Exploring Conceptual Variation by Design for the aQysta pump placement process

Name: Thom van der Gragt

Student nr: 4308425

Master: Watermanagement

Supervisors: M. Ertsen, J.C. Diehl, W. Kersten, O. Hoes, T. Overgoor, J. Michavilla

Table of contents

Abstract

aQysta is a company that has developed spiral pumps that can deliver water for irrigation through hydraulic energy (aQysta, 2018). That makes these pumps very dependent on the location where they are placed for their water delivery. Their dependency on hydropower also impacts the water supply of these pumps to surrounding irrigation fields (Lawrence et al., 2018). Besides technical boundary conditions these pumps also have to compete with traditional powered pumps and stakeholder opinions considering this is a new technology. All these factors contribute to a rather exciting process to find the right locations for these pumps, or Pump Placement Process (PPP). Since this PPP has to be adapted to many different regions around the world the PPP becomes very complex and time intensive. Context Variation by Design (CVD) is an approach that might offer a solution to this PPP. This approach lets the user utilize the strength of many different contexts, which coincide with the many regions where the pumps are being installed (Kersten, Crul, Engelen, van, & Diehl, 2018). An Adaptive Framework (AF) has been constructed that allows the various projects in the PPP to be compared with each other according to the CVD approach. This AF was subsequently filled in by various people active in aQysta's PPP, and by comparing different projects new patterns have arisen. These patterns offer new ways to investigate and improve the PPP. It has thus been proven possible to apply CVD to aQysta's PPP and create new insights concerning the PPP.

1 Introduction

aQysta has developed two spiral pumps that can pump up water from rivers or canals powered by the flowing water itself (aQysta, 2017). These pumps can thus operate without the need of an external power source like electricity or gasoline. This however does make the pump, much like other hydro-powered techniques, very dependent on the location where they are placed (Manzano-Agugliaro, Taher, Zapata-Sierra, Juaidi, & Montoya, 2017). Because these pumps depend on the environment itself for their possibility to pump water around extra attention is needed for the location determination for these pumps. Not only the technical aspects such as hydropower potential and canal slope are relevant, social, economic and environmental aspects are important to the pump placement decisions as well (Butera & Balestra, 2015). Those issues can differ from regions to locations in a specific canal or river section. aQysta itself already has put much effort into deciding if a location is well suited by creating a site feasibility form. This form contains different categories on general, technical, socio-economical as well as strategic factors. This way the pump placement process (PPP) is made more efficient by filling in the form and review if the site conditions meet the boundary conditions for the pump. However, this form and the standards it entails were designed by aQysta itself and is used separately for each new location. Each new location thus has to be evaluated separately, and similar conditions with matching solutions might go unnoticed.

What if there was a method to discover solutions that can cover a width variety of problems that might not be connected at first thought? That is where Context Variation by Design (CVD) can prove valuable to the PPP of aQysta. This method focusses on anticipating future obstacles by broadening a products, or in this case process', design space (Kersten, Crul, Diehl, & Engelen, van, 2015). At the moment aQysta has to investigate each possible area where pumps can be installed to meet the needs of the local canals, communities and countries. It would be interesting to see if CVD can anticipate future obstacles or opportunities in expansion locations for aQysta so that less investigation has to be done each time, or at least a more streamlined process of meeting local demands can be realized. These demands could be categorized into weather resilience, portability, waste screens etc. The nature of CVD is that it is adaptive and creates design space for complex problems. This calls for a flexible process that can be enhanced to suit the specific needs for different kind of regions. Some regions where pumps can be installed will be more intensively managed by aQysta, while other regions a lot of tasks might be handled by external companies. Such a process guided by CVD principles can be best managed through an Adaptive Framework (AF) (Lankford & International Water Management Institute, 2007. How such an AF guided by CVD principles can be created in the case of aQysta's PPP is the focus of this thesis. The goal of this thesis becomes the following:

Design an adaptive framework for the pump placement process for aQysta based on CVD thinking

The thesis will focus on creating a process that is guided by CVD principles and is useable through an AF that will result in adequate locations being chosen of where to place the pumps. To get to this point however some other steps have to be taken first in the form of sub research questions. These questions are:

- What elements can be identified that make up the pump placement process?
- How can such a process be transformed into an AF?
- Can CVD thinking be applied to this AF?

The elaboration of this research in this thesis can be aligned alongside the sub-questions as they represent the order in which the AF was created. That will be explained in the methodology chapter and can also be seen in the results chapter. Before those, first the literature review in the next chapter will address the theory of CVD plus other relevant theories and the questions how all this can contribute to an understanding of the context in which this thesis is positioned. After all, context is not limited to hydro pumps and the processes that guide their placement.

2 Literature Review

In this chapter the relevant scientific theories concerning this thesis will be discussed. These theories cover the following subject: CVD, AF, placement requirements for spiral pumps and business organisation. These scientific resources are then supplemented with insights from aQysta's own documents to understand how their current decision process is organised.

2.1 Context Variation by Design

The featured approach of this thesis will be Context Variation by Design (CVD), thus it provides a logical start to begin the literature study by exploring CVD more in depth. CVD is not so much a theory but more an approach (Kersten et al., 2015). The goal of CVD is that by Design (D) varying (V) the context (C) so that new insights arise surrounding a product that is being developed. The objective is to anticipate future challenges so that a product can be created that is suited for those multiple challenges without creating a new product each time. This product can be a physical tool, or even a more abstract new paradigm. At the heart of CVD is varying the context, since it is so important to how products function, are received and succeed in their goals. Especially in water management and thus irrigation systems, context is extremely important (Hillman, 2006). At the base of the CVD approach lies the recognition that most challenges are complex situations that should be respected as such. This means that restraint should be shown when addressing these situations and not try to simplify them. CVD gains it strength by observing the many complicated aspects of design challenges and connecting these aspects to gain added value and new insights to the design process. What CVD is can be explained by showing three different levels of 'interconnectedness' and summarized in Figure 1.

1. At the first level there is only one specific market (m). This could be a local area, demographic or any other phenomenon that has its own specific user (u) needs. Then a product can be designed to form a solution (s) to these needs.
2. At the second level there is a development from the first solution to adapt it to a second market. The design is expanded upon to fit consecutive markets and profits from earlier gained insights.
3. It is at this third level that CVD can be observed if the different markets are simultaneously considered and there are entire networks (n) of relevant stakeholders surrounding the markets. the different solutions for each market and relations with the networks are influencing each other at the design stage. This creates a broad field of solutions that can still be specific for different markets, but also overlap to create a more complete product than when these solutions are found consecutively.

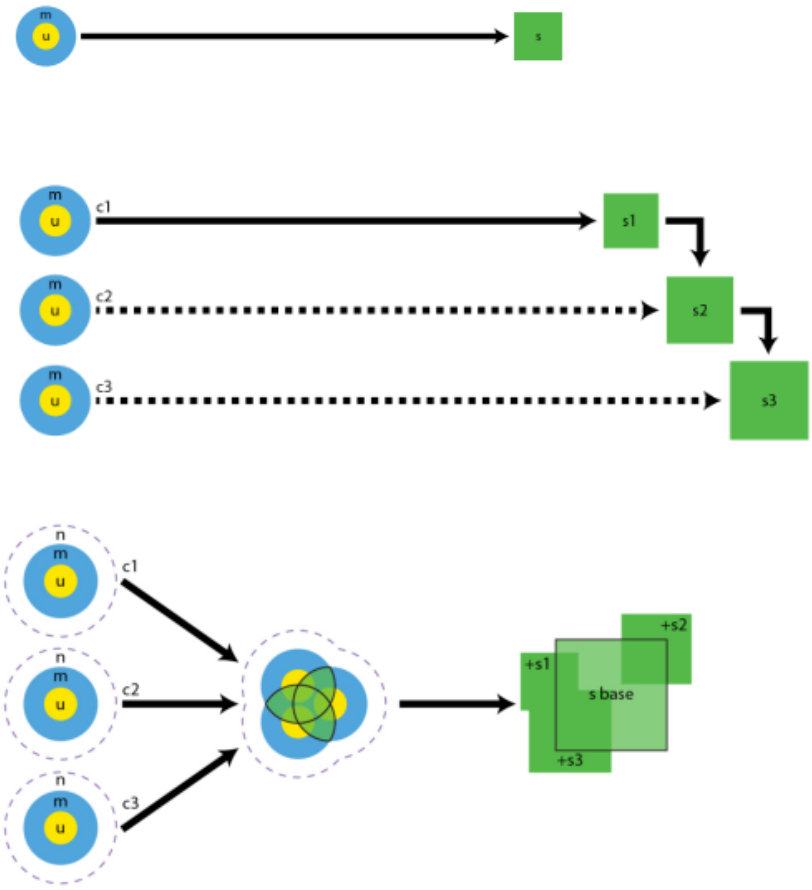


Figure 1: Three design strategies compared (Kersten et al., 2015)

Following the general concept of CVD the design principles upon which this approach was built will be explored. The general design approaches are supported by four main design principles (Leenders, Engelen, & Kratzer, 2007): hierarchical decomposition, systematic variation, satisficing & discursiveness. *Hierarchical decomposition:* When addressing complex situations, instead of decomposing it into smaller sub problems, try to focus on the characteristics of the complexity. By doing this it enables the designer to see similarities across multiple contexts more easily. *Systematic variation:* Try not only to vary in the product or services that are available, but also vary across markets, networks and their combinations to gain more insights early on, before the major placement decisions for that location are taken. *Satisficing:* Set own set of criteria for when the product is finished instead of continuously optimizing. Optimisation is only possible for small closed systems. *Discursiveness*: Reshuffle the order in which processes occur to gain new insights. By anticipating on later steps in the design process valuable insights can be anticipated on at earlier steps. CVD focusses especially on systematic variation by varying in context but also relies heavily on the other three design principles (Kersten et al., 2018). The AF should therefore consider these design principles and how they are incorporated. What CVD adds into the mix is that it argues to apply these principles as early

as possible in the design process. The challenge of this thesis then becomes to not apply CVD to a product, in this case the hydro pumps of aQysta, but to the process that is used to decide where to place these pumps. If it is possible to compare multiple contexts for the PPP patterns , or better called shared insights (Kersten et al., 2018), can arise which can increase the creativity and efficiency of the PPP.

CVD thus tries to move away from a linear design process towards a more integrated process. This also calls for other linear processes within the company to change along. To orchestrate this interconnected setup a value network is needed (Hagel & Brown, 2011). Such value networks organise their actors and manage instead of direct them. Managing value networks can only work if the complexity of design challenges is accepted (Norman, 2010). This poses a challenge to try and consider design tasks as complex as possible while also following some sort of repeatable approach. Structuring complexity in a design process is key to a sustainable future development of the product (Brown & Eisenhardt, 1997). The paradox is however that CVD argues strongly against structuring as that can limit the design space. CVD processes should thus focus more on connections than end targets. This paradox can be observed in a broad field of company strategies (Chesbrough, 2003). There is a clear call for finding a workable balance between clear and structured approaches that still manage to be adaptable and capable of handling complex situations.

2.2 Adaptable Frameworks

Translating this complexity to a structured approach seems quite the task, but an AF might provide a solution (Lankford & International Water Management Institute, 2007). Such a framework provides structure in how to manage new situations but leaves enough space for context specific resolutions. Although Lankford based his AF on river basin management, it could still provide useful insights for this thesis. This framework consists of two parts: part one (Figure 2) is a cyclical process that describes each stage of strategy decision making for a river basin. Part two is the actual AF describing all steps that can be seen in Figure 2 accompanied by multiple choices.

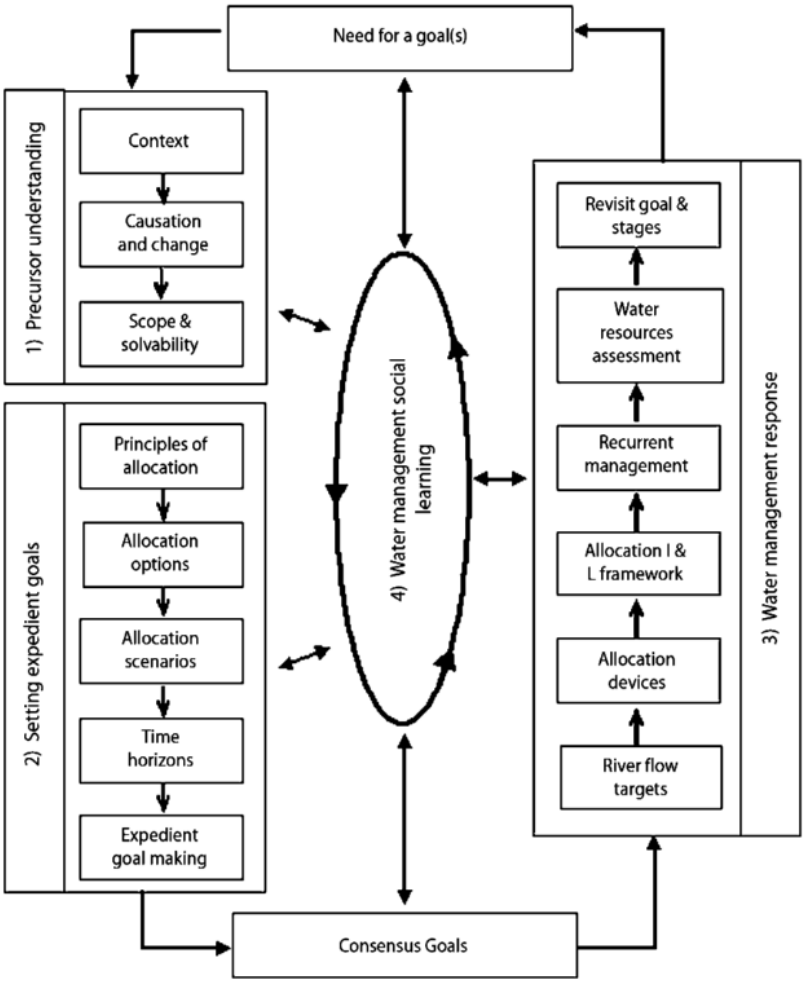


Figure 2 Cyclical process of strategy decision making (Lankford & International Water Management Institute, 2007)

The cyclical process is consistent with the complexity vs structured paradigm. It first addresses steps that broaden the strategy to include as many aspects as possible, when in the second half of its cycle the scope narrows again to come to select the most promising aspects. Part two of Lankford's AF consist of a list of variables where for each variable multiple actions are described based on the variable's status. Lankford's cyclical process can be divided into two distinct stages. The first stage is about context and defining the goals, where the second stage is about deciding on the goals and working towards them. This approach is also advised by Veeneman (De Bruijn & Veeneman, 2009) where he states that in the beginning complexity should be tackled by a goal seeking stance to gain a broad overview. To the end this should be replaced by a goal achieving stance to come to a successful conclusion. Where Lankford acknowledges the importance of involving stakeholders along the process, Ahern explicitly places key stakeholders along each step of his AF (Figure 3).

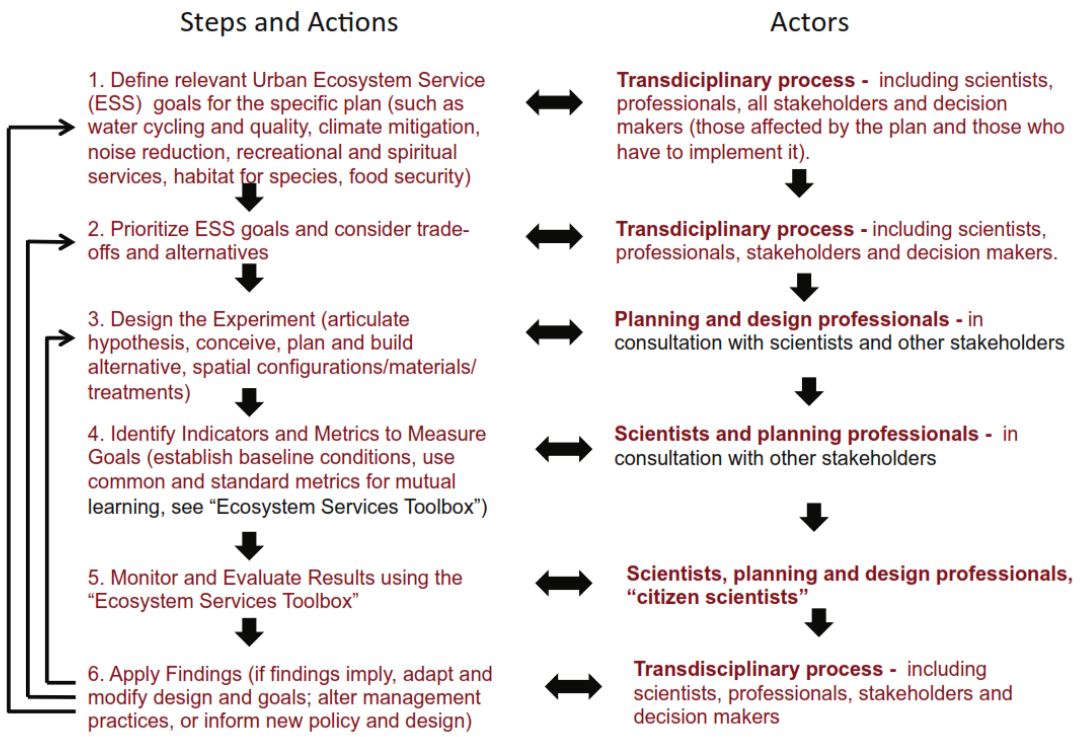


Figure 3 transdisciplinary AF for design processes (Ahern, Cilliers, & Niemelä, 2014)

He also focusses his AF on the four scientific design principles of: conceive, implement, monitor, and analyse. This because designing is never a finished job and there needs to always be room for evaluation and improvement upon the results.

Context can refer to a broad spectrum of variables and combination of aspects such as location, culture, terrain gradient, end-user groups, social norms and more. These can provide for complex situations but can become complicated if they are not recognised as such at an early stage (Norman, 2010). This broad context can be divided among five parts necessary for a successful pump placement decision making: availability of hydropower, together with technical, social, environmental and economic factors (Butera & Balestra, 2015). The challenge remains to balance a realistic view of complex situations and clear parameters on which to base pump placement decisions.

2.3 Pump Placement Process

Next to CVD and the accompanying AF the hydro powered pumps itself are also of importance to this thesis. Since hydro powered pumps are dependent on their surroundings for their effectiveness, finding the right locations to install them takes extra care. The pumps of aQysta are designed to provide two things: 1) Creating access to irrigation 2) Enabling water-efficient pressurized irrigation techniques (Thapa & Dulal, 2018). Creating access to irrigation is done by using a pump to transport water from the canal/river to the irrigation field. Enabling water-efficient pressurized irrigation techniques is accomplice by coupling this pressurized water to drip irrigation systems. The pumps of

aQysta are spiral pumps that create water pressure to transport water to irrigation fields. These spiral pumps work by having a water wheel that is driven by flowing water and a pipe wrapped around an axle, as seen in Figure 4, to create the spiral which can theoretically achieve an efficiency of 75%. This spiral pump can then elevate water around 10 times higher than its diameter.

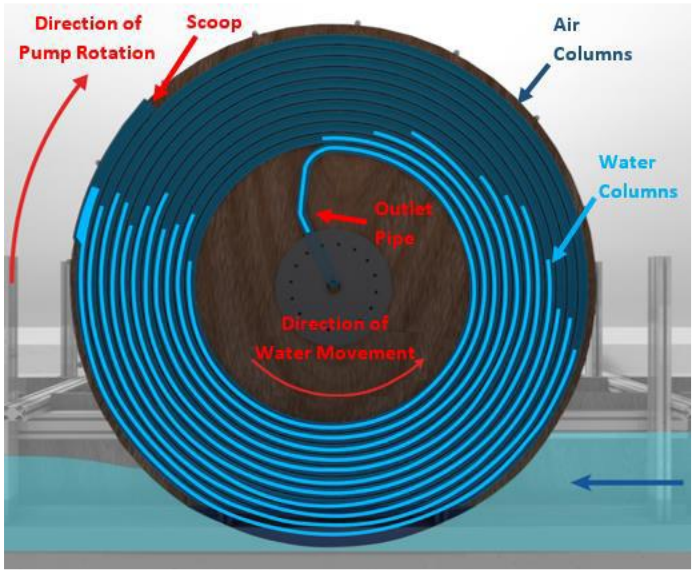


Figure 4 Spirals wrapped around an axle to create a spiral pump (Lawrence et al., 2018)

Currently aQysta has one spiral pump in active production which is the Barsha pump. This pump can elevate water up to 20m together with a flowrate of 0.5 l/s. There is also the HyPump currently in development which can pump up to 30m high accompanied by a flowrate of 11 l/s. These relative low flowrates compared to conventional powered pumps can be compensated by connecting the spiral pumps to drip irrigation systems. Conventional pumps can also be connected to drip irrigation systems but because of the pressure demands will have high operating costs. Drip irrigation being a more efficient way to water crops compared to flood or sprinkler irrigation (Postel, Polak, Gonzales, & Keller, 2001). This spiral pump is however dependent on the canal or river that its placed in due to the water wheel that has to transform the kinetic energy of the flowing water into pumping power (Quaranta, 2018). These water wheels can be compared to small hydropower (SHP) since their needs in waterpower align. Quaranta also proposes three different variations for water wheels: over-, breast- and undershot to cope with varying circumstances where the wheels are placed. One of the most important aspects to base SHP investment on however is electricity prices (Bøckman, Fleten, Juliussen, Langhammer, & Revdal, 2008). This relates inversely with the placing potential of spiral pumps as they compete with electric pumps. If energy prices are high then spiral pumps become more attractive. Other important aspects of deciding where to place SHP and thus spiral pumps are laws

and regulations enabling making changes to existing canals, political stability, communities willing to invest in new technologies and available local companies that have knowledge on installing SHP (Ferreira, Camacho, Malagoli, & Júnior, 2016). The same requirements are comparatively universal across different regions such as Europe (Manzano-Agugliaro et al., 2017), Africa (Chiyembekezo, Kimambo, & Nielsen, 2012), Asia (Ueda, Goto, Namihira, & Hirose, 2013) & (Lebel, Garden, & Imamura, 2005) and South-America (Ferreira et al., 2016). These sources have given a wide view on important aspects to recon with when placing SHP which are very comparable to the needs of placing the pumps made by aQysta. This can provide useful input to construct the AF.

2.4 Business organisation

Such an adaptive framework can only be successfully incorporated if it fits the company it is designed for. The goal of the adaptive framework is to handle the changing situations wherein the pumps have to be situated, which reflects also aQysta's rapidly evolving structure. This places aQysta as a developing company at the second stage according to Vesper (Vesper, 1980). This stage describes a start-up that has developed a working product and now needs to scale up to sell the product in profitable volumes. At this point it is important to find a balance between the informal organisation, and a more formal structure that helps in scaling up and selling the pumps. That's why it's important to not only look at the physical and social context of the locations where the pumps are to be placed, but also at the process of how aQysta comes to the decision of pump placement. Small businesses have a significantly higher chance to survive if they are active international, have a broad list of partners, diversify their products and are flexible (Dobbs & Hamilton, 2007). This aligns with the goals of the AF to streamline the formal structure of site selection for the spiral pumps, and still maintain a flexible organisation with accounting for the points that Dobbs & Hamilton (2007) mentioned.

3 Methodology

In this section the methods that were used to create the results for this thesis will be discussed. This chapter's goal is to validate the research method's chosen to achieve the results needed to answer the research questions.

To understand CVD and how it could be applied to a PPP through an AF, the terms itself had to be understood by reading up on the relevant scientific literature. This chapter also revealed important aspects about the PPP providing the basis on what to decide the variables. Subsequently the PPP specific to aQysta was identified through a document analysis and interviews. This enabled a PPP overview to be created as well as further understanding of which variables are important. The initial PPP was expanded upon through a second round of interviews in Spain as part of field research that also added more variables. Then the PPP was transformed into an AF by doing a third round of interviews and exploring different PPP's around the world. This led to more variables ensuring that cases could be compared globally. A last round of interviews was conducted to verify the AF and see if it could be understood and used by aQysta.

For this thesis a qualitative research approach was chosen to explore the added value of CVD to the PPP. Since the research questions are about understanding a process and how to improve this process with help of the CVD approach qualitative research methods were chosen. This qualitative research was based upon scientific literature, aQysta's internal documents, semi-structured interviews and field research. A literature review has to be done to grasp the relevant theories of the subject area and an understanding of the discussed products such as the spiral pumps and AF's (Hart, 2018). The document analysis was done to show insight in aQysta's own PPP. Internal documents of aQysta were studied to reveal their formal PPP, it also revealed information on how to start the interviews and on which subjects to focus by highlighting aQysta's approach and enabling the researcher to continue asking questions about this approach. The interviews were set up as semi-structured interviews, wherein the interviewer could ask specific questions to the interviewee. Even though there are pre-determined questions, the interview takes place in a relaxed setting which allows the interviewee to deviate from the questions. This way answers might arise that the interviewer would not have anticipated on beforehand (Clifford, French, & Valentine, 2010). Table 1 gives an overview of all the interviews conducted together with how many respondents there were and what the goals of these interviews were. Each round will be further explained in the following sub-chapters to give insight in how the data was acquired and interpreted. To complement these sub-chapters data-documents are available in Appendix B that describe in more detail how each research round took place and who the respondents for each round are.

Round	Date	Respondents	Interview goal
1	May	3	Exploring aQysta's current PPP
2	July	8	Stakeholders contribution to the PPP in Spain
3	August	7	Explore PPP in different countries where aQysta is active
4	Sept. - Oct.	7	Validation of AF
5	November	4	Discussing results of the AF

Table 1 overview of interviews

For the second round of interviews the researcher had to go to Spain, enabling him to do his research in the field. This gave the interviewer a way to look beyond the answers of the interview and see the environments in which the respondents had to operate (Silverman, 2005). These multiple different methods on data acquisition have been chosen so that they may complement each other by means of triangulation (Silverman, 2005). By choosing four methods of data acquisition it will be possible to generalize on the findings. There were in total five research rounds in which data was gathered through the various methods. An overview and the order in which these methods were performed can be seen in Figure 5. The scientific literature analysis has previously been highlighted in its own chapter, so it will not be discussed here.

Figure 5 research rounds accompanied by methods

3.1 First research round

Before an AF can be created it is important to have a PPP to apply it to. The document analysis is the first step in understanding the current PPP by analysing internal documents of aQysta. These give a rough outline of what the procedures are of the current PPP since the process itself was not complete and formalised yet. Different important topics are highlighted in the documents, but there is no documented formal process yet from beginning to end on the PPP. These documents also serve as a guide on how to start the interviews at aQysta to further explore the current PPP. The documents for example highlighted four different areas which are important to aQysta's PPP. This proved then interesting to see if these four areas would also arise during the first round of interviews. But also interesting was the subjects that were not found in the documents, namely how to engage possible clients or interact with stakeholders. This was then incorporated in the first round of interviews to find out if and how these subjects were informally handled. Since there was no formal PPP discovered in the document analysis, the first round of interviews focused on identifying how aQysta currently handles the PPP. Three persons were interviewed who together covered the whole PPP. These steps led to an identification of the PPP according to aQysta.

3.2 Second research round

Investigating only at aQysta itself does not provide enough information to generalize the PPP on. The wants and wishes of clients and stakeholders also influences the PPP (Ferreira et al., 2016). These insights were not gained during the first round of interviews. Therefore, extensive interviews were held in two regions in Spain where the HyPump will be tested. By going to the pump selection site, it was possible to visit these communities and interview certain stakeholders. By going in person it enabled the researcher access to the situation of interest normally controlled by gatekeepers (Silverman, 2013). The interviews were also adapted to the different types of stakeholders that could be encountered: water authorities, farmers and partners. Farmers were represented by the farm owners who were the main client group in Spain. Water authorities were the operators of the irrigation canals or government representatives and partners were company representatives who could possible work together with aQysta in the PPP. Some stakeholders were reluctant to speak at first, it would have been even more difficult if they had to be contacted through skype interviews. A complication to the communication was that the researcher did not speak the language of those he wanted to interview. An employee of aQysta accompanied the researcher to translate the interviews. This caused some difficulties in responding to the answers given by the interviewee, so this round of interviews is a bit more structured than the previous one. It was also desirable to visit a few potential pumping sites in person to evaluate how certain variables like infrastructure or canal availability would have to translate to an AF.

3.3 Third research round

After the second research round a complete overview of the PPP with various types of stakeholders represented was available. It became however clear that there still was not enough variation in observed regions to produce an AF based on the CVD approach. The two regions in Spain were in some cases different (quality of road & canal infrastructure, energy prices, willingness to adapt…) but they were still both in Spain and thus shared a lot of other variables (political stability, laws & regulations, working culture…). It was decided to do an additional round of interviews with partners and personnel of aQysta who were active in countries around the world. The people interviewed had only experience with the Barsha Pump, while the previous two research rounds focussed on the HyPump. In general these two pumps follow a comparable PPP, since they are both spiral pumps. But on cases like logistics and technical requirements the pumps differ significantly. This distinction was kept in mind when creating the AF and comparing variables. The interviews were done through skype and by the researcher alone since all the interviewees were sufficient in English. The questions asked were the same as in research round one with the addition of a question about laws & regulations and one about social and economical limitations. The laws & regulations question was added since the research in

Spain revealed that this is a subject of major importance. This topic can differ a lot from country to country, so it got its own question dedicated to it. The social and economical limitations question was added since the scope of the interview surpassed merely observing the PPP like in round 1 but also focused on specific characteristics of each country. With these interviews done construction could begin on the AF. The results of these interviews also showed there was a difference in PPP between countries where aQysta was overseeing the process and countries where big parts of this process were left to partners. Another outcome was the different levels of scale that are relevant to the PPP. Some respondents operated on a regional level, and others on a national level. This causes problems when filling in variables that are more suited towards a national or regional scale level. More on this in the results.

3.4 Fourth research round

After constructing the AF with all the input from the previous research rounds it was important to gather feedback on this AF. This served two goals: one was to test if the AF could be understood by its target user group, the other was to gather a lot of projects of varying countries and regions so that these could be compared according to the CVD approach. Therefore, the respondents from the first and third research round were invited to fill in a feedback version of the AF based on their experience with a pump placement project. Respondents could choose to either fill in a project concerning the HyPump or the Barsha pump. These two pumps differ significantly on certain variables like canal dimensions, cost and logistics. However, only two projects for the HyPump were ongoing during this research. Limiting the AF to the HyPump would make it difficult observing how multiple projects can be compared for the AF. It was decided to allow projects for both the pumps be filled in for the AF to get as much data as possible. This led to a wide range of regions and countries that were put in the AF. Still, there were only seven respondents for this round so there was also no division made between the national/regional and focus/retail distinction that was observed the previous round. Another thing that became clear was that not all the projects were filled in completely. Respondents often only had knowledge about a specific section of the PPP like sales, logistics or design. In the end it would leave very little variables that could be compared over various projects if projects would be separated based on pump type or project type.

3.5 Fifth research round

The last research round served to examine if interesting synergies could be discovered by comparing different projects in the AF through CVD thinking. From all the input of the previous research round seven projects across different countries were collected and could be compared according to their variables. Results were produced this way and these results have been shown to personnel at aQysta to investigate how they perceived the functioning of the AF. Three people from aQysta Delft were

interviewed together with one person from aQysta Colombia. This was done at a meeting to enable discussion among the participants about the effectiveness of the AF and to get representation from people involved in different aspects of the PPP. The results from this meeting are used to draw conclusions on the quality of the results from the AF.

4 Results

In this chapter the findings of this study will be presented. These results will be shown in the same order that the research took place to give insight in the authors reasoning. This chapter is divided into five sections: aQysta analysis, stakeholder analysis, AF development, AF validation and AF results. These sections share their results with the previously discussed research rounds in the methodology chapter. This way the research done each round can be linked to the results shown here.

4.1 aQysta analysis

Before the PPP can be enhanced, it must be understood how it operates in its current form. To that end documents of aQysta on this process have been analysed, and interviews have been conducted with persons who are involved in the process.

aQysta has its own site feasibility form to help decide if a location is fit for installation of its Barsha Pump. This form focusses specifically on technical factors, with some attention to socio-economical and strategic factors. The technical factors include the required flow rate of the water in the river/canal, the dimensions of said water source, and how much and how far the pump can transport water. The socio-economical questions inquire about the clients reasoning behind getting the pump, whereas the strategic factors explore the marketing potential of that location. Besides the feasibility form there are policy documents that comment on a more extensive field of variables to discuss before a site can be decided upon. The site feasibility is also only a part of the whole current site selection process (Figure 6).

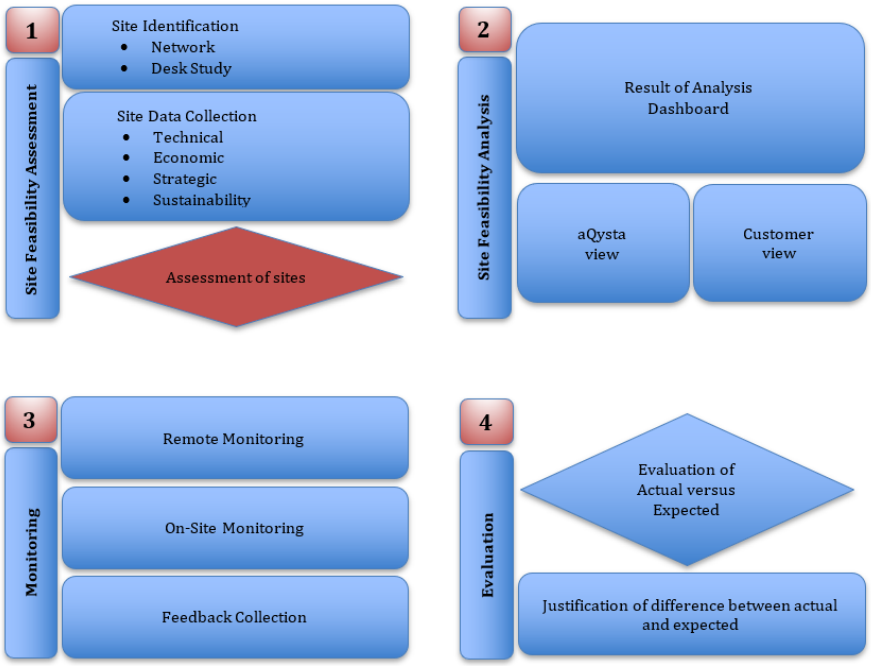


Figure 6 site selection process of aQysta (aQysta, 2018)

This process is divided into four parts:

- **Site feasibility assessment,** which focusses on the technical, socio-economical and strategic factors as described in the earlier discussed feasibility form
- **Site feasibility analysis,** which considers the stakeholders important to the PPP
- **Monitoring,** which covers the activities to be performed to monitor key technical and economical parameters during the operating phase.
- **Evaluation,** which is the comparison of the expected and the actual outcomes.

Especially the first two categories are important to this research since they consider the decision making on where to place pumps. The latter two are also important to building an effective AF as Lankford (2007) states with respect to an evaluation process, but this is not considered for this research due to time constraints. Multiple technical variables are highlighted in the document, but it lacks in variables on stakeholders and partners. Also, the various documents highlight important aspects of the PPP but not in what order these should be considered. This hints that the site selection cannot be performed in a vacuum, and that the surrounding processes should be given attention. Stakeholder opinions, laws, possible partners & climatic variations are also variables that can influence the decision-making process. aQysta eventually decides upon four categories in which the decision-making process can be divided in Figure 7.

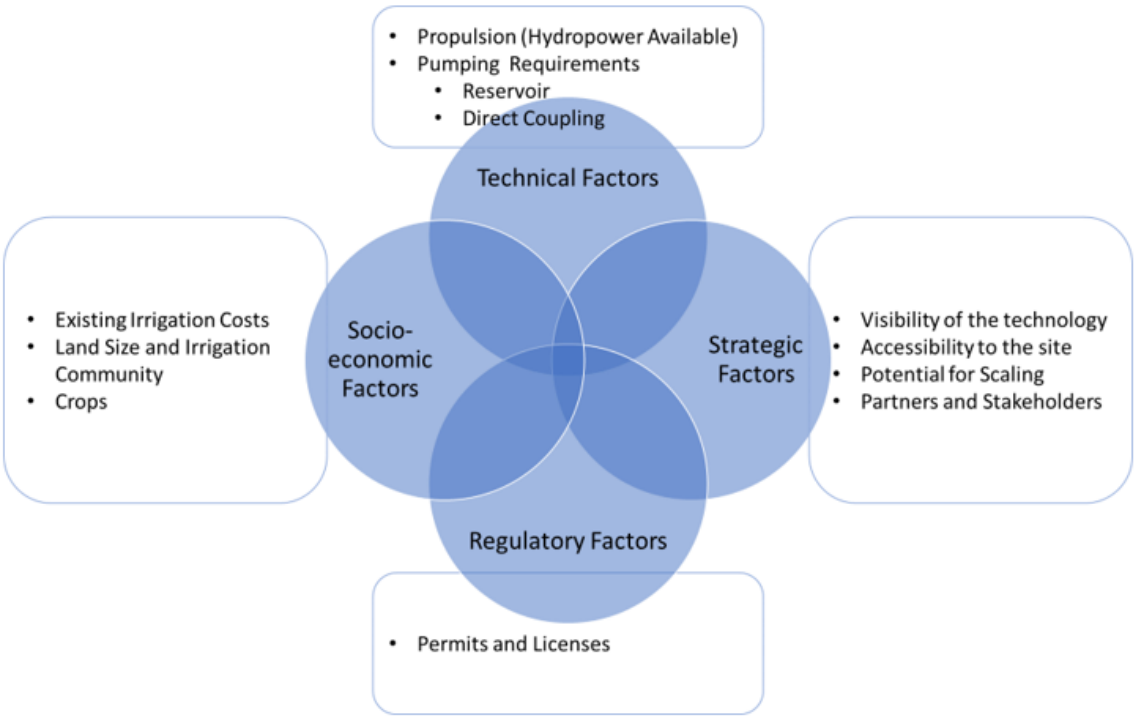


Figure 7 aQysta categories for pump placement process (aQysta, 2018)

From these categories, the three previously discussed categories of technical, socio-economical and strategic factors are accompanied by regulatory factors. Furthermore, the documents focus solely on one site, without taking into consideration other regions and/or how those lessons learned should be incorporated. These findings from aQysta documents were supplemented by three interviews done at aQysta to gain more insight into the PPP. The following overview (Figure 8) is based on all the previous research results.

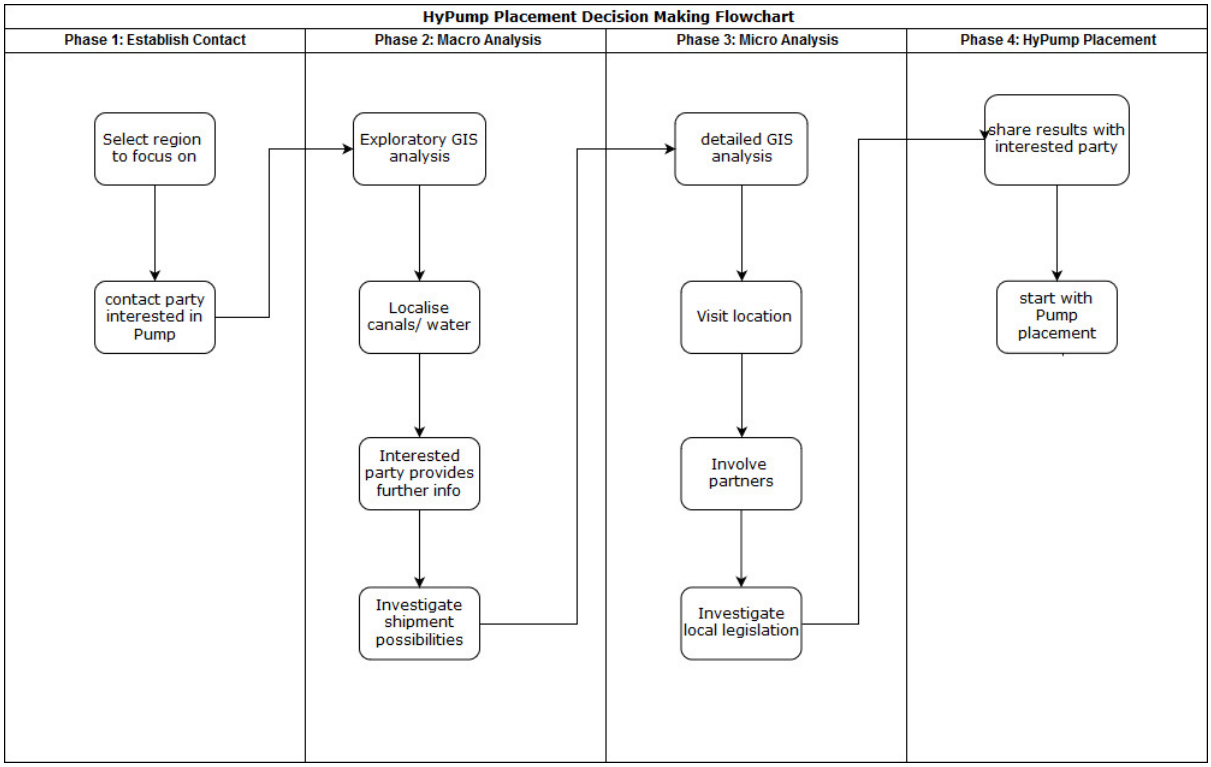


Figure 8 the PPP as initially identified

It shows the PPP as a linear process starting at the upper left. In practice this PPP can differ if for example, there is an existing client who wants another type of pump. And it happens that some steps are more convenient to execute earlier due to circumstances. In general however the documents and interviews agree that this should be the formal PPP. It consists of four phases wherein the steps share a common theme. The first phase is about getting in contact with possible clients. The second phase is investigating the region to see if it is physically and logistically suitable for pump placement in general. The third phase is about looking where the pumps should be placed in the canal and involving stakeholders in the process. The last phase is about reaching a deal with the client and placing the pump. A more detailed description of all the steps now follows:

- **Select region to focus on,** the first step in the PPP is deciding in which region to start searching for interested clients, and thus suitable pump placement locations. This is done by investigating the region on a macro scale by looking at climate, terrain, scale of farms etc…
- **Contact party interested in Pump,** this step is about reaching out to the interested client by sending them the parameters of the pump.
- **Exploratory GIS analysis,** in this step the geographical data such as climate, elevation and vegetation maps are collected.
- **Localise canals/water,** here all the waterways of the region are identified that are suitable for the pumps together with locations for reservoirs that can store the pumped water.

- **Interested party provides further info,** now the interested client is asked about information about other interested stakeholders, data on his farm dimensions and an overview of interesting organisations.
- **Investigate shipment possibilities,** this step involves researching the logistical opportunities of the region. Can the pump be easily transported and installed, are there companies available that have experience with this?
- **Detailed GIS analysis,** all the acquired data up until now gets filled in so that a few possible locations for the pump placement emerge.
- **Visit location,** to see if the acquired information and the outcome of the previous step match with the local conditions. Additionally, variables such as flow rate can be gathered. It also offers an opportunity to meet the stakeholders in person.
- **Involve partners,** stakeholders who can help with modelling or placement can be engaged to begin assisting in the remaining steps of the PPP.
- **Investigate local legislation,** find out what permits are needed and if there are laws that can influence the pump placement.
- **Share results with interested party,** choose the preferential pump placement locations and share this with the client.
- **Start with pump placement,** after all is agreed upon start with the placement of the pumps.

A few things can be concluded from the document analysis, interviews and this first overview of the PPP:

- There is no clear decision-making process yet, the PPP is mainly based on individual experience on how to approach pump placement decisions. Although most of the content in Figure 8 is mentioned in aQysta documents and interviews, it did not previously exist as a formal PPP. The resulting PPP in is therefore a consensus on how the PPP works in general.
- General information on various countries is being gathered but not yet compared structurally. Projects are now regarded on a case by case status. This also follows from the fact that there is no formal PPP yet and thus a structured way to compare projects to each other. This can prove a good opportunity for the CVD approach.
- Three of the four categories that aQysta deemed important to the PPP are currently covered by the various steps: socio-economic factors, technical factors and regulatory factors. That leaves room to improve the PPP with strategic factors.
- The currently developed PPP is based on information from aQysta. It can be improved with the experiences from stakeholders.

4.2 Stakeholder analysis

Investigating only at aQysta itself does not provide enough information to generalize the PPP on. Stakeholders make up a large portion of the PPP, it would be wise to involve their perspective on said PPP. Extensive interviews were held in two regions in Spain where the HyPump will be tested. This way the PPP could be examined as it was being performed. Three types of stakeholders were interviewed: farmers, water authorities and partners. This led to the following overview (Figure 9) and a more complete PPP list of relevant variables.

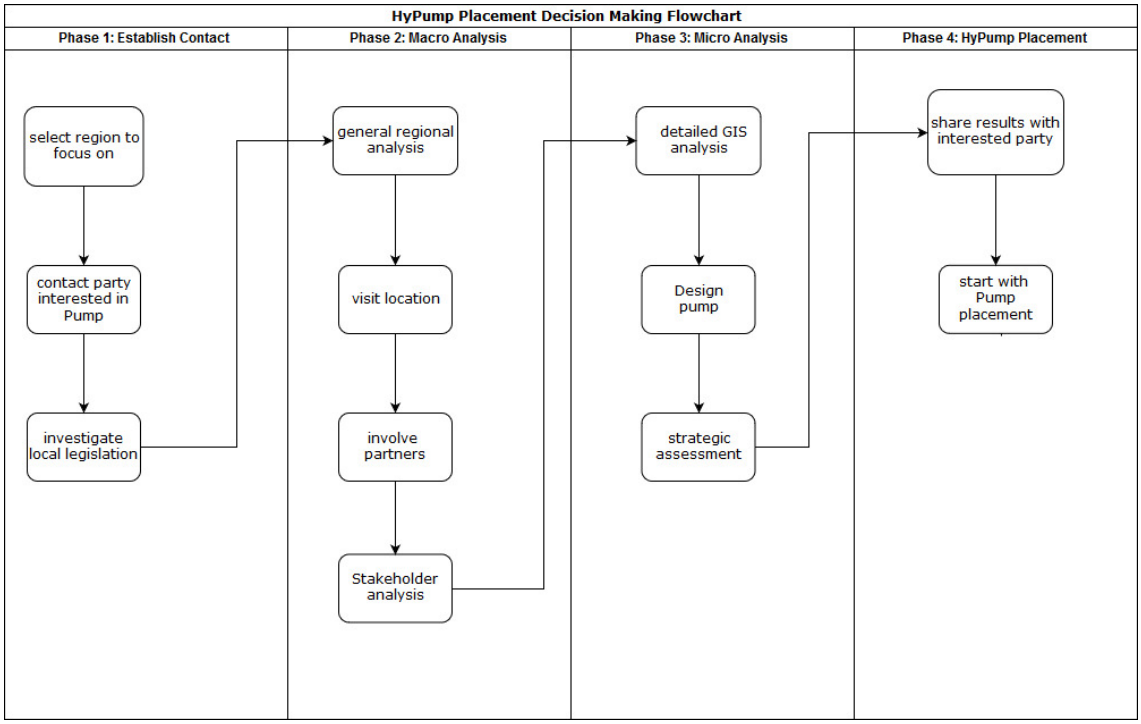


Figure 9 definitive PPP

The field research in Spain led to new insights that altered the form of the PPP, these changes will now be addressed. **Investigate local legislation** has been moved up to the first phase. It became clear that the legal processes can take up a lot of time and should be done as soon as possible. **General regional analysis** is the combination from the previous steps: first rough GIS analysis and localise canals/water. These two steps are similar in that they describe the region where the pumps should be placed. Combining them into one step makes for a more compact and thus workable PPP. **Visit location** was put earlier in the PPP because it proved very important to validate the outcomes from the general regional analysis early on. That way it can be found out in time if conditions from maps still match those on the ground. It also offers an opportunity to engage the local community early on, which is important since farmers are reluctant to change. Together with farmers water authorities are also suspicious of any structures placed in the canals, so meeting them early is important to build good relations for a smooth permit process. **Involve possible partners** follows the same reasoning as stated

in the previous sentence. Finding good partners can ensure that a lot of local measurements can be performed without aQysta having to be present. **Stakeholder analysis** replaces the 'Interested party provides further info' step as it covers more actions. Not only the feedback from the client(s) is important, but also engaging the stakeholder network that was identified in the two earlier steps. **Design pump** is a step that focusses on the pump design itself. Previously the pump design started out somewhere along the general regional analysis step and continued until the pump had to be placed. Now it is emphasized with its own step which also allows for incorporating special client wishes and a moment to choose for a variation of the pump that suits the location best. **Strategic assessment** is also a new step that highlights the strategic aspects. Even though strategy was an important factor in the aQysta documents it was not identified in the earlier PPP. But it is nonetheless a very important step since the technology is so different from what its users are normally accustomed to. Most stakeholders interviewed in Spain were interested but also reluctant to personally invest in spiral pumps. This means that effort has to be put in convincing stakeholders of the added value, and strategic assessment explores how this can be best achieved.

Now that not only aQysta's perspective but also that from stakeholders has been considered the PPP is complete. This however is still not enough information to base an AF on since the process is still linear. If the framework were to be adaptive it must be able to accommodate different types of situations. In the next sub-chapter the PPP will be explored for a wide variety of contexts, and then the AF will be created.

4.3 Creating the AF

Now the PPP has been figured out with stakeholders in mind, but only those from two reasons in Spain. To get a more global perspective on the PPP, interviews were conducted with people who were active in different parts of the world on aQysta's behalf to figure out how the AF could be universally applicable. This way it was found out that there can be made two general distinctions when considering the PPP. There is a difference in description between countries in general vs specific regions in those countries and a difference between focus countries and retail countries (Figure 10). The division in scale can be made because sometimes aQysta is active on a nationwide level (Nepal, Colombia) and other times on a more regional level (Hijar & Lliria in Spain, Java & Zumba in Indonesia). aQysta also differs in approach for focus countries (Spain, Nepal) where they are present in all the steps of the PPP and retail countries (Colombia, Indonesia) where retailers do most of these steps.

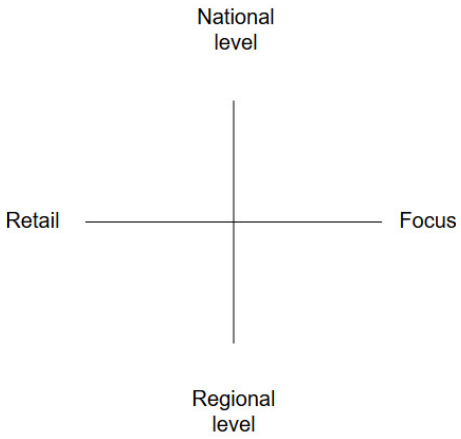


Figure 10 scale-axes of the AF

When combining the important topics that are mentioned across documents, literature and interviews the variables for the AF can be chosen. This leads to a division along two scale-axes in Figure 10. The chosen categories and accompanying variables of the AF can be seen in appendix A. Some variables are more suited for a regional or national level, but it is important to first figure out if the variables make sense at all. An overview of the AF is presented below in Table 2. It shows how much variables are accompanying each step and which themes are covered by the variables: so-con = socio-economical, tech = technical, legal = legal, strat = strategic. The last column shows if a step is more general or specific in its description of a region.

Step	Variables	Categories	Specific / General
Select region	10	So-con, tech	General
Contact	6	So-con	Specific
Legal	5	Legal	General
General analysis	4	So-con, tech	General
Visit	8	So-con, tech, strat	Specific
Partners	2	Strat	General
Stakeholders	3	So-con, tech, strat	General
Detailed analysis	4	Tech	Specific
Design pump	4	Tech	Specific
Strategic assessment	3	Strat	Specific
Share with client	3	So-con, tech	Specific
Pump placement	3	Tech	specific

Table 2 overview of the AF

It can be seen that the first half of the AF is more general in its description of the regions, and the second half is more specific. That follows nicely with the literature that an effective AF should start with a broad scope so that many perspectives can be considered before gradually narrowing the scope to get an effective decision at the end. The categories seem divided well amongst the different steps except for the legal category. It now has its own step dedicated towards laws and legal permits but perhaps this holds the category back to be inserted into the other steps. The following sub-chapter will discuss if these variables and steps are perceived to be adequate by aQysta.

In Table 3 a preview of the filled in AF is shown. This table shows the first step of the AF, selecting a region to focus on, and compares three regions by a few variables. Not all variables of this step are shown since the purpose is to demonstrate how the AF currently looks like. When multiple regions are observed hopefully trends can be distinguished along some rows of variables. These are not limited to the steps themselves but can connect to other variables in different steps. For example buying power of farms can be related to the interested stakeholders variable over in the stakeholder analysis step.

select region to focus on			
	Lliria	Hijar	Nepal
Buying power of farmers	enough money to individually buy pump	enough money to individually buy pump	Depend on government for pumps
Dominant type of irrigation	Sprinkler and drip irrigations	Sprinkler and flood irrigation	Flood irrigation
State of canals	Government owned, concrete canals	Community owned, dirt canals	Government owned
Scale of farms	Between 5 and 40 ha	Around 10 ha, fragmented ownership	
Climate	Hot dry summer and wet moderate winter	Hot dry summer and wet moderate winter	
Infrastructure	Good road, energy and water infrastructure	Good road, energy and water infrastructure	

Table 3 preview of filled in AF

In the following sub-chapter the AF will be send out to different branches of aQysta to get different regions filled in according to their variables. It can then be verified if the steps are in a logical order to describe the PPP in different regions of the world, if the variables make sense to describe these steps and finally if CVD can be applied by comparing these different regions according to their variables.

4.4 Validating the AF

By submitting the AF to the people at aQysta who have been interviewed previously for input it can be checked if the categories and variables chosen at first make sense at all. A feedback version of the AF was sent out to persons with various roles in the PPP. Below in Table 4 an overview is presented of the results from the feedback on the AF. Along each step the remarks, added variables and filled in variables are listed. Remarks represent how much feedback there was on the variables chosen in that step. Added variables show how much variables were added in total by respondents. Filled in variables describes how much variables were filled in eventually across all respondents for the respective step.

Step	Remarks	Added variables	Filled in variables
Select region	3	1	95%
Contact	3	3	75%
Legal	0	5	68%
General analysis	3	4	55%
Visit	1	5	47%
Partners	0	1	63%
Stakeholders	0	0	33%
Detailed analysis	0	0	28%
Design pump	1	1	63%
Strategic assessment	1	0	42%
Share with client	1	0	29%
Pump placement	0	0	50%

Table 4 feedback on AF

As can be seen the first step, select region, has the most remarks and the highest percentage of filled in variables. This could mean that this step was initially wrongly identified by the author because it has the most critique on its variables. Another explanation is that respondents used the most effort on the first step as it is also the most filled in step. There is a downwards trend visible in the filled in variables so there could be a bias towards earlier steps where respondents filled in more variables and thus were more critical.

The pattern of a declining rate of filled in variables can be explained if the various roles that filled in the AF are examined. In the following tables the respondents are shown according to their roles in the PPP, for which region/country they filled in the AF and how much of each step they filled in. Showing the total variables that can be filled in at the top, and the filled in variables in the row of the corresponding role.

Role	Region/country	Select 10	Contact 6	Legal 5	General 4	Visit 8
PPP oversight	Hijar	10	6	4	4	8
PPP oversight	Nepal	10	4	3	1	0
PPP oversight	Indonesia	10	4	3	1	0
Design	Belgium	9	3	4	2	5
Market research	Colombia	10	2	1	0	0
GIS analyst	Lliria	10	5	2	2	5

Table 5 overview of respondents to feedback AF

Partners 2	Stakeholders 3	Detailed 4	Design 4	Strategic 3	Share 3	Placement 3
2	3	3	4	3	3	3
1	1	0	4	0	0	1
1	0	0	4	0	0	1
0	0	0	0	0	0	0
2	0	1	0	1	1	1
2	1	0	4	3	2	3

Table 6 Continuation of overview of respondents to feedback AF

These tables follow the same pattern overall as Table 4, the later steps are being less filled in by the respondents. But now a difference between people who are active in the whole PPP and people who are only occupied with certain parts of the PPP can be observed.

The underlying data can be found in Appendix C. Here the remarks per role are displayed and new variables that were suggested for each step. The most remarks are concerning the clarity and goal of the AF. That might have something to do with the various roles the respondents fulfil in the PPP, while they had to fill in the entire PPP for the AF. The feedback on the variables itself can be divided in two

subjects. One: the difference between scale makes some variables less suitable for certain projects. When a respondent fills in the AF for Colombia, the presence of canals does not add much as a variable. Two: when multiple people fill in variables, they can use different units of measurement to describe surface, flowrate and other quantitative variables. Or they could all use different description of a new client, that makes comparison across multiple projects difficult. When certain variables can be filled in by pre-selected units or multiple choice answers the comparison will be easier and confusion will be less for respondents as to what they should fill in. There was however no big disagreement on the order of the steps, and their contents.

4.5 Discussing results of the AF

With data gathered on different projects in the AF the CVD approach could be used. Firstly, the different projects can be categorized among the four planes that were observed in sub-chapter 4.3. This would give the following overview:

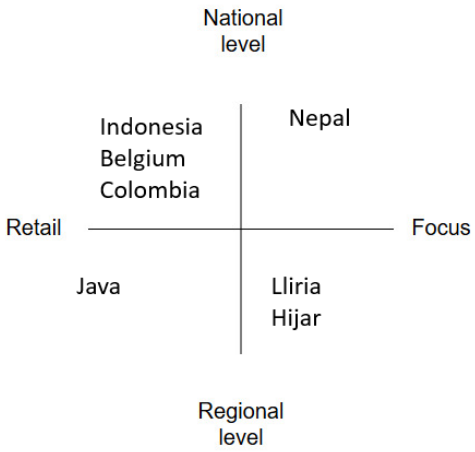


Figure 11 Division of projects along scale-axes

Three comparisons have been made: Hijar & Nepal, Lliria & Hijar, Spain & Colombia. These regions were selected because they had enough variables filled in and give a representation among different scale-axes. The three cases will be discussed separately after which the feedback from aQysta will be shown.

These two projects seem to differ much since they lie on different continents and a difference in scale. However, that also allows for interesting discoveries if similarities can be found despite the huge differences. Farmers in both Hijar and Nepal make predominantly use of flood irrigation. If can be discovered how the transition from flood irrigation to drip irrigation happened in Nepal, it can help farmers in Hijar changing to drip irrigation.

These two projects are both located in Spain and share a lot of similar outcomes for their variables. In this case it is interesting to see where these projects differ, which gives a direction to further investigate the reasons for these differences.

Variable	Lliria	Hijar	Why interesting?
Ownership of canals	Canals owned by water authority	Canals owned by irrigation community	Influences permit processes
Place in canal hierarchy	Upstream community	Downstream community	Influences access to water
Observe surroundings of pump	Chance of stealing/ damaging pumps	Little chance of stealing/ damaging pumps	Can chance of stealing be reduced in Lliria with Hijar examples?

Table 7 Comparison of variables between Lliria & Hijar

Here is an example of two projects with a lot of differences. Instead of focussing on the few similarities, the differences can also be explored to see why they differ and if the approaches can be copied to one another.

Variable	Spain	Colombia	Why interesting?
Evaluate promotion opportunities	Demonstration of pumps	Farmers as ambassadors	Find ways to involve farmers more in promoting pumps
Search for new partners in the region	Partner with reforestation companies	Partner with social impact companies	Can these two companies cross borders?
Ownership of canals	Canals owned by local water authorities	Canals owned by government, but de facto by companies	Legal lessons from Spain might help with Colombia permits.

Table 8 Comparison of variables between Lliria & Colombia

The primary function of the AF and how a CVD approach can be handled seems to be the direct comparison of variables from two projects.

From the feedback session with four employees of aQysta the following came up:

- Can this AF be automated? The AF currently must be completed manually. When two projects are selected their variables have to be manually compared. This applies to the filling in of variables as well. Some variables can be made multiple choice so that they get easier to compare.
- The AF can be used as a process overview. There is a wish from aQysta to have more overview and control over their PPP. By having an AF where the status of all steps are kept up to date, and who is responsible for them this overview can be simplified. This was not the original goal of the AF, but can be seen as a positive side-result.

- Some variables are not specific enough. E.G.: presence of canals is a very broad term when concerning countries. A distinction can be made between variables for the different scale levels.
- It was often hard for respondents to fill in the AF for the whole PPP. Most respondents had knowledge of only a distinct section of the PPP like sales, technical… It was asked if the AF could be divided into sub-AF's which focus on the section that corresponds with the divide between specialization of aQysta's employees. This way one person can overview the section he knows most about.
- How can a future AF look? What shape would it have, what software would it work on and what will its functions be? In the current state the AF is a rather experimental tool to explore the CVD approach concerning aQysta's PPP. The meeting made clear that there is a wish to know how a more developed product will look like that can be used by aQysta.

Besides this feedback the function of comparing variables across different projects, which is the envisioned CVD approach of this AF, was accepted. It was still unclear however what the positive contribution could be to ongoing or future projects. But the possibility to investigate differences or similarities that are made possible by the AF was regarded as promising.

5 Discussion

This chapter will discuss the outcomes of the previous chapters and tries to give an answer to the earlier stated research questions that have started this thesis. There will first be a small recap of the research process for this thesis.

5.1 Discussing the results

This research was built around a few research questions that will be answered in the following sub-chapters. The first sub-research question was what elements can be identified that make up the pump placement process? Hereby the aim was to identify firstly what the steps are that make up a PPP. The second sub-research question was how this identified process can then be transformed into an AF? This also requires identifying the variables that make up each step and incorporate the PPP into an AF that is adaptable to different circumstances wherein the pumps are placed. The third sub-research question was if CVD thinking could be applied to this AF? Now that a working AF has been created, it has to be able to compare multiple scenarios of the PPP to enable CVD thinking. And finally, this thesis' main research question: can an adaptive framework for the pump placement process for aQysta based on CVD thinking be created? This can be concluded by examining the outcome of the earlier sub-questions and the last research step that investigates if the AF can produce satisfactory results.

5.2 What elements can be identified that make up the pump placement process

The first research question was answered by analysing literature on the PPP in general and documents and interviews on the PPP specifically. Important factors determined by Butera & Balestra (2015) on placing hydropower pumps were also identified through documents and interviews. Energy prices came back frequently in interviews as being very important on whether to decide for a spiral pump or not (Bøckman et al., 2008). Furthermore laws & regulations, willingness of communities to adapt new technologies and available local technical knowledge (Ferreira et al., 2016) were also found in interviews and documents to contribute highly to the success of the PPP. This resulted eventually in the identified PPP shown in Figure 9 at aQysta.

5.3 How can such a process be transformed into an AF

The second research question was answered by creating the AF. An AF is an ideal tool to handle complex situations and combine complexity with a structured approach (Lankford & International Water Management Institute, 2007). It is best suited to a semi-linear process where all the steps are comprised of variables that can be measured and reported. Another important aspect of a good AF is that it begins complex and works towards a narrow scope (De Bruijn & Veeneman, 2009), a thing which the AF tries to achieve by having the first few steps be more general in describing the region and the latter steps be more specific on where to place pumps.

5.4 Can CVD thinking be applied to this AF

The third research question was tried to answer by letting respondents work with the AF. CVD has been incorporated into the AF by setting it up in such a way that multiple regions are compared to each other. This way multiple different regions can be simultaneously considered thus enabling CVD (Kersten et al., 2018). Two of the important design principles (Leenders et al., 2007) can be found in the AF: systematic variation and Hierarchical decomposition. Systematic variation is enabled by setting multiple regions off against each other by comparing all their variables. This is also the core of CVD. Hierarchical decomposition is found in the way that all the steps that encompass the PPP are decomposed into the variables that make them up.

It can be discussed how much the AF is dependent on CVD? Is CVD an integral part of the AF or would the AF also be achieved if only the PPP was observed, and a framework was built to apply it to different projects in different countries/regions? There is no clear boundary on what CVD can and can't do as the paper states it is very flexible and can be applied to a multitude of situations (Kersten et al., 2018). The influence of CVD on this AF can be observed if CVD is omitted from the AF. That would result in a linear PPP where all the steps would have to be checked of according to the measures that have to be taken per step. This could still offer some structure and guidance on what to do for the PPP, but it is no longer able to compare different projects and look for synergies anymore. The framework could still be adaptive by anticipating on which variables to account for according to the scale of the project. A country wide project could ask for a different set of variables then a region focused project. This has however not been tested in this research. If this line of thinking would be expanded, the order of the steps could also vary based on the scale of the projects.

Two levels of CVD can be distinguished. The first level is enabling different projects to be compared with each other. The second level would be discovering shared insights through these comparisons (Kersten et al., 2018). Currently the AF accommodates the CVD approach by making it possible to compare various projects, and through these comparisons creating shared insights. This will be explained further in the following sub-chapter.

5.5 Can an AF for the PPP for aQysta based on CVD thinking be created

For the final answer if an AF for the PPP based on CVD thinking can be created the responses to the fourth research round can be evaluated. Herein the AF was filled in for seven projects, showing that it was understood by the respondents how to fill in the AF. All the steps and thereby variables that make up the AF were appreciated for being sensical and giving guidance to the PPP. This shows that the AF has the right steps in the right order. To confirm this statement a fifth research round was done wherein results from the AF were discussed in a focus group.

Although there was not much discussion on the chosen variables when respondents were asked to fill in the AF, now some discussion started when projects were being compared to each other. Some variables are difficult to interpret when compared against each other such as the availability of canals. This does not have to mean that comparisons among projects is not possible, but that some of the variables should be re-evaluated for a next version of the AF. The CVD approach which enables comparison of different projects through their variables was appreciated. Through showing the shared insights that arise when different projects can be compared with the AF understanding of the CVD approach followed. Together with the understanding of CVD the appreciation for the possibilities of the AF grew. Feedback from the focus group was not so much focused on CVD, but on how a future AF could look like. The current version is not user friendly and mostly an experimental build to explore the possibilities of CVD for the PPP. This version shows what can be possible with a better polished future version. Because currently different projects have to be compared manually by their variables, the outcome is largely dependent on the expertise of the user of the AF. And how well a user can operate the AF is influenced by its quality and shape. If it is unclear what some variables are representing, an unfamiliar user could fill in the wrong units and therefore negatively impact the outcome.

5.6 Limitations

There are a few limitations to this study that might be helped by future research. For one, the AF created for this study was a crude version mainly for research purposes. Because of this it was hard to fill it in for the respondents. This version was made in Excel and required for each project to manually fill in the variables. This can result in different kind of values for the same variable across multiple projects that make it harder to compare. Thereby the synergies have to be found manually between different projects, making it harder to discover shared insights. A clearer AF could have resulted in projects that are filled in more completely. Another thing is that the validation of this thesis' AF was done by a relatively small sample base of 7 respondents. When more projects would have been available to compare each other against more interesting insights could have arisen.

5.7 Conclusion

This study was one of the first studies applying CVD to a process instead of a product. That way it showed that CVD is not only bound to the realm of product design but can also function as a leading approach in organising processes, in this case deciding where to place aQysta's spiral pumps. This resulted in the AF which can describe the PPP for various projects and compare those projects with each other. From the fourth research round it can be said that the steps and order of these steps in the AF are sufficient in describing aQysta's PPP. Concluding from the feedback of the latest research round the AF achieves its goal in applying CVD. It enables to compare varying projects with each other,

and from that produce shared insights which will help aQysta improve their PPP. The AF allows the discovery that Nepal and a region in Spain both follow a transition from flood to drip irrigation. This might already be known by various people at aQysta, but with the help of the AF it becomes explicit and can be investigated further for shared insights. And not only similarities between seemingly different regions, but also differences between apparently similar projects can arise with the help of the AF. Why do two regions in Spain differ in the risk of stealing and damaging of property? With the help of the AF this difference becomes visible and gives an interesting question which would not appear when these projects would be observed separately. The AF (currently) has no method to answer these questions, but the fact that they appear is proof that the CVD approach works and a start in exploring these shared insights. Without the CVD aspect there would still be an overview of the PPP that has its value, but it no longer enables the users to look for hidden synergies between various projects.

5.8 Future research

Some of the earlier discussed limitations can be resolved in a future study, along with some interesting questions that arose during this research. First, for a future study more cases are wanted to better fill out the AF along all its scale-axes. A separation can then be made between the different spiral pumps in the PPP, although it can still be interesting to compare the PPP for different products. A next version of the AF could be built with a specialized software tool instead of Excel. This tool should then enable to look for shared insights and automatically fill in variables. This would enable to further explore the applicability of CVD to the PPP. The adaptability of the AF can also be enhanced through a software program by letting it automatically adapt the order of the steps according to the nature of the project.

Bibliography

Ahern, J., Cilliers, S., & Niemelä, J. (2014). The concept of ecosystem services in adaptive urban planning and design: A framework for supporting innovation. *Landscape and Urban Planning*, *125*, 254–259. https://doi.org/10.1016/j.landurbplan.2014.01.020

aQysta. (2017). *HyPump presentation*.

aQysta. (2018). *aQysta_Deliverable_4.1*.

Bøckman, T., Fleten, S.-E., Juliussen, E., Langhammer, H. J., & Revdal, I. (2008). Investment timing and optimal capacity choice for small hydropower projects. *European Journal of Operational Research*, *190*(1), 255–267. https://doi.org/10.1016/j.ejor.2007.05.044

Brown, S. L., & Eisenhardt, K. M. (1997). The Art of Continuous Change: Linking Complexity Theory and Time-Paced Evolution in Relentlessly Shifting Organizations. *Administrative Science Quarterly*, *42*(1), 1. https://doi.org/10.2307/2393807

Butera, I., & Balestra, R. (2015). Estimation of the hydropower potential of irrigation networks. *Renewable and Sustainable Energy Reviews*, *48*, 140–151. https://doi.org/10.1016/j.rser.2015.03.046

Chesbrough, H. W. (2003). *Open innovation: the new imperative for creating and profiting from technology*. Boston, Mass: Harvard Business School Press.

Chiyembekezo, K., Kimambo, C., & Nielsen, T. (2012). Potential of small-scale hydropower for electiricyt genereation in Sub-Saharan Africa. International Scholarly Research Network.

Clifford, N. J., French, S., & Valentine, G. (Eds.). (2010). *Key methods in geography* (2nd ed). Thousand Oaks, CA: Sage Publications.

De Bruijn, H., & Veeneman, W. (2009). Decision-making for light rail. *Transportation Research Part A: Policy and Practice*, *43*(4), 349–359. https://doi.org/10.1016/j.tra.2008.11.003

Dobbs, M., & Hamilton, R. T. (2007). Small business growth: recent evidence and new directions. *International Journal of Entrepreneurial Behavior & Research*, *13*(5), 296–322. https://doi.org/10.1108/13552550710780885

Ferreira, J. H. I., Camacho, J. R., Malagoli, J. A., & Júnior, S. C. G. (2016). Assessment of the potential of small hydropower development in Brazil. *Renewable and Sustainable Energy Reviews*, *56*, 380–387. https://doi.org/10.1016/j.rser.2015.11.035

Hagel, J., & Brown, J. S. (2011). Creation Nets: Harnessing The Potential Of Open Innovation. *Journal of Service Science (JSS)*, *1*(2), 27. https://doi.org/10.19030/jss.v1i2.4293

Hart, C. (2018). *Doing a Literature Review: Releasing the Research Imagination*. SAGE.

Hillman, M. (2006). Situated justice in environmental decision-making: Lessons from river management in Southeastern Australia. *Geoforum*, *37*(5), 695–707. https://doi.org/10.1016/j.geoforum.2005.11.009

Kersten, W., Crul, M., R, Diehl, J., C, & Engelen, van, J., M, L. (2015). Context Variation by Design.

Kersten, W., Crul, M., R, Engelen, van, J., M, L., & Diehl, J., C,. (2018). CVD working paper.

Lankford, B. A., & International Water Management Institute (Eds.). (2007). *From integrated to expedient: an adaptive framework for river basin management in developing countries*. Colombo: International Water Management Institute.

Lawrence, A., Rahman, A., Conneely, J., Maroudas, N., Newsome, P., Kakar, S., … Ciesielski, T. (2018). spiral pumps in nigeria.pdf.

Lebel, L., Garden, P., & Imamura, M. (2005). The Politics of Scale, Position, and Place in the Governance of Water Resources in the Mekong Region. *Ecology and Society*, 18.

Leenders, R. T. A. J., Engelen, J. M. L. V., & Kratzer, J. (2007). Systematic Design Methods and the Creative Performance of New Product Teams: Do They Contradict or Complement Each Other? *Journal of Product Innovation Management*, *24*(2), 166–179. https://doi.org/10.1111/j.1540-5885.2007.00241.x

Manzano-Agugliaro, F., Taher, M., Zapata-Sierra, A., Juaidi, A., & Montoya, F. G. (2017). An overview of research and energy evolution for small hydropower in Europe. *Renewable and Sustainable Energy Reviews*, *75*, 476–489. https://doi.org/10.1016/j.rser.2016.11.013

Norman, D. A. (2010). *Living with Complexity*. MIT Press.

Postel, S., Polak, P., Gonzales, F., & Keller, J. (2001). Drip Irrigation for Small Farmers. *Water International*, *26*(1), 3–13. https://doi.org/10.1080/02508060108686882

Quaranta, E. (2018). Stream water wheels as renewable energy supply in flowing water: Theoretical considerations, performance assessment and design recommendations. *Energy for Sustainable Development*, *45*, 96–109. https://doi.org/10.1016/j.esd.2018.05.002

Silverman, D. (2005). *Doing Qualitative Research* (second edition). London: SAGE publications Ltd.

Silverman, D. (2013). *Doing Qualitative Research (fourth edition): A Practical Handbook*. SAGE.

Thapa, P., & Dulal, S. (2018). Opportunities and Challenges faced by emerging renewable energy-based lift- irrigation systems: A Case Study of Hydro-powered Irrigation Pumps, 24.

Ueda, T., Goto, M., Namihira, A., & Hirose, Y. (2013). Perspectives of Small-scale Hydropower Generation Using Irrigation Water in Japan. *Japan Agricultural Research Quarterly: JARQ*, *47*(2), 135–140. https://doi.org/10.6090/jarq.47.135

Vesper, K. H. (1980). New Venture Planning. *Journal of Business Strategy*, *1*(2), 73–75. https://doi.org/10.1108/eb038903

Abbreviations

Abbreviation	Full term
CVD	Context Variation by Design
AF	Adaptive Framework
SHP	Small Hydro Power
PPP	Pump Placement Process
DSS	Decision Support System

List of Figures

List of tables

Appendix A

Select region to focus on			
Buying power of farmers	Dominant type of irrigation	Existence of canals	Existence of rivers
Scale of farms	Climate	Road infrastructure	Energy infrastructure
Irrigation season(s)	Which type of crops		
Contact with party interested pump			
Type of client	Previous relation with client	How did client find out about aQysta?	Current energy prices
Current water prices	Current maintenance costs		
Investigate legislation			
Ownership of canals	Permits for general construction	Permits for environmental construction	Permits for hydraulic construction
Political situation			
General regional analysis			
Collect GIS datasets	Indicate local characteristics	Elevation difference	Cost evaluation
Visit location			
Flowrate in canals/rivers	Gradient of canals rivers	Head drops available	Width of canals/rivers
Observe surroundings of pumps	Community interest	Pictures and videos of region	Drone elevation maps
Involve partners			
Search for new partners in the region	Use existing partner network		
Stakeholder analysis			
Site feasibility form filled in by stakeholders	Interested stakeholders	Culture of stakeholders	
Detailed analysis			
Preferred pump locations	Preferred reservoir locations	Land serviced by pumps	Locally collected data
Design pump			
Distance to farms	Size of farms	Head to deliver	Pump variation
Strategic assessment			
Check reachability of locations	Stakeholder network	Evaluate promotion opportunities	
Share results with client			
Technical optimum	Interested stakeholders	Receive feedback from client	
Pump placement			
Logistics	Installation	Who installs	

Appendix B

Data document 1: Observing aQysta

This document will present the means and results of data acquisition of the first research round in detail. In this round three sources of data were used: Literature, Document and interviews.

At the starting phase of this thesis the literature study was done to increase the researcher's knowledge about the topics and make it possible to apply relevant theory for the research. The important topics were covered by a main research question and varying sub research questions. Since through the course of the research some sub-questions changed the main research question will be used to capture this research's relevant topics for a literature study. In the beginning the main research question was: **How can an adaptive framework for pump placement decision-making for aQysta based on CVD thinking be created?** This research question can then be divided into three components:

1. The Context Variation by Design approach
2. And Adaptive Framework
3. The Pump Placement Process of aQysta

For each of these topics relevant literature was sought to discuss in the literature chapter. A small part about business organisation was also investigated as it became clear that the start-up structure of aQysta also impacted its PPP. Literature was acquired through the following means:

- Using online search engines such as Google Scholar
- Going through completed and ongoing Msc Water Resource Management papers on the TUDelft website
- Getting suggestions from supervisors of this thesis and other graduating students

A general view on what influences a PPP was acquired through the literature study. To fit this general view to aQysta it was necessary to study the company itself. One way of achieving this was through internal document analysation. The first batch of documents were achieved by consulting with the supervisors who manage this research's process from the company side. These documents consisted of flyers about the spiral pumps, presentations about these pumps and policy documents on the PPP. Studying these documents led to requesting additional information which sometimes was not available as document and therefore was communicated by the relevant personnel themselves. As the research continued personnel of aQysta got aware and sometimes send interesting documents on

their own accord. This eventually led to a sufficient amount of documents to create an idea of aQysta's PPP. An overview of studied documents is presented below.

Document name	Content
Spiral pumps in Nigeria	Describes working principle of spiral pumps in case study in Nigeria
Day one: site selection Italy	Search for pump sites in Italy
Easy Pay: Business model in Indonesia	A way for farmers to finance their pump by selling their crops assisted by aQysta
Opportunities and Challenges faced by emerging renewable energy-based lift-irrigation systems: A Case Study of Hydro-powered Irrigation Pumps	Business case example of the Barsha Pump
aQysta Deliverable 4.1 v2	The PPP and all aspects involved
Barsha Pump demonstration site assessment form	Form for exploring the suitability of sites for the Barsha Pump
HyPump presentation	Ppt showing the main features and technical specifications of the HyPump

This first round consists of three interviews that can be further divided in the first two interviews and a little bit afterwards the third interview. An overview of the interviews is presented in the tables below.

Role interviewee	Discussed topics
Lead fluid dynamics engineer	PPP at aQysta
GIS analyst	PPP at aQysta
Product designer	Validate the constructed PPP, explore technical abilities of the HyPump

After the document and literature analysis there was an indication of what entails the PPP. To investigate in how far this applied to aQysta firstly the two supervisors of this thesis were interviewed. This was because they are both active in the PPP, and familiar with the researcher and his subject. These interviews were conducted in a relaxed setting because of the familiarity of the participants with each other and the familiar location of aQysta where they were held. During the interviews the interviewer wrote down the answers as complete as possible. This caused that sometimes a little pause was needed to catch up, bThe interviews were semi-structured with the first few questions open ended which provided enough room for the interviewees to direct topics they deemed relevant for the research. Then followed some questions that explored some particular aspects of the PPP

highlighted by literature (partners & stakeholders). The interview ended with some questions about topics that came up in the documents and might prove important aspects that need to be adaptive in the AF (Scale of project, range of available products).

The results from these two interviews were summarized in a separate document. This way a first general description of aQysta's PPP was created. It was validated with the two interviewees to confirm that no details were lost in the synthesis and summarization of the interviews. This was also done to give the interviewees a chance to add additional information on the PPP which was not achieved yet through the interviews. After the general description of the PPP was done, it was adapted to a linear PPP divided into separate steps. This was again presented to the two former interviewees to ensure that no mutations in the process happened due to transforming it from a general summary into a step-based process. A third interview was held with another person at aQysta to expand on the current PPP. The questions were a variant of those for the first two interviews with some added questions about design of the spiral pump (how adaptive should pump be, what is design based on).

- What are you doing at aQysta?
- Which elements are now observed that impact pump placement decision making?
- Who are your partners?
- Is there a structured way in which pump placement decisions are made?
- How do you engage and then involve local communities?
- In which countries are you active, and what countries are you planning to expand to?
- Where do you thinks is room for improvement for pump placement decision making?
- Is there a divide between macro and micro analysis?
- What are all products currently being developed?

Data document 2: Spain field research

This series of interviews took place in Spain, thus opening a whole new environment of doing interviews. This gave the opportunity to visit the field where the HyPump will be installed, but also presented some challenges in overcoming cultural and language barriers for the interviewer. The interviews were each time conducted at the working environment of the interviewee. This was done out of convenience for the interviewee, and gave additional insight into the working environment for the interviewer. The two occurring challenges will now be discussed.

Cultural challenges: In Spain it was custom with a large part of the interviewees to hold a siesta. This meant that during a few hours over day no interviewees were available. Since the interviewer was not accustomed with this, a lot of meetings were difficult to arrange since phone calls were not answered

during siesta. This also limited time during which the interviewer could meet up, since the interviewer went home at for him appropriate times, while possible interviewees would still have been available.

Language barrier: The interviewer does not speak Spanish, and a lot of the interviewees did not speak English. This was mitigated by being accompanied by a colleague who did speak Spanish, but interviewing through a translator makes that a lot of detail can go missing. The interviews were recorded with the use of a smartphone, but at one occasion this was not possible, and the translator had to write the answers done.

Another aspect that came up during the interviews was that the concept of a spiral pump was somewhat abstract to most interviewees. After a few interviews this was resolved by bringing flyers and showing a few videos of the spiral pumps in action.

Role	Location	Language	Topics
Water Authority	Lliria	English	Canal ownership, irrigation community, technical feasibility, regulations
Water Authority	Lliria	Spanish	Water rights, water availability, prices
Farmer	Llira	Spanish	Irrigation community
Farmer	Lliria	English	Biodynamical agriculture, sustainable awareness, promoting HyPump
Partner	Lliria	Spanish	Technical feasibility, irrigation community
Water Authority	Lliria	Spanish	Modernization of irrigation, promoting HyPump, regulations
Water Authority	Hijar	Spanish	Prices, canal ownership, regulations
Farmer	Hijar	Spanish	Irrigation community, technical feasibility

Three different stakeholder roles were observed:

Water Authority: These stakeholders fulfil some form of government and are ensuring that existing regulations get respected. They can give information about regulations surrounding the two regions.

Farmer: These are the stakeholders who are the primary targets to sell the HyPump to. They can answer how the HyPump will be received in the irrigation community and what the farmers wishes are for this product.

Partners: This stakeholder group helps aQysta with transportation and installation of the spiral pumps. They can give their thoughts on the technical and logistical processes.

Because these three groups have distinct characteristics the interview questions were adapted to this.

Questions Farmers

- **Introduction**
- Could you briefly introduce yourself?
- How familiar and interested are you of renewable energy for irrigation pumping?

- **HyPump specifics**
- What are your expectations from the HyPump?
- Do you think the HyPump could be successful here?
- Who would you have to contact and involved to install a HyPump?
- How much do you want to alter the environment to accommodate the HyPump?
- Which technical limitations do you see to the installation of a HyPump?
- Which social or economic limitations do you see to the installation of a HyPump?
- **Contact**
- Do you see room for improvement on contact with aQysta?
- Are there additional services that aQysta could provide to you? E.g.:
- Introduce to other partners of aQysta
- Help improve business plan
- Give indication of crop water needs
- **Additional**
- How much are you allowed to alter the environment?
- Which regions would suit the HyPump best?
- Who would you recommend the HyPump to?
- How much are you paying now for pumped water? E.g. in €/m3 of water or €/kWh
- How much would you be willing to pay for a HyPump (in €) or for water provided by a HyPump (in €/m3 of water or €/kWh)?

Questions Water Authorities

- **Introduction**
- Could you briefly introduce yourself?
- **HyPump specifics**
- What are your expectations from the HyPump?
- Do you think the HyPump could be successful here?
- Who would you have to contact and involved to install a HyPump? E.g.
- How much do you want to alter the environment to accommodate the HyPump?
- Which technical limitations do you see to the installation of a HyPump?
- Which social or economic limitations do you see to the installation of a HyPump?
- How much should be paid for a HyPump (in €) or for water provided by a HyPump (in €/m3 of water or €/kWh)?
- **Contact**
- Do you see room for improvement on contact with aQysta?
- **Additional**
- How much do you want to alter the environment to accommodate the HyPump?
- Which regions would suit the HyPump best?
- Who would you recommend the HyPump to?

Questions Partners

- **Introduction**
- Could you briefly introduce yourself?
- **Hypump Specifics**
- What are your expectations from the HyPump?
- Do you think the HyPump could be successful here?

- Who would you have to contact and involved to install a HyPump? E.g.
- Which technical limitations do you see to the installation of a HyPump?
- Which social or economic limitations do you see to the installation of a HyPump?
- How much should be paid for a HyPump (in €) or for water provided by a HyPump (in €/m3 of water or €/kWh)?
- **Contact**
- Do you see room for improvement on contact with aQysta?
- **Additional**
- Where do you see improvement for installation process?
- Does your approach on installation differ between different regions?
- Which regions would suit the HyPump best?
- Who would you recommend the HyPump to?

Data document 3: Interviews aQysta global

These interviews were performed mostly through skype so that aQysta personnel working in different parts of the world could be interviewed. The interviewees were sent information about the thesis in advance so that they would understand the context wherein these interviews took place. The Interviews took place in English and the interviewer transcribed during the interviews. Out of these transcriptions the key sentences for each interview were sought out and placed in an overview with the important sentences from all interviews so that patterns about important aspects for the AF emerged and variables could be decided upon. The interviews discussed the PPP according to the experience of the interviewee, which mostly tied to the country they are stationed in. An overview of the interviews is presented below.

Role	PPP in…	Means of interview	Topics
Overseeing PPP	Nepal	Skype	Government organisation, pump financing, irrigation communities, logistics
Business development	Indonesia	Skype	Pump financing, contacting partners, regulations
Market research	Colombia	Skype	Promotion, retailers, stakeholders
HyPump design	Italy	Skype	Contacting partners, technical limitations
Overseeing PPP	Global	In person	Business opportunities, reglations, partners, design
HyPump design	England	Skype	Design, technical limitations, irrigation communities, regulations
Market research	Malawi	In person	Irrigation communities, design

For these interviews two distinctions between interviewees were made:

- Active in the PPP: these interviews are with persons who are active in large parts of the PPP of their respective region.
- Designing the HyPump: These interviews are with persons who are involved in designing parts of the HyPump

The interviews were conducted with the following list of questions:

Active in the PPP

- Can you describe what you do at aQysta?
- What are some conditions specific for working in your region?
- How is ownership of land, canals & pumps organised?
- Where there any technical limitations to introduce pumps?
- Where there any social or economical limitations to introduce pumps?
- What influences the pump decision making process?
- Do you see room for improvement on the pump placement decision making process?

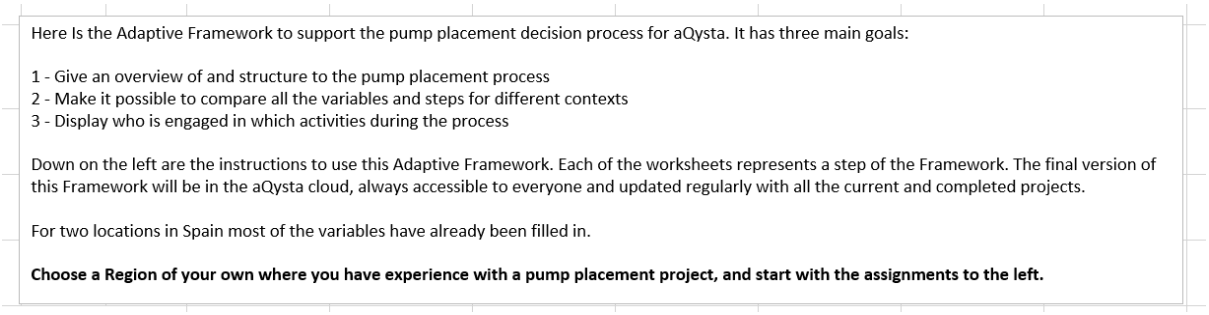
Designing the HyPump

- Can you describe what you do?
- What are important parameters to base design on?
- What influences the pump decision making process?
- How do you think clients can be persuaded to get the HyPump?
- What are conditions specific for your country?
- What are HyPump specifications that should be adaptable?

Data document 4: Validating the AF

For this research round the constructed AF was going to be verified with the different people at aQysta that were contacted in previous research rounds. They were asked to fill in the AF according to their experience with a project concerning the placement of a pump (Barsha or HyPump). The PPP could be filled in completely or only partially depending on the involvement of the respondent. The AF was sent as a tweaked version that included the questions asked to the respondents and visual guidance on what to fill in, accompanied with a few projects already filled in. This was done so that respondents didn't need to read a separate file with instructions on how to fill in the AF and questions. Together with this feedback AF a document was sent to explain the current research and the goal of filling in the AF.

Now an overview of how this feedback AF looks like will be given. The feedback AF is build in Excel, just as the AF. On the first tab of the Excel is an overview with the goal of the AF, what is expected from the people filling it in, and an overview of the steps and order of the AF.


Here Is the Adaptive Framework to support the pump placement decision process for aQysta. It has three main goals:

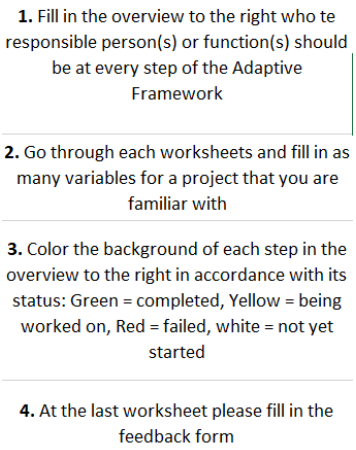
1 - Give an overview of and structure to the pump placement process
2 - Make it possible to compare all the variables and steps for different contexts
3 - Display who is engaged in which activities during the process

Down on the left are the instructions to use this Adaptive Framework. Each of the worksheets represents a step of the Framework. The final version of this Framework will be in the aQysta cloud, always accessible to everyone and updated regularly with all the current and completed projects.

For two locations in Spain most of the variables have already been filled in.

Choose a Region of your own where you have experience with a pump placement project, and start with the assignments to the left.

This is an overview of the goals of the AF present on the first tab.


1. Fill in the overview to the right who te responsible person(s) or function(s) should be at every step of the Adaptive Framework

2. Go through each worksheets and fill in as many variables for a project that you are familiar with

3. Color the background of each step in the overview to the right in accordance with its status: Green = completed, Yellow = being worked on, Red = failed, white = not yet started

4. At the last worksheet please fill in the feedback form

These are the assignments for the respondents.

Responsible person(s)/ functon(s)	Steps of phase 1	Responsible person(s)/ functon(s)	Steps of phase 2	Responsible person(s)/ functon(s)	Steps of phase 3	Responsible person(s)/ functon(s)	Steps of phase 4
e.g. Head of strategy	**select region to focus**		**general analysis**		**detailed analysis**		**share design**
e.g. Jaime & Lennart	**contact party**		**visit project**		**design pump**		**place pump**
	investigate legal		**involve partners**		**strategic assessment**		
			Engage stakeholders				

This is an overview of all the steps in the AF and the order in which these steps are placed in the PPP.

On the following tabs, each tab will represent a step in the PPP and has a column that should be filled in by the respondent.

select region to focus on		**Start filling in this column for a pump placement project of your choosing**	
Variables ↓ / Location →	Lliria	Hijar	*Fill in your region/country*
Buying power of farmers	enough money to individualy buy pump	enough money to individualy buy pump	*give short description of buying power*
Dominant type of irrigation	Sprinkler and drip irrigations	Sprinkler and flood irrigation	
Existence of canals	Extensive canal network	Extensive canal network	
Existence of rivers	No usable rivers for irrigation	No usable rivers for irrigation	
Scale of farms	Between 5 and 40 ha	Around 10 ha, fragmented ownership	
Climate	Hot dry summer and wet moderate winter	Hot dry summer and wet moderate winter	

Here the variables that comprise the step are shown on the left. The two regions of Spain which have already been filled in can be seen next to these variables. On the right is a highlighted area which is reserved for the respondent to fill in. Each step of the PPP is organized like this on its own tab in the Excel file.

After all the steps of the PPP is a summary tab which shows all the steps in one tab with the variables filled in. It is possible to quickly overview all the variables of the different projects and compare them this way.

Data document 5: Discussing results of the AF

For this last research round some results from the AF were produced, and these results were shown and discussed with aQysta. The feedback on these results was collected through a focus group. This form was chosen to stimulate discussion among the partakers over the results. One focus group member was present via Skype, but this did not result in a disturbed participation among the group members. Before the focus group meeting the participants were sent a document with the outcome of the results in chapter 4.5.

Role	Pressence
Market research	Skype
Guiding PPP	In person
Detailed & General regional analysis	In person
Product design	In person

During the focus group meeting the participants were first shown a PowerPoint presentation with the results from chapter 4.5 to make sure everyone has seen the same data. After this the participants were asked on their thoughts about these results and if they would like to discuss those thoughts. There was no question list made for this meeting to get an outcome that was entirely dependent on what the participants thought.

Appendix C

The respondents had the freedom to add remarks on the feedback AF and add variables themselves. An overview of this feedback is given here. First a table is shown with the remarks about the AF. It begins with some general remarks that were made by most respondents which apply to the AF in general, and follows with remarks about steps or variables in those steps. The role of the respondent is shown next to the remarks.

Step	Variable	Remark	Role
General remarks		Consider pre-defined option for number of variables	
		Level of detail not always clear: national vs regional	
		Goal of AF unclear	
Select region	Existence of canals	Change to: availability of canals	Design
		Define prices etc. as numerals	Design
		Add a timetable for planning	Design
Contact	Maintenance cost	Unclear	PPP oversight, GIS analyst
		Add sources to filled in variables	Design
General analysis	Elevation difference	For what scale? Max-min for entire area? Or between two points of canals?	PPP oversight, GIS analyst, Market research
Visit	Flowrate in Canals	Flow velocity would be better	GIS analyst
Design	Head to deliver	Is a broad term	PPP oversight
Strategic assessment		Reachability and local infrastructure need to be briefly evaluated earlier on in the process (before visit). Then bottlenecks can be investigated during visits.	PPP oversight
Share with client	Received feedback from client	In which sense? Make clear that its about confirmation of pump placement location	PPP oversight

Pump Placement		crucial to identify for instance access for machinery, ability to reserve construction-space, potential to store large items on-site, etc. etc. earlier in the process, preferably before planning a visit.	PPP oversight

The respondents also suggested new variables for different steps in the AF which are shown in the following table.

Step	Added variable	Role
Select region	Power distance	Design
Contact	Required flowrate	Design
	Attitude	GIS analyst
	Relationship status with aQysta	GIS analyst
Legal	Permits difficulty level	GIS analyst
	Water use rights	PPP oversight
	Certification requirements	PPP oversight
	Specific import requirements	PPP oversight
	Taxes	PPP oversight
General analysis	River type	PPP oversight
	Acces to machinery	PPP oversight
	Ability to reserve construction space	PPP oversight
	On site storage of large items	PPP oversight
Visit	Recent events (Earthquake..)	Design
	Coordinates of pump locations	Design
	Dates of visits	PPP oversight
	(Drone) videos of surrounding infrastructure	PPP oversight
	Drone mapping	PPP oversight
Partners	Ways to search for new partners	Design
Design pump	Deflector in place	GIS analyst