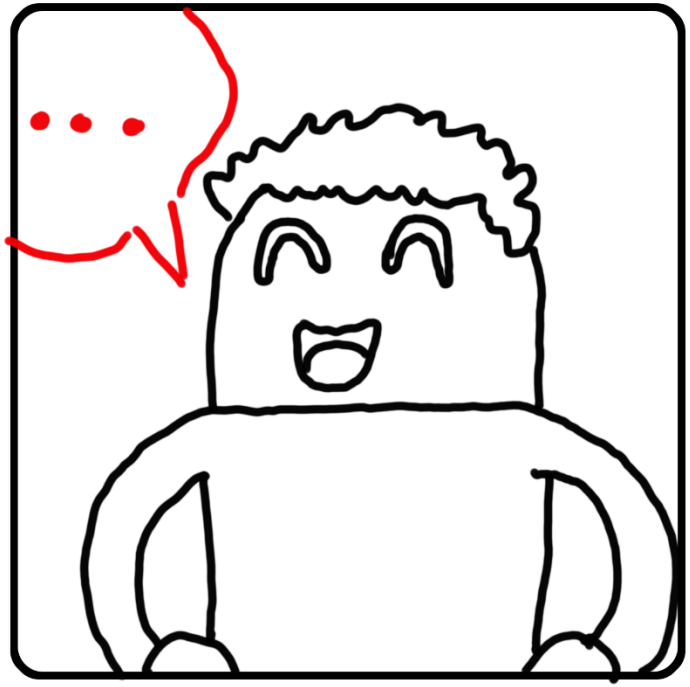
- Shift to full frontal view of both houses, A is visibly annoyed by his neighhour
- B finishes his greeting and asks how A is doing



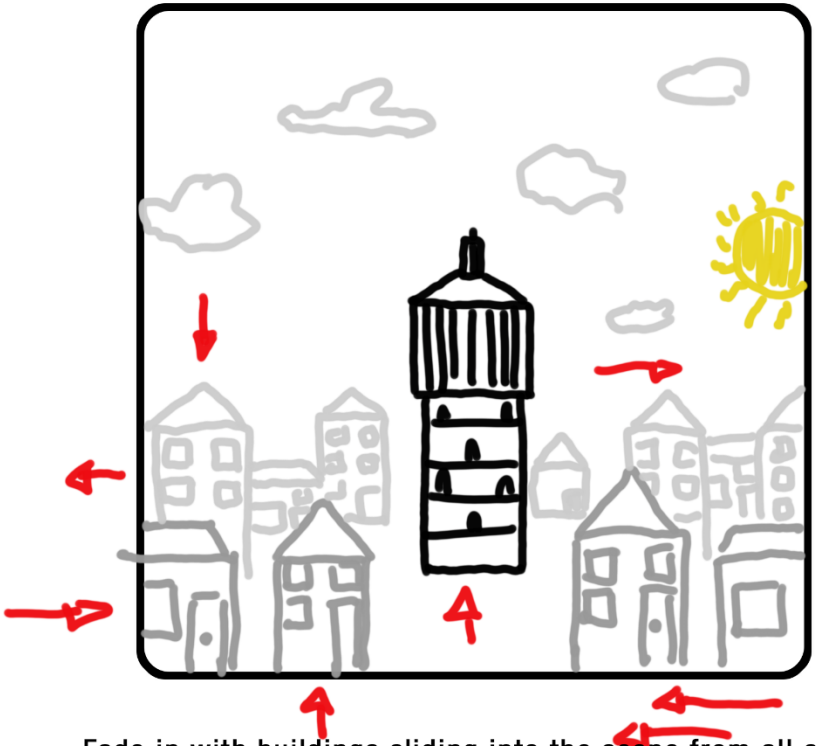
- A short conversation is ensuing, where B is inviting A to a cool beverage.
- A refuses but mentions that his neighbour apparently received mail
- Cut between the two characters

- The letter slides up from the bottom and B's eyes scan the letter, he nods and speaks to himself stating that his sewer tax has never been lower

- A in annoyed disbelief asks whether he may see the letter to compare it to his own tax bill.
- The letter slides in from the side.
- First relaxed, A also scans the letter with his eyes, mumbling to himself but then suddenly errupts and cries out that he is paying way more than B
- He immediately asks B how that can be

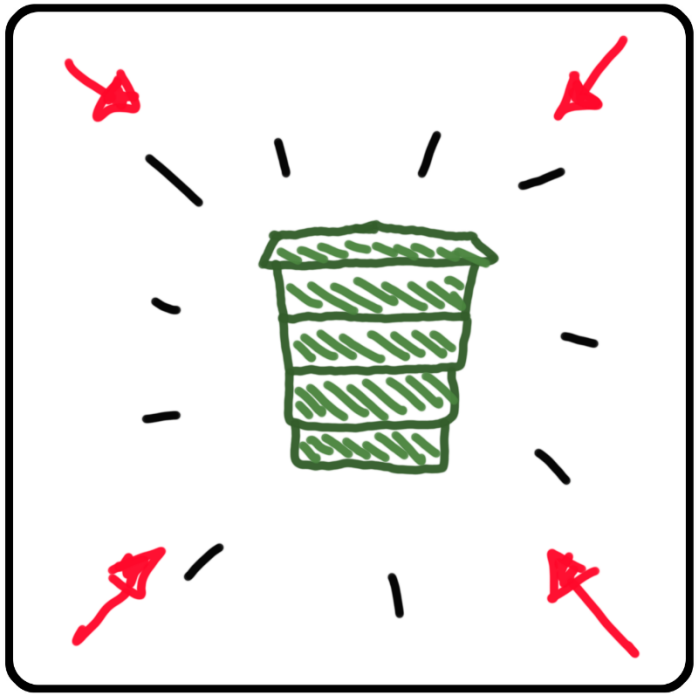


- B, seemingly happy to explain starts by mentioning “you know these water towers, right?”
- Fade out

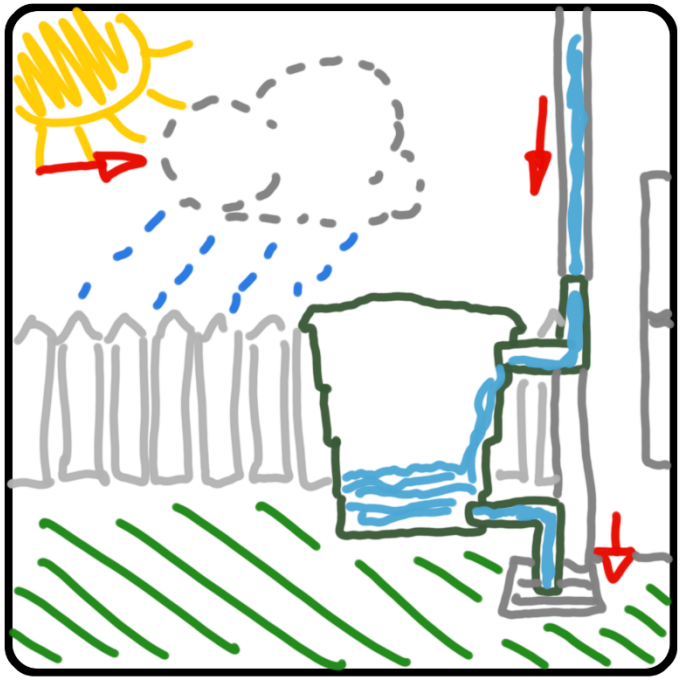


- Fade in with buildings sliding into the scene from all sides, including a water tower appearing i the middle.
- From the off, B starts explaing how the tower helped with water demand at day time and was refilled at night.
- This is accompanied by the tower turning transparent, making the flow of water visible.
- The sky rotates to night, when he mentions the part, the tower refills again at day, then turns opaque
- the background dissolves as the tower splits into three parts and moves around

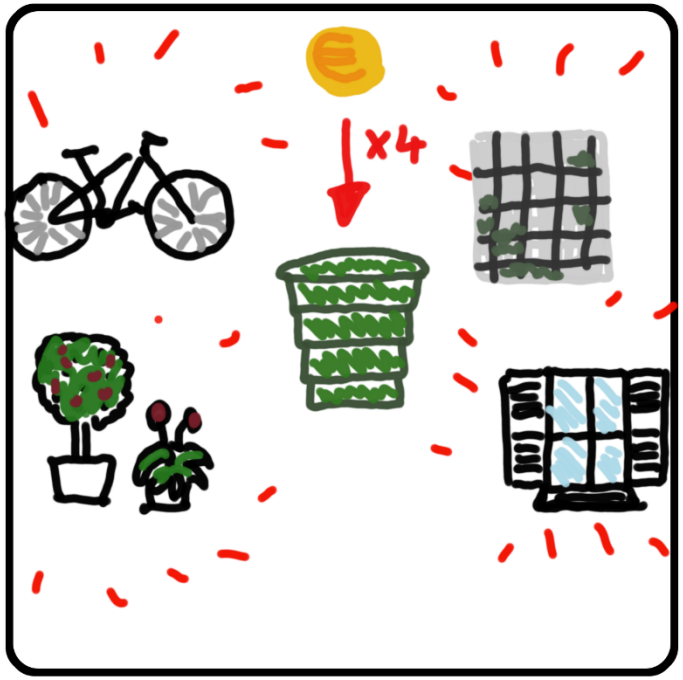
- The tower distributes itself around the frame while a map fades into the scene.
- Meanwhile B exlains how there were many towers before covering the city, but that time they slowly disappeared (fading away of towers)
- Ultimately also the map fades away, while A remarks from the off what this has to do with the sewer tax



- Fade in theregentoren as B mentions that he got himself one of them.
- The regentoren start shifting position as seen in the following frame

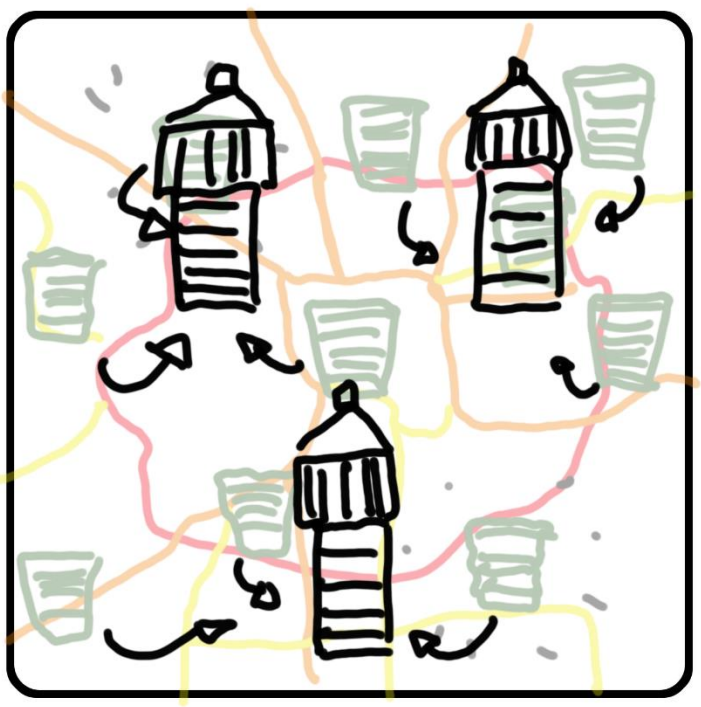


Building and background shift into the scene as B starts to explain the functioning of the regentoren, similarly as with the water tower
- The device turns “transparent” as the way of the water is visualized, while B states the awareness of the regentores about upcoming rain and automatically empties accordingly.
With rain clouds approaching from the side, the regentoren once again refills. It then turn opaque and moves back into the middle of the screen

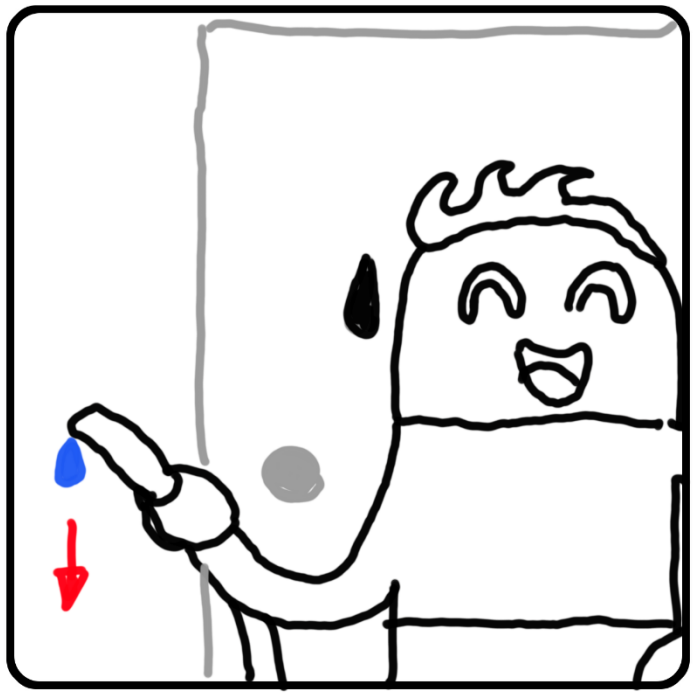


Use case scenarios for the harvested water pop into the scene while B explains accordingly.
- As the 4 items each disappear a coin making a “ka-ching” sound drops into the regentoren

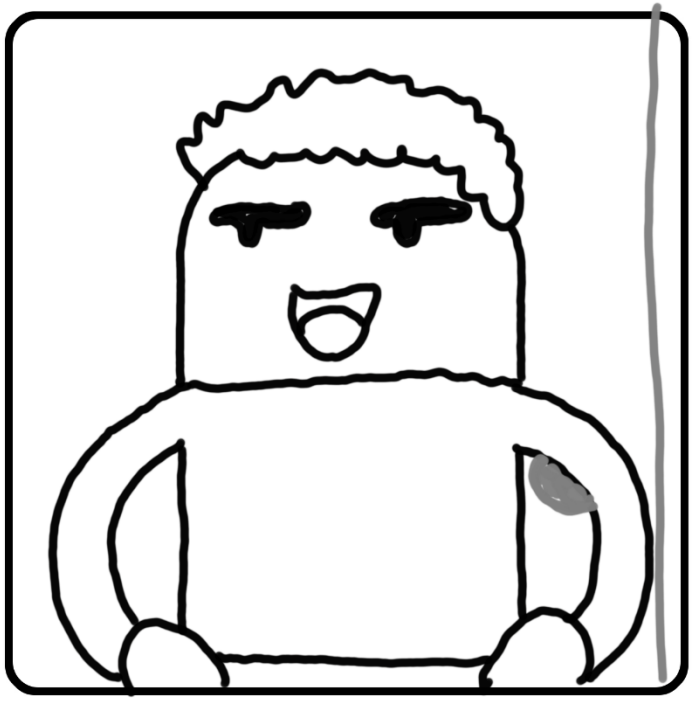
The regentoren then shrink and multipliy after the map slowly fades into the scene once again. The show up in more and more places as B explain that citizens are not only saving water but also...



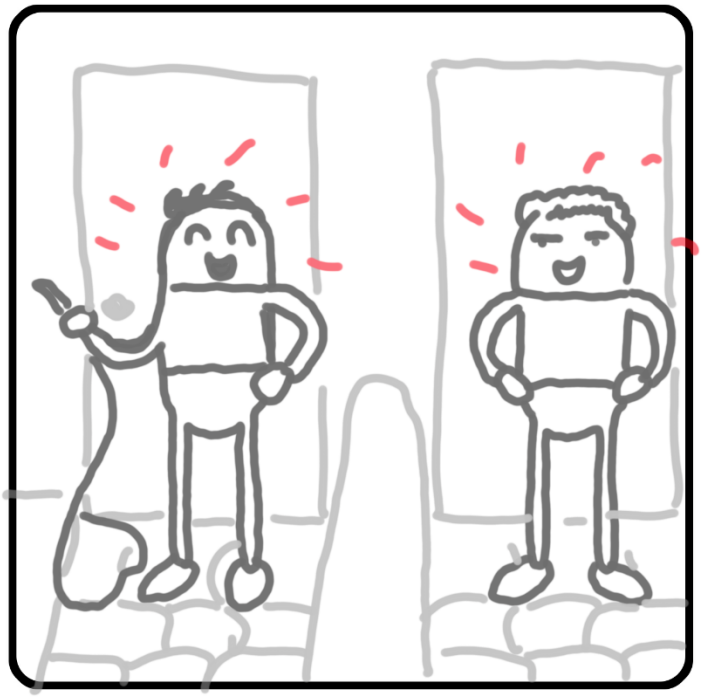
... revive the idea of the watertower in a decentralized way.
- As B gives this info the regentoren flock into specific points, fade out and watertowers fade in, in their stead.
B concludes: The best thing is the municipality believes in the idea and gives early adopters discounts they can freely share with friends
- SFX of the faucet closing and water dripping is heard



A, ackwardly and somewhat shy, having got the message says:
“So, um, about that beer you were talking about..”



B replies, with a smug, knowing expression on his face
“yeah sure, come over”



- SFX of summer, birds chirping as we slowly zoom out of the scene
- Alternatively ackward somwhat fake laughter could be included. fade to white.

In slow succession, the logo for the regentoren is shown, followed by the logos of the municipality, waterboard and then the University of Twente.

E: Final Script

Additional SFX

Ladybug	A	B
Sigh of relief	Whistling	Affirmative noises (uhhuh, Hmhm)
Screaming	Snorting (annoyed)	
gulping		

Scene 0 – Ladybug

- Hah! What a lovely summer day (alt.: What a beautiful sunny day)
- Not a single cloud in the sky
- Wait- Wait what? What the- what the heck?
- How can it be raining? How is it raining?
- What's that sound? /noise?
- Holy crap/Holy Moly/ Holy Bumblebee

Scene 1 – The two Neighbours

#	A	B
0	- *Whistles some tunes*	
1		- Hey hey hey Neighbour! How's it going?
2	- *Annoyed exhale* (then, to himself): Not this guy..	
3	- ***Short, Poignant*** Fine. Thanks.	
4		- Wanna come over for a bottle of beer?
5	- ***Avoiding*** Hmm. Umm.. No thanks, I'm kinda busy. **Alt.:** Nah, I'm good.	
6	- Uuh, By the way, you just got your mail.	
7		- Well, suit yourself then. Alt.: Well, that's a pity!
8	*Annoyed exhale, almost like a gasp*	
9		- Alright, let's see what we got here.. municipality and waterboard tax, huh? Uh-huh..mh-hm.. ***scans*** checks out. ***happily*** Gotta be the lowest so far!
10	- Whoa-whoa-whoa **Alt.:** Waitwaitwait	

	- Did you just say the lowest so far? C-Can I maybe compare it with mine? **Alt.:** Could I have a look please?	
11		- Sure thing, here you go
12	- ***scans*** uh-huh. mhmh. WAIT WHAT I PAY SO MUCH MORE [than this guy] - ***awkwardly*** eheh.. nice.. so uh, what do you do to save on your tax?	
13		- Glad you ask! - Sooo.. you know about this watertowers around town?

Scene 2 – The Water tower

#	A	B
1		- Back in the day, when people started flocking into the cities water management became an increasingly difficult issue - So, during the daytime, watertowers helped to tackle increased demand - While at night, most of the people were asleep, so it got slowly refilled ready to be used again the following day - We actually used to have a bunch of them [in the city] but they have been slowly disappearing over time
2	- Hold it. What does that have to do with anything? - **Alt.:** waitwaitwait, what does that have to do with anything?	
3		- Well, I got myself a regentoren - It's a rainwater harvesting system that you can connect to your flatroof - and unlike the other ones this one got brains - It knows when it's gonna rain and empties itself automatically - This way it can never be too full or too empty - So whether I'm watering my plants, srubbing my tiles, washing my bike or cleaning my windows - I'm saving a little bit every single time

Scene 3 – Regentoren

#	A	B
1		- Well, I got myself a regentoren - It's a rainwater harvesting system that you can connect to your flatroof - and unlike the other ones this one got brains - It knows when it's gonna rain and empties itself automatically - This way it can never be too full or too empty - So whether I'm watering my plants, srubbing my tiles, washing my bike or cleaning my windows - I'm saving a little bit every single time

Scene 4 – Reviving the watertower

#	A	B
1		- So imagine this: With enough people on board we're saving a bunch of money while recreating what watertowers used to do for the city - And you know what the best part is? Because the municipality really believes in this idea they're handing out discounts to early adopters to share with their friends and family
2	- Sooo.. About that beer..	
3		- Riiiiight, come on over!
4	**Awkward laughter**	**Awkward laughter**

F: Semi-Structured Questions

Q1: What did you think about the animation?

Q2: Is the concept convincing?

Q3: Can you point out what was causing the most confusion about the animation?

Q4: What could be improved?

Q5: What are the best/worst aspects of the animation?

G: Open Questions: Evaluation Comments

Participant 1:

What is the message?

Do we need the first part of the movie? Can it be shorter?

(With the GBLT -> it's not correct)

With Vitens it's not substantial

Participant 2:

I get the metaphor.

Marketing is complex: municipality, waterboard, vitens

I get that many small (SRB) function as one big one (water tower)

Participants 3:

Long Introduction

Drinking water, waterboard taxes, municipality taxes run through each other.

Why is the left neighbour not happy?

Don't use the word "never"

Participant 4:

Nice, funny movie

Think about the logo

The re-use of rainwater can be more explicit and earlier in the movie

The movie is a bit slow

Especially the start. It's funny but for a campaign a bit long

The neighbour discussion can be shorter

The sound is very useful

Participants 5:

The animation makes me happy, it's attractive, but the beginning part with the letter is confusing

The intro is long.

The message is confusing

Participants 6:

nice, funny

A little bit slow

I got the clue

Invites to get more information. My curiosity is big!