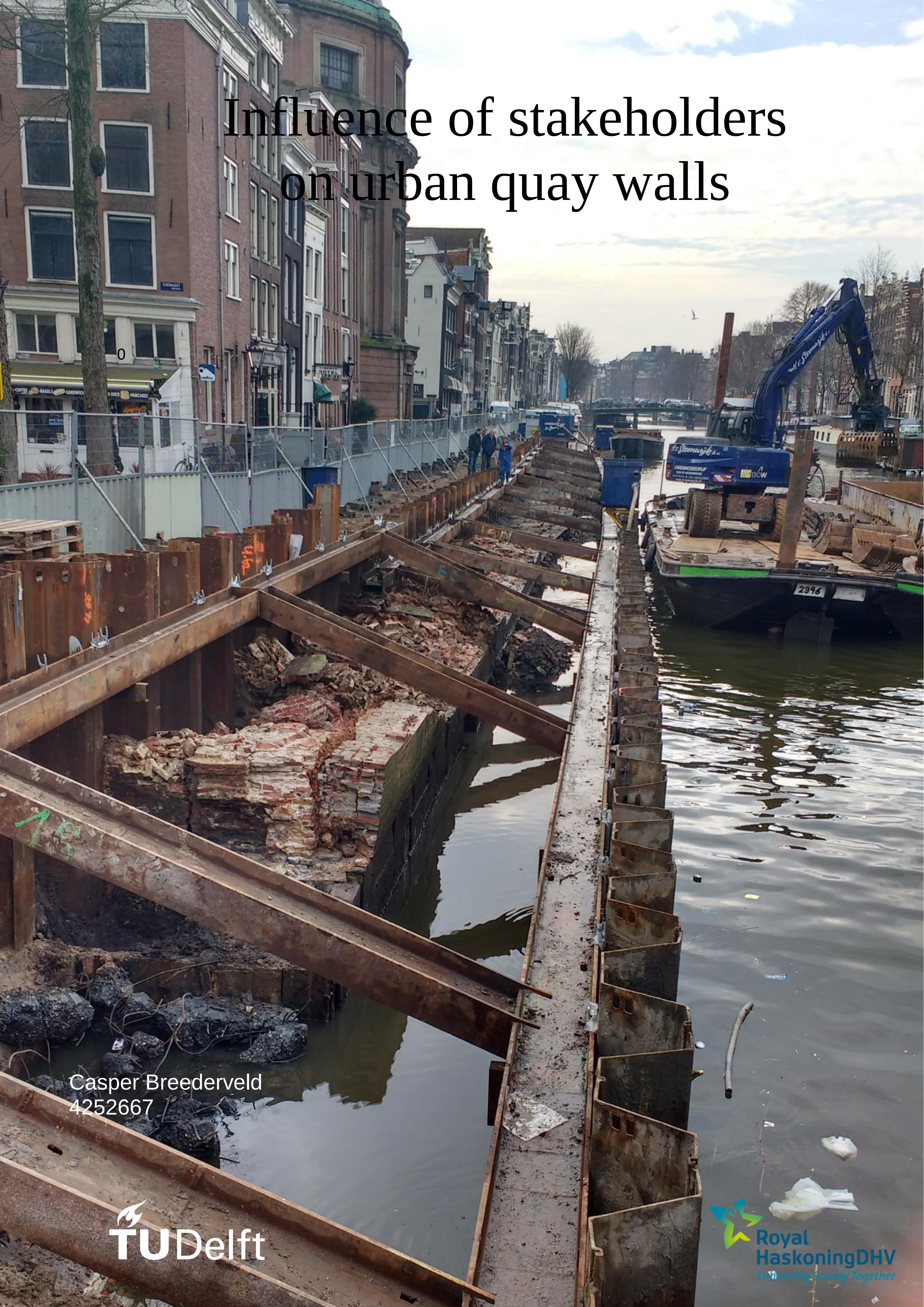
Influence of stakeholders on urban quay walls



0

Casper Breederveld
4252667

Influence of Stakeholders on urban quay walls

Determining the resistance using a Construction & Stakeholder matrix

By

Casper Breederveld
4252667

in partial fulfilment of the requirements for the degree of

Master of Science

at the Delft University of Technology,
to be defended publicly on Friday November 10, 2017 at 1011:30 AM.

Supervisor:	Prof. dr. ir. M.J.C.M. Hertogh	TU Delft
Thesis committee:	Dr.ir. J.G. de Gijt	TU Delft
	Ir. J.J. Kool	Royal HaskoningDHV

Preface

This report is part of the graduation project of the master program Hydraulic Engineering at the Faculty of Civil Engineering & Geosciences at the Delft University of Technology.

I would like to express my gratitude to all my colleagues of Royal HaskoningDHV for helping during my research, but I would also like to thank Royal HaskoningDHV for the opportunity to perform my graduation project at this company and get acquainted with their activities.

A special thanks to Prof. dr. ir. M.J.C.M. Hertogh, Dr.ir J.G. de Gijt and ir. J.J. Kool for their guidance to reach this result of my thesis. During my thesis I interviewed persons of different municipalities, contractors and consultancies. Their experiences, knowledge, time and effort provided valuable information for my research and I hope that my thesis gives them valuable information. Also thanks to Niels Verduijn for his feedback on this report.

Casper Breederveld
Schiedam, 15-09-2017

Summary

In the municipality of Amsterdam there are about 500 kilometers of quay walls. These have to be maintained, and when a quay wall does not meet the safety requirements it has to be replaced by a new quay wall. During the entire replacement project many stakeholders are affected. This can lead to resistance against the project. Resistance can be expected when the interests of the stakeholders are not (sufficiently) integrated in the design or construction method of the replacing quay wall. The high density of stakeholders in urban areas increases the probability that stakeholders will resist against the project. In Amsterdam the lead time for replacing a quay wall is up to five years (Municipality of Amsterdam, June 2017); this lead time accounts for the time from the decision to replace the quay wall until the realization of the new quay wall. One of the reasons for the long duration of the replacement projects is the time invested in dealing with the resistance of stakeholders.

While the construction method of the new quay wall has influence on the reaction of the stakeholders, the reactions of the stakeholders on the other hand may influence the construction method. Therefore, in order to reduce the lead time for replacing a quay wall, an optimum between the construction method and the reaction of stakeholders is expedient. In order to minimize the resistance of the stakeholders it is advisable to take the interests of the stakeholders into account. The objective of the present research has been to develop a method to determine the construction method that will most be in accordance with the interests of the stakeholders, in order to possibly minimize the resistance produced by the stakeholders. This resulted in the following research question: how can be determined which construction method for replacing urban quay walls will most likely produce the least resistance of stakeholders in a particular project?

C&S-matrix

In this research, a method called “construction stakeholder matrix” (C&S-matrix) was constructed, the method is showed in figure 1. This matrix connects the stakeholders and the construction method directly, by comparing the extent to which different construction methods are in accordance with the stakes of the stakeholders. Thereby, the matrix takes into account the influence of different stakeholders on the outcome of the project. The outcome of the matrix is a numerical value: the lower the number, the more resistance can be expected.

First, the construction processes of different designs are decomposed into steps. For each step multiple methods are considered and assessed with the stakes of the stakeholders. If a method is considered to be in accordance with the stakes of the stakeholders, a +1 numerical value is assigned to the method. If a method is considered to be at variance with the interests of the stakeholders, a -1 numerical value is assigned to the method. Methods that have no correspondence whatsoever with the interests of the stakeholders, are assigned a numerical value of 0. In order to perform this assessment measurable criteria are needed for each stake. Some stakeholders have relative stakes, which are hard to assess. These relative stakes are translated into measurable criteria in order to apply them in the C&S-matrix.

Secondly, the influence of different stakeholders on the outcome of the project is assessed. The amount of resistance that a stakeholder can cause is related to the influence of the stakeholder. For example: the more a stakeholder has the ability to delay the project, the more resistance he can produce. In order to determine the power of stakeholders, the power-vs-interest method is used. It visualizes the power and interest of stakeholders in a grid. The position of each stakeholder in the grid is translated into in a numerical value expressing his power and interest in the project.

This numerical value is coupled with the assessment of the interests of the stakeholders reached when comparing the different construction methods, to ensure that the assessment of a powerful stakeholder has more influence on the outcome of the C&S-matrix than the assessment of a less powerful stakeholder. The outcome of the matrix is a numerical value expressing how much resistance is expected when performing a particular construction method. As said, the lower the resulting numerical value, the more resistance is to be expected.

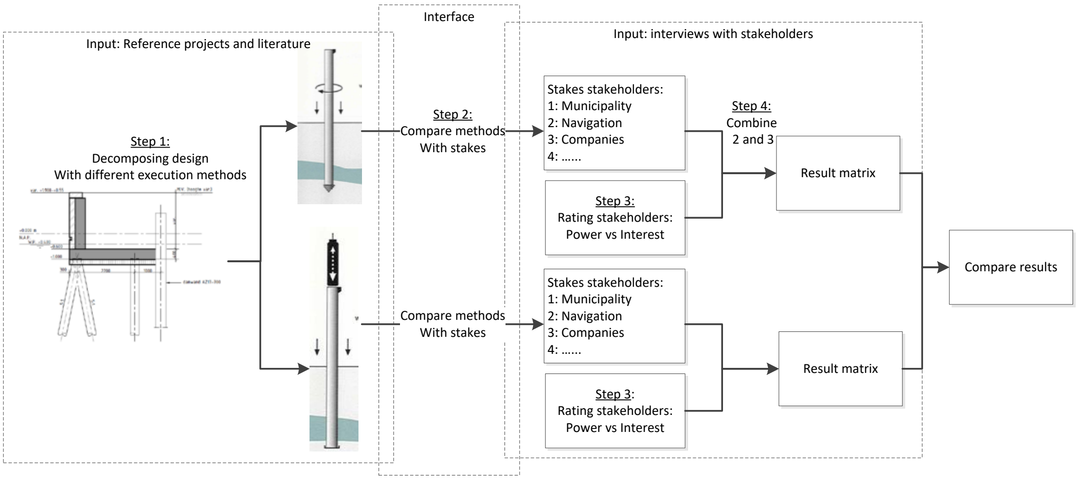


Figure 1: The research method of the C&S-matrix

Other factors

However, the outcome of the matrix alone is not governing in the decision whether or not to apply a construction method. At least two other factors will usually be taken into account: the duration of the construction period and the costs. The duration of the construction period, which is not taken into account in comparison of the construction methods with respect to the stakes of the stakeholders, also determines the amount of resistance to be expected. Usually, a shorter construction period leads to less resistance. On the other hand, neither the costs are taken into account the comparison. The resulting values of the C&S-matrix yet have to be weighed against the costs of construction methods and the duration of the project.

The combination of the C&S-matrix and the assessing of the factors duration and cost is illustrated below, where the explained above is applied on a case of a quay wall replacement project in the Prinsengracht in Amsterdam.

Case Prinsengracht

As said in the introduction, in Amsterdam the lead-time for replacing a quay wall is particularly long. To illustrate the use of the C&S-matrix, we will now apply it to a case of a quay wall replacement project on the Prinsengracht in Amsterdam.

Since the Prinsengracht is a canal in the center of the city of Amsterdam, we will only consider urban quay wall designs that are applicable for the urban area of Amsterdam. The following four types of quay walls are selected:

1. L-wall
2. Combi-wall with inclined piles
3. Combined wall
4. Steel pile wall

With these four types of quay walls, the stakeholder analysis is performed.

For the stakeholder analysis, fifteen stakeholders and their stakes are identified. The power-vs-interest method was performed in cooperation with professionals from different municipalities, consultancies and contractors. During interviews, each professional expressed their own unique vision on the position of the stakeholders in the grid. The different resulting grids were combined to the grid that can be found in Figure 2, which visualizes the average of the numerical values of the power and interest provided by each of the interviewees.

The circle visualizes the position of the stakeholder, the horizontal and vertical bars visualizes the relative variance. The relative variance shows the relation between the times that a stakeholder received a high or low value for the power or interest with respect to the total amount of interviews that were held. The longer the bars in figure 2, the higher the variation in power or interest.

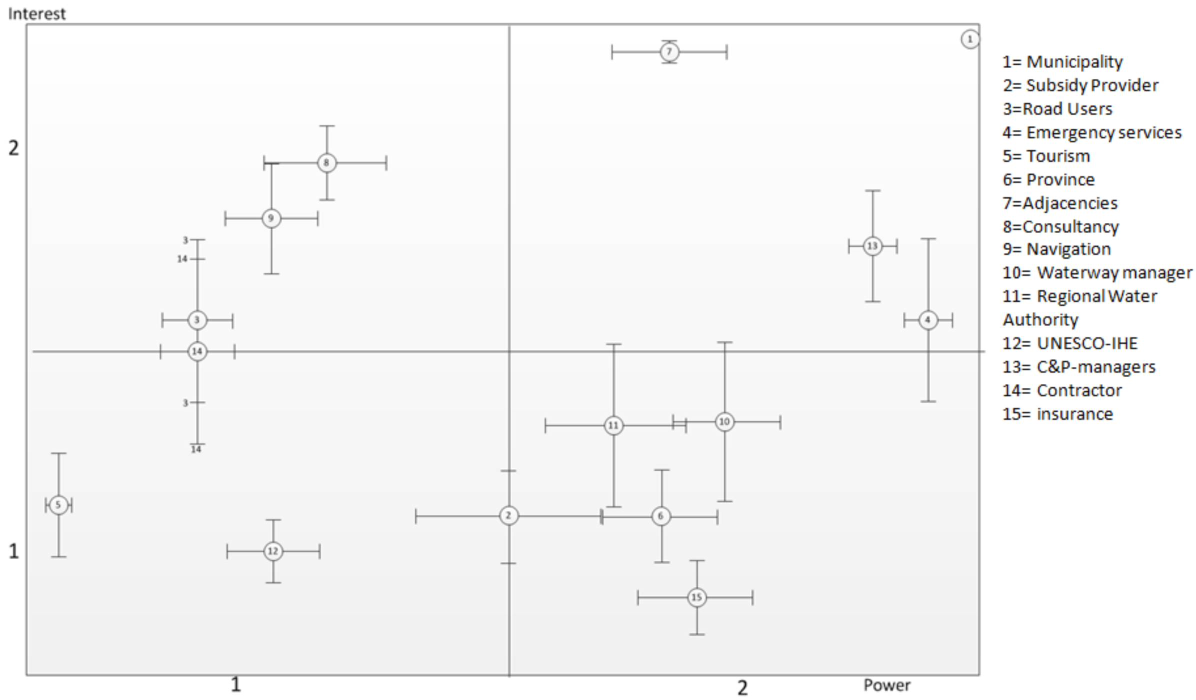


Figure 2: Overview stakeholders and their position in the grid

The combi-wall with inclined piles and the L-wall produce the least amount resistance accordance the C&S-matrix, but the combi-wall has lower costs and a shorter construction period. Therefore the combi-wall with inclined piles is the best solution for the Prinsengracht. The combined wall and the steel pile wall produce much more resistance, which is not expedient.

The C&S-matrix is a useful method to determine which construction method produces the least resistance. Since the output is numerical value it enables that the construction methods and the expected resistance can be compared, which makes this method unique. The effectiveness of the C&S-matrix mainly depends on the stakeholder analysis, it requires that all the stakeholders with their interest are identified and that the power-vs-interest grid resembles the actual power and interest of the stakeholders. This method predicts which stakeholders will most likely resist, this gives information for other measures to reduce this resistance for example compensation.

The C&S-matrix is developed for a replacement project, but needs to be tested on other infrastructure projects. In this research the stakeholders are generalized: mutual relationships between stakeholders and different reactions on detail level within a stakeholder group are not taken into account. It is recommended that these factors are added to the C&S -matrix.

Contents

List of figures

1 Introduction

1.1. General

The canals of Amsterdam were built around 1600-1700 and consist four main canals: Singel, Herengracht, Keizersgracht and Prinsengracht. The first canals were built for draining the surrounding land. In time the function of the canals changed to transportation due to the expansion of the city. In 2011 the canals of Amsterdam were placed on the world heritage list of UNESCO. The canals are a tourist attraction and are an important source of income for the city of Amsterdam. The urban quay walls are more than 100 years old and inspections show that some of them are at the end of their technical life-cycle or even have failed. In order to guarantee the safety of these quay walls measures are needed: the quay walls have to be refurbished. Amsterdam is not the only city with urban quay walls:

- Utrecht
- Haarlem
- Schiedam
- Dordrecht
- Den Haag

1.2 Problem description

The quay walls of the canals are located in the center of Amsterdam, this means that historic houses are located next to the quay walls and that there are different users of the street and canals. During the refurbishment of the quay wall the people and organizations in the surrounding will be affected by the activities. Figure 3 gives an overview of the people and parties that are affected during the activities when replacing the quay walls. The affected are referred to as stakeholders, in this research the following definition is stakeholders is used:

Definition stakeholder

"A stakeholder is an internal or external actor which is involved by the project and via interaction can influence the progress and imaging of the project" (Veenswijk, 2013). An actor can be an individual, group or organization.

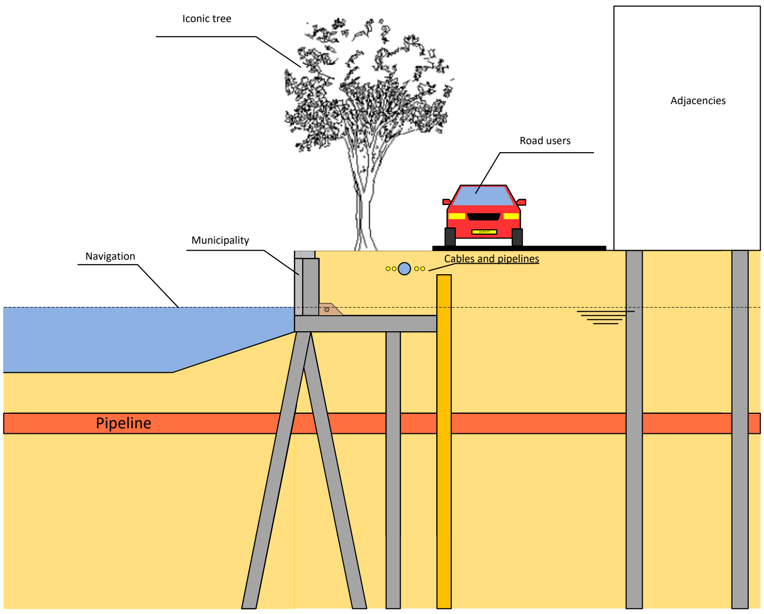


Figure 3: Cross-section of the environment that is affected during the activities

Stakeholders encounter hindrance during the construction of the project, this experience can differ per stakeholder. The hindrance can result in resistance against the activities which can result in delay of the project, extra costs, loss of trust and image damage of the client. Delay can occur when residents protest against a permit and extra costs occur when this protest leads to changes in design or construction method. Also the failure to manage the need of the stakeholders is one of the most common causes of the project failure around the world in large infrastructure projects (Beckers, et al., 2013). The replacement of urban quay walls in Amsterdam is a complex project due to high density of stakeholders, it takes around 5 years to replace a quay wall (Gemeente Amsterdam, 2017). This is from the moment that the decision is made to replace the quay wall till the realization of the new quay wall. One of the reasons for the long duration of the replacement projects is the time invested in dealing with the resistance of stakeholders. When the interests of the stakeholders are not sufficiently dealt with (according to the stakeholder) it can lead to resistance against the project. The high density of stakeholders (many and different users) increases the risk of high resistance against the project, which affects the success of the projects. In order to let the projects succeed, the amount of resistance that can be expected must be minimized. Success can be defined as a project that meets the technical specifications, and if there is a high level of satisfaction concerning the project outcome among key people in the parent organization, project team and key users of the project effort (De Wit, 1988). For this study project success can be defined as a replaced quay wall with satisfied stakeholders within time, budget that also meets the technical requirements of the quay wall.

In total the municipality of Amsterdam manages around 500 km of quay walls which are designed for a technical life-cycle of 100 years. That means that the municipality needs to replace 5 km a year, at this moment this goal is not achieved (Gemeente Amsterdam, 2017). This has multiple reasons:

- High risks for the environment, especially the historic buildings
- Resistance of stakeholders
- Relocating boat houses
- Uncertainties in the soil due to archeologic objects, cables and pipelines

This leap time has to be reduced and a possiblity is to investigate which construction method results in the least amount of resistance. Each project faces different stakeholders and interests, therefore the design has to be adjusted to the each project. There is a need for a method that determines which construction method results in the least resistance of stakeholders when an urban quay wall is replaced.

1.2.1 Life-cycle quay wall

Since the thirteenth century many types of quay walls have been developed in cities and ports, their function was the transshipment of goods. It appeared that many municipalities have their own perception and approach in redesigning these old structures (J.G. de Gijt & A.A.Roubos, 2013). In time the magnitude, intensity and type of loads on urban quay walls have changed: traffic and tree loads have become the dominant loads instead of mooring and transshipment loads. Due to the change of loads and ageing of the quay walls, the objects have reached the end of the life-cycle and do not meet the safety requirements anymore. The normal life-time-cycle of a quay wall is shown in Figure 4, during the operation time the quay wall will be inspected and maintained (step 1). The inspections of the quay wall provide information about the condition of the quay wall and the decision whether the quay wall meets the safety requirements and should be replaced or not (2). If replacement is needed, the next step will be making a design that meets the boundary conditions (3). After the tender the actual activities will start in the construction phase (4). Finally the operation phase will start with monitoring, inspections and maintenance of the quay wall (1). The new quay walls in Amsterdam are designed for an operation period of 100 years while the design and execution period is approximately 5 years, this includes preparation of the project with foundation investigations of the adjacent buildings.

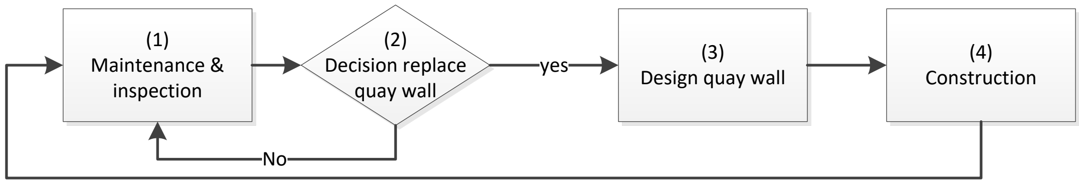


Figure 4: The life cycle of the quay wall

1.2.2 Is replacement needed?

Why should we undertake action if there is resistance from the surroundings? When no measures are undertaken in time, the quay wall will collapse which can have large consequences. A collapsed quay wall can lead to deformations in buildings, cables and pipelines or even failure. It also has large direct- and indirect costs. Direct costs are the repair cost and indirect costs are the consequences for the environment for example reduction of accessibility to the area for residents and companies and the reduction of trust and image damage of the Municipality. Not even mentioning the possibility of fatal casualties. Figure 5 shows a scheme with possible consequences when the (wrong) decision is made that the replacement of the quay wall is not necessary.

These large consequences explain the need of the replacement of quay walls: it is morally unacceptable to have objects at your responsibility which are not safe! If this would be the case, it means that the management of the city has failed. This occurred on 15 October 2013 when a historic urban quay wall collapsed in Utrecht. The bottom level of the canal was lower than the quay wall, caused by dredging and navigation, led to piping and finally collapse of the quay wall (DUIC, 2013). Philine Goldbohm proves in her thesis ‘Asset management in Urban areas’ (Goldbohm, 2016) that managing objects and execute maintenance adds value to urban area.

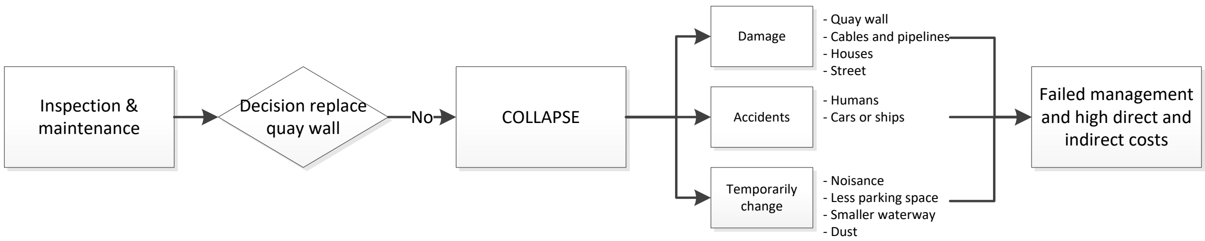


Figure 5: Consequences when no measures are taken

1.2.3 Origin of resistance

The need of taking measures seems justified but why is there resistance?

The first reason is change. A human is looking for a place where he feels comfortable and safe. But changes mean that he is leaving the comfort zone and entering the unknown, which results in resistance (Mazouz, 2015). In this context the replacement of the quay wall can be seen as a change: the current location will be changed. This change can be divided in two parts: a temporarily change and a final change of the situation. The temporarily change is the change of the location due to execution: less area is available on the public area, waterways and nuisance is produced. This is often denoted as hindrance: “something that makes it more difficult for you to do something or something to develop” (Cambridge Dictionary). The activities creates a temporarily situation where the location becomes “more difficult” than the old situation which can be seen as change and this change can increase the resistance against the project.

Final change can be seen as the changes of the location before and after the execution phase, for example extra parking space or removing a tree. This thesis focuses on replacing the quay wall and restoring the old situation. Improvements to the new situation can be used to gain additional support for the project. When the changes are focused on the design of the public area, then this additional support will be equal for each project despite the different types of the quay walls or execution methods.

The second reason for resistance is the concerns about possible damage to their properties as a result of the activities. During the execution the machines produce vibrations which can lead to deformations and cracks in walls or foundations of buildings and cables and pipelines. Damage can also be seen profit loss for companies like hotels or restaurants. The “not in my backyard” (NIMBY) argument can also be used by stakeholders, but this argument is often used for new developments and less common for the replacement of urban quay walls. The line of approach for the urban quay walls is to replace the quay walls and the preference is to restore the location as much as possible. Sometimes changes in the situation are inevitable, for example when the roots of trees decrease the stability of the quay wall then the trees have to be removed. Especially cutting a tree is a sensitive subject which produces a lot of resistance. For example the Veenkade in The Hague: multiple trees had to be cut in order to replace the quay walls. The resident resisted against the project and went to court in order to preserve the trees. Eventually they lost the case and the trees were removed (Omroep West, 2016). The resistance of the residents caused a delay of the project and additional costs for the Municipality of The Hague. Despite the fact that often resistance is produced, these projects also gives opportunities to improve the public area, for instance old pipelines can be replaced or extra parking area.

Figure 6 shows the origin of the stakeholders resistance connected to the life-cycle stage. Change combined with damage defines the resistance and influences the success of the project. The causes of resistance are the result of insufficient adaptation of stakeholders’ interests. In order to gain support from a stakeholder the interest should be adapted in the design and construction method. This can be repeated for each stakeholder until sufficient support is created among stakeholders.

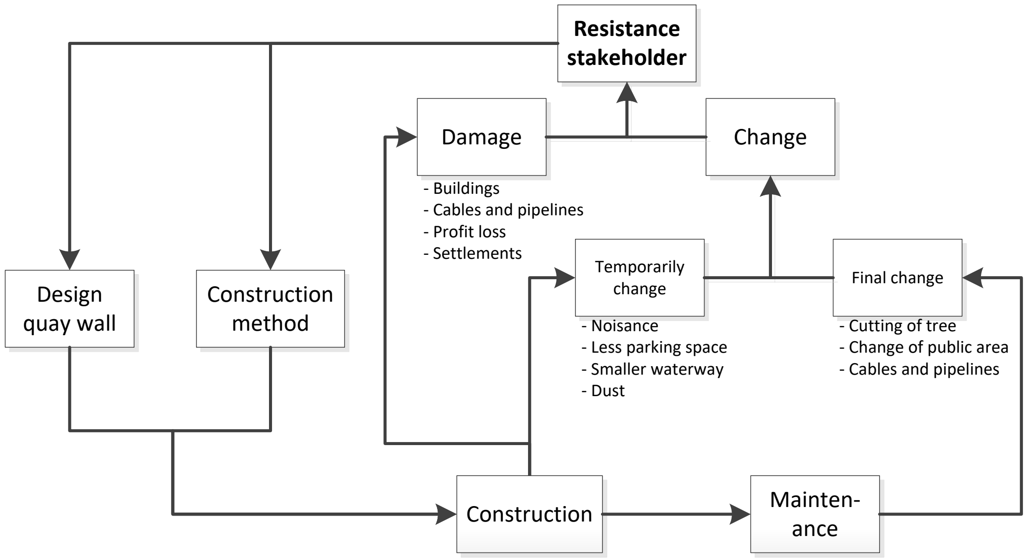


Figure 6: Origin of the resistance and influence of the design

1.2.4 Research objective

The objective of the research is to create a method that determines which construction method will produce the least resistance of the stakeholders. Resistance can be expected when the interests of the stakeholders are not (sufficiently) integrated in the design or construction method.

Note that resistance can also be reduced by communication with stakeholders, but this part is not included in this research: it focuses on direct influences on the design and construction method. Stakeholders have different interests but also different influence. For example Stakeholder A can have more influence on the end result than stakeholder B. By applying a stakeholder analysis, information can be obtained which stakeholder has the largest influence and can produce the largest resistance. The final result is a construction method that results in the least amount of resistance of the stakeholders. It also provides information which stakeholders will most likely resist and can help to determine which measures can be used to reduce the resistance, for example compensation. The developed method will be applied on a case in the Prinsengracht in Amsterdam.

Research question:
How can be determined which construction method for replacing urban quay walls will most likely produce the least resistance of stakeholders in a particular project?

Additional Questions:

- Which type of quay walls can be used in urban cities?
- Who are the stakeholders and what are their interests?
- How much influence does a stakeholder have on the outcome of the project?
- Which type of design and construction methods results in the least resistance?

1.3 Research method

The research process is shown in the figure below.

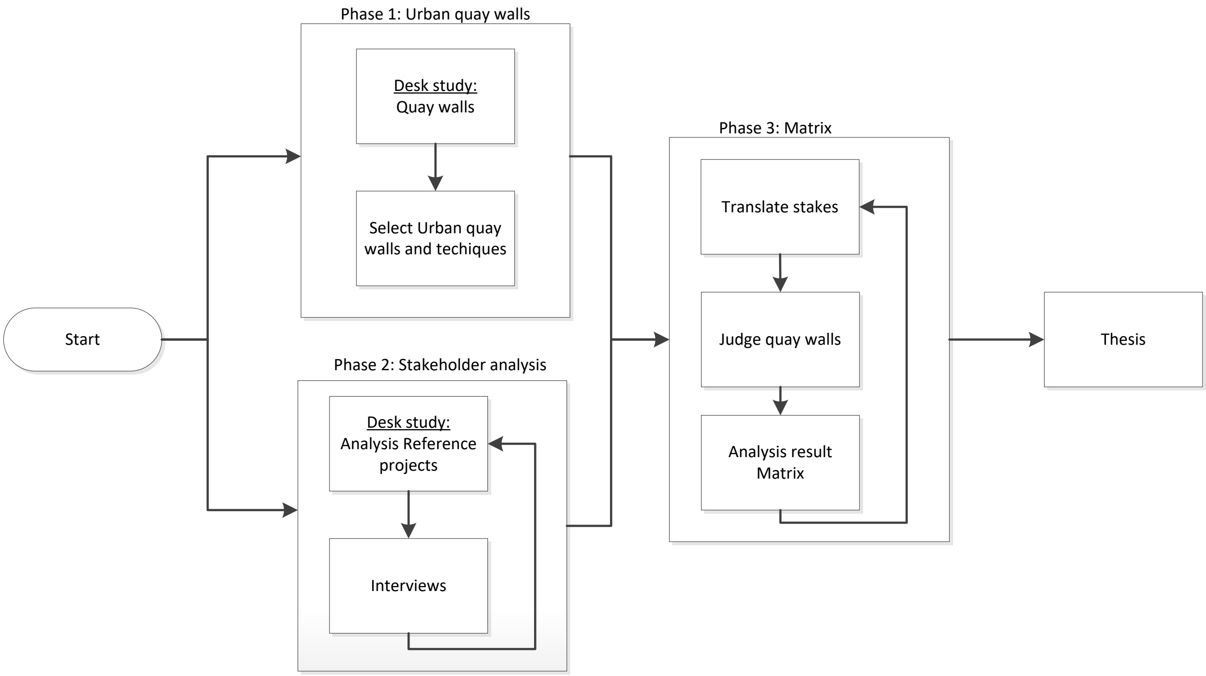


Figure 7: Research process

Phase 1 consists of selecting the quay walls that are applicable for the urban areas. Therefore multiple projects will be studied to investigate which types are recently applied in cities as Amsterdam, Rotterdam, Den Haag, Schiedam, Dordrecht and Utrecht. Eventually four types of quay walls will be selected as input for the matrix. In order to compare the four quay walls, they should be designed with equal boundary conditions, in this case the Prinsengracht in Amsterdam. The design will consist of simplified calculations to get information about the dimensions of the materials, the feasibility of the design and the equipment that is needed to construct the quay wall.

Phase 2 is performing a stakeholder analysis, which consists of the identification of the stakeholders with their interest and the identification of the power of the stakeholder to influence the project. Recent replacement projects of urban quay walls will be analyzed to identify the stakeholders and their interest. The power-vs-interest method will be used to identify the power of the stakeholders, this method creates a visualization of the influence of the stakeholders. The power-vs-interest method will be performed with persons of different municipalities, consultancies and contractors with experiences with projects in urban areas.

Phase 3 is setting up the matrix, which is a multi-criteria-analysis to investigate which type of quay wall results in the least amount of resistance. The input of the matrix is shown in the figure below. The power-vs-interest grid adds value to the interest of the stakeholders. Stakeholders with a high influence gain a high value, when the interests of these stakeholders are met then more resistance is reduced. The interests of the stakeholders are translated into measurable criteria for the assessment. Then each quay wall design combined with construction techniques will be assessed to the boundary conditions. It is assumed that when the interest of a stakeholder is integrated in the construction method, it will not produce resistance against the project and vice versa. The result of the matrix is a numerical value that represents the amount of resistance that can be predicted: the lower the value of the matrix, the more resistance can be expected.

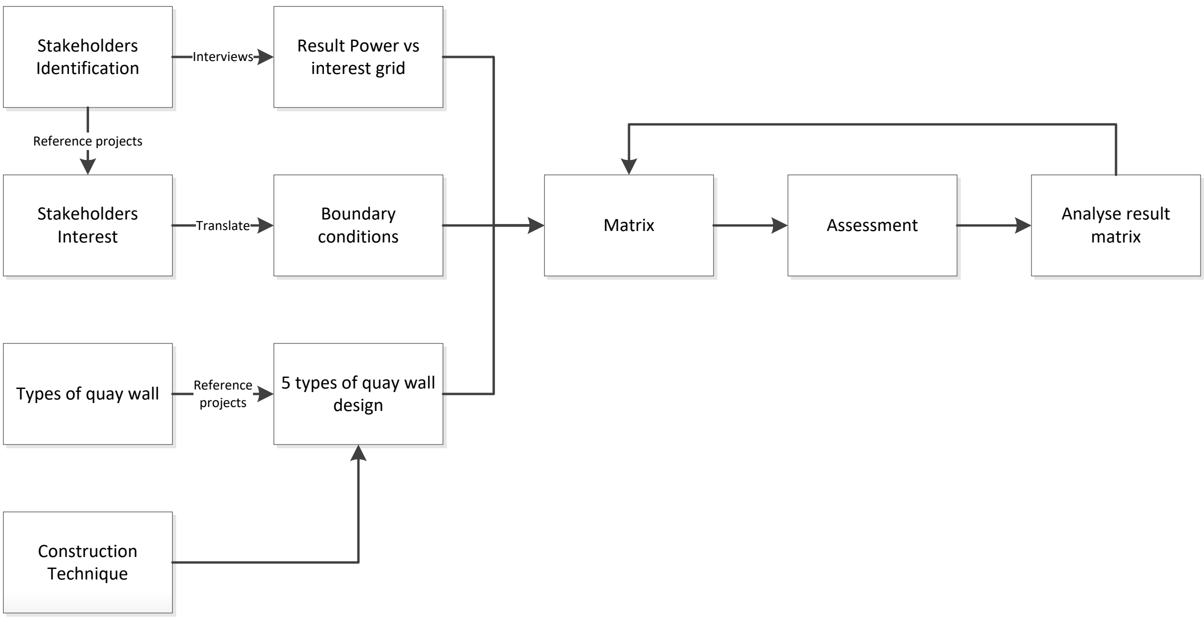


Figure 8: Phase 3, the input of the matrix

To enable the assessment of the interest of the stakeholders measurable criteria are required. For example the interest of road users is accessibility, the measurable criteria can be the area of the building pit or the remaining accessibility of the street. A larger building pit will result in a lower score. This translation of stakes can be performed for each stake.

Eventually two cases will be investigated:
1. Which construction method results in the least amount of resistance that can be expected by the stakeholders?
2. Which construction is most cost-effective with respect to the amount of resistance that can be expected by the stakeholders?

Another parameter that determines the outcome of the method is the construction period, this will be included in the results of the method. Eventually the length of the construction period influences the reaction of the stakeholders against the project. In the second case the costs will be included to see what the influences of the costs are with respect to the resistance that can be expected. This will be done by determining the costs for each design with standard prices. Both cases will be compared to investigate the additional value of the expected resistance with respect to the additional costs for reducing the risks of resistance. The cost parameter will provide information about the added value of different construction techniques, for example when technique A is compared with technique B and A is cheaper but less favorable. Then the method can be used to determine how much resistance can be reduced when method B is selected instead of method A.

1.4 Limitations

Reducing the resistance of stakeholders and stakeholder participation can be achieved with various methods, for example communication or compensation are well known methods to reduce the resistance of stakeholders that have no influence on the construction methods of a quay wall. These methods have an indirect influence on the project, since both measures influence the budget of the project. The following chapter describes the limitations of the developed method.

1.4.1 Communication

Stakeholder management is an important aspect in construction projects, it is used to connect the surrounding with the project in order to reduce the resistance. A tool for stakeholder management is the communication with the stakeholders: public communication. Therefore communication is a measure to reduce the risk of resistance. How do you communicate with the environment? What do you communicate with the stakeholders? When do you communicate and how do you keep them informed and what do you tell them? Which measures could increase the support of the project? All these questions are related to public communication, however this will not be taken into account in this thesis, because the communication with the public is a study on his own. This method focuses on the direct influences of the construction techniques and the reactions of the stakeholders.
The main reason for this is that the background of my study is hydraulic structures, which has my priority and also because public communication is a different field of study.

1.4.2 Compensation

Another method to reduce the resistance of the project is to compensate the stakeholders for the hindrance during the activities. Compensation is often used for companies and residents living close to the project. Compensation can be:

- Money for compensation of income loss
- Discount for events or holidays
- Collaboration between companies and project team
- Shares in companies or projects

Shares in projects are often applied for new projects, for example wind turbines (Ghaleigh, June 2013). This research focuses the direct influence of the stakeholders on the project and the activities during the construction. Nevertheless the method can give a prediction of which stakeholders will most likely provide resistance. This prediction can help to determine where compensation can be used to reduce the resistance of some stakeholders.

1.4.3 Generalization of stakeholders

Stakeholders have different interests and could response differently to each project. This makes each project unique. Besides within a group of stakeholders interests and responses can differ per person. For example, all the residents nearby a project agree on the activities of the project and the expected hindrance, except that neighbor who always has comments on everything. In that case extra effort is needed to convince this one person about the need of the project and the expected hindrance. So in detail each stakeholder can react different. For this research the stakeholders are generalized, they have the same interest and their reaction is the same. The differences on detail level are excluded.

Another generalization is the mutual relationships between stakeholders which can affect the project. Previous experiences between stakeholders can influence the relationship and affect the project, this holds for both negative and positive experiences. For example when the cable manager has negative experiences with a contractor, it will be much more difficult for the contractor to get permission to work around the cables of the manager. In this thesis the mutual relationships are not taken into account, the stakeholders have none mutual prejudiced and look objectively to each other.

1.4.4 Improving public area

This method focuses on replacing the quay walls and restoring the old situation. Normally these projects give opportunities to improve the public area. The activities of the project will take place and changes of the public area can be constructed for reduced costs due to combining the activities. These improvements are often wishes but eventually the project leader determines whether the wish will be granted or not. Improvements of the public area can be:

- Extra parking space for cars of bicycles
- Installing Electric Vehicle Charging Station

These improvements can be used to reduce more resistance of stakeholders and can be seen as an addition for this research.

2 Construction & Stakeholder matrix

The main goal of the matrix is to obtain a construction method and design of an urban quay wall that determines which construction method results in the least resistance that can be expected by the stakeholders. It compares multiple quay wall designs, and different techniques, in relation to the stakes of the stakeholders. In this matrix the stakes will be compared with the techniques, this matrix will be called "Construction & Stakes matrix", further on the abbreviation C&S-matrix will be used. In this chapter the method of the C&S- matrix will be explained in detail. In chapter 2.1 the matrix will be explained step by step, chapter 2.2 describes the information that is needed as input for the matrix and the resources. The C&S-matrix requires interests with measurable criteria to enable the assessment of the construction methods, this is explained in chapter 2.3.

2.1 Explanation of C&S-matrix

The method of the C&S-matrix is shown on the page 20,
Figure 10. The C&S-matrix investigates which method could result in the least resistance produced by the stakeholders by comparing the stakes of the stakeholders with the construction methods of the quay wall. Resistance can be produced by stakeholders when their stakes or interests are not (sufficiently) taken into account in the design process. In this chapter each step of the C&S-matrix will be explained.

The method can be divided into four steps:

1. Decomposing the construction process
2. Construction techniques vs stakes
3. Rating of the stakeholders
4. Combine step 2 and 3

Figure 10 also shows that this method actually combines two separate subjects in an infrastructure project. This is shown by the dashed lines in Figure 10. The area within the left block with the dashed line is the subject of the design of the quay wall and the possible construction methods that can be used. The area within the right block shows the stakeholder analysis consisting the identification and rating of the stakeholders. The C&S-matrix connects these two subjects and creates an interface between them.

Step 1: decomposing the construction process
The construction of a quay wall is a process that consist multiple steps of activities. These activities, combined with the required materials, equipment and their impact on the surrounding, are determined for each step in the construction process. The impact on the surroundings mainly influences the resistance of the stakeholders.
Figure 10 shows an example of an activity: installing the foundation piles of the quay wall. There are multiple ways to install piles: drive piles into the soil using screwed piles or hammering prefabricated piles. Each method has his (dis)advantages resulting in different effects on the surroundings. For each step, multiple construction techniques will be investigated and their impact on the surroundings. Not only the techniques will be investigated but also the location where the equipment is installed will be investigated. For example, what is more favorable for the stakeholders: the equipped installed on the street or on a pontoon?

Step 2: Construction techniques vs stakes

The effect on the surroundings is compared with the stakes of the stakeholders. Stakeholders can have multiple stakes, which can be conflicting or in accordance with the stakes of other stakeholders. Each stakeholder can react differently to the activities, each method influences multiple stakeholders, which could lead to different reactions. The interest are obtained via interviews with the stakeholders and analysis of reference projects, this will be explained in the chapter 2.2.
The effect on the surroundings can be positive or negative of neutral with respect to the stake(s). When the activities have a negative relation with the stake of a stakeholder, it will get a negative rating and vice versa. If a method is considered to be in accordance with the stakes of the stakeholders, a +1 numerical value is assigned to the method. If a method is considered to be at variance with the interests of the stakeholders, a -1 numerical value is assigned to the method. Methods that have no correspondence whatsoever with the interests of the stakeholders, are assigned a numerical value of 0. An example of the assessment is: the interest of the navigation is the accessibility of the channel. When the equipment is located on a pontoon, the accessibility of the channel will decrease. This method is in conflict to the stake of the navigation, this result in a negative rating in the matrix (-1) for the navigation. Eventually each construction method will be assessed with all the interest of the stakeholders.
Some stakes are relative and therefore hard to judge, for example: value for their money is a relative stake of the tourists. When has a tourist the feeling that he paid the right price for his visit to Amsterdam? In order to be able to assess theses stakes, they should be rewritten into measurable criteria. Therefore these relative stakes should be translated into measurable criteria. The translation of these relative stakes into measurable criteria is described in chapter 2.3: assessment of the stakes.

Step 3: Rating of the stakeholders

Stakeholders have the ability to influence the process or the outcome of a project, but this ability to influence the project differs per stakeholder. It depends on the power of the stakeholder: the stake of a powerful stakeholder will most likely be granted than a less powerful stakeholder. The reason for this is that a powerful stakeholder has more ability to influence the project than a less powerful stakeholder. The Municipality has, for example, much more power to influence the project than tourists. A stakeholder analysis will provide insight of the power of a stakeholder, the analysis that is applied for this research is the power-vs-interest method which creates a visualization of the stakeholders. It consists of a grid with four areas and two axes: power and interest. Each area is characterized by the amount of interest and power of a stakeholder. The power and interest of each stakeholder is discussed which results in a position in an area in the grid. The position of the area is then translated into a value for the power and interest, this is shown in Figure 9. The multiplication of these two values determines the amount of resistance that a stakeholder can provide. For example the municipality is owner of the quay wall and has much power and interest, this leads to a total value of 4.

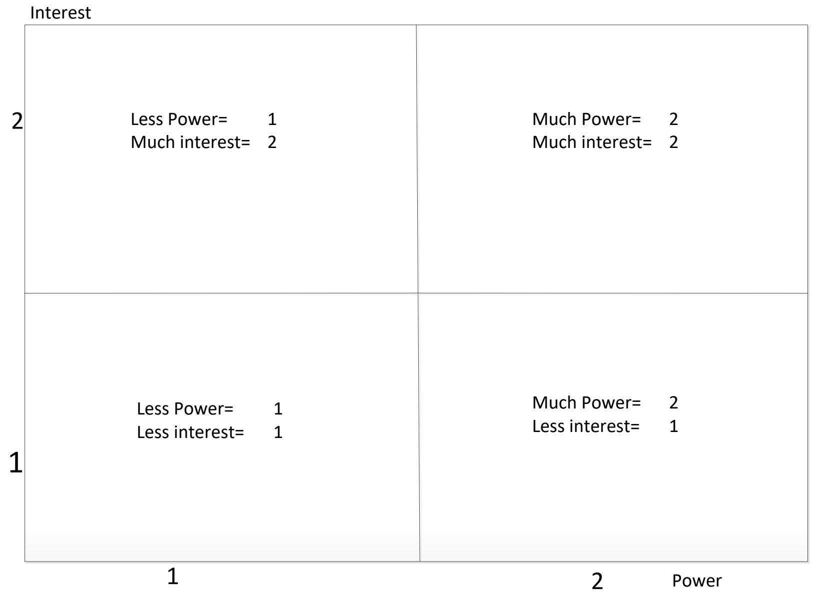


Figure 9: explanation rating stakeholders

Step 4: Combine step 2 and 3

In order to determine the most favorable method it is vital that the most powerful stakes are granted as much as possible. Therefore the assessment of the techniques will be combined with the stakeholder analysis. The result will be an overview of the different techniques and number that represents the favorability of that specific method. The higher the number, the more favorable the method is for the stakeholders. Eventually all methods combined will result in a design and execution method that will be most favorable for the stakeholders. For example : a construction method has a positive relation(+1) with the stake of the Municipality(value 4), this results in a total value of +4. The total sum of the stakeholders provides information which method is most favorable for the stakeholders.

Additionally the consequences for the budget and execution can be investigated. This method will also provide information about which stakeholders are negatively affected by the project and will most likely provide resistance.

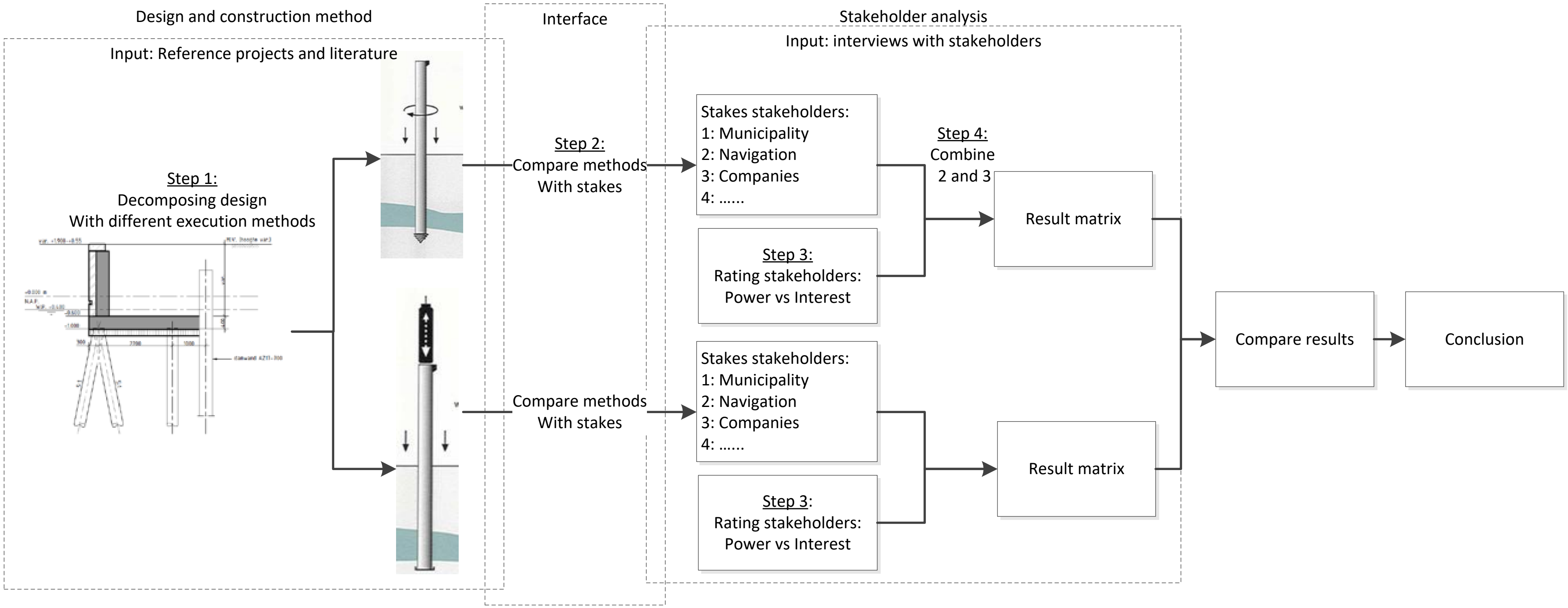


Figure 10: Scheme of the method

2.2 Input of C&S-matrix

In order to perform the C&S-matrix different information sources are needed. This chapter describes the information and the resources needed for the resources.

The C&S-matrix uses different resources of information:

- Reference projects
- Literature
- Interviews

Reference projects and literature will be used to select quay wall designs that are applicable for urban areas. Therefore finished projects within Amsterdam and other cities will be investigated. The reference projects also provide information for the identification of the stakeholders.

Interviews will be used to obtain information about the stakes of the different stakeholders and to perform a stakeholder analysis. The reference projects already provided an overview of all the stakeholders that are affected during the replacement of urban quay walls. The interviews were held with professionals of multiple municipalities, contractors and consultancies with experiences with urban quay walls.
The interview consisted of two parts: (1) determining the stakes of the stakeholders and (2) perform the stakeholder analysis. A pre-arranged list of stakeholders will be discussed in order to determine the interest of the stakeholder and their position in the power-vs-interest grid (see Figure 11 for example of a power-vs-interest grid). It is important that each professional determines the position of the stakeholder from their own perspective about stakeholders. This gives valuable information regarding the vision on stakeholders. For the interview power is defined as the ability to influence the outcome of the project or influence the progress. Interest is defined as the importance for a person or organization. With respect to the quay walls, interest can be seen as the effect of the project on the stakeholder.

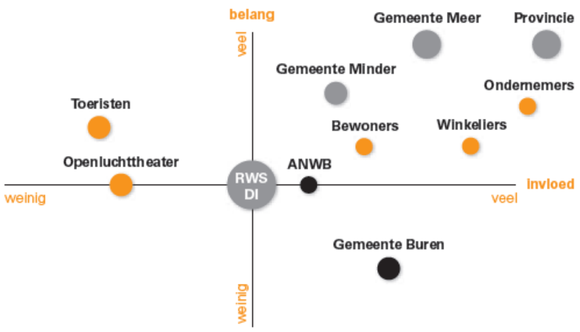


Figure 11: A power-vs-interest grid, source: (Veenswijk, 2013)

2.3 Assessment of the stakes

As mentioned before, all the stakeholders have their own interest(s), which can be conflicting or in accordance with stakes of other stakeholders. In order to assess the construction methods with respect to the stakes, the stakes should be defined as measurable criteria. This chapter explains how the stakes of the stakeholders are assessed and when the stake a positive, negative or neutral relation has with the construction technique. Some stakeholders have a relative stake and are therefore hard to assess. These stakes are translated into measurable criteria, this translation of stakes is also clarified in this chapter.

Table 1 shows a short version of the entire table of stakeholders, stakes and measurable criteria. Figure 15 (page 46) shows the entire list of stakeholders and their interests. No interface means that the construction has no interface with the stake of the stakeholder. For example UNESCO-IHE is only interested in the characteristic appearance but the method of replacement is not important. Therefore hammering or press-in of sheet piles is not relevant for UNESCO-IHE, resulting is a neutral assessment

Stakeholder	Stake	Measurable Stake

Assessment		
Negative (-1)	Neutral (0)	Positive (+1)

Table 1: Preview of the table with stakeholders and measurable criteria

3 Urban quay walls

Quay walls are built since the thirteen century and have developed in time. Different types of quay walls are found in the Netherlands with their own characteristics. In this chapter four quay wall designs will be selected for the matrix and for each step multiple construction techniques will be compared. In chapter 3.1 the main quay wall types are described, the following chapter describes the four selected quay walls for the C&S-matrix. The next chapters give a short description for each design and the required construction steps to build the quay wall.

In order to compare the quay walls and the construction techniques mutually, a design is needed for each quay wall. Therefore a location in Amsterdam is chosen as a case: the Prinsengracht. In the case a quay wall has to be replaced over a length of 30 meters. Eventually four designs are chosen to use in the C&S-matrix where 2 quay walls were already designed for Amsterdam. The other two types of quay walls were calculated using D-sheet. In order to compare the quay walls the boundary conditions of the first two designs are used to design the final two quay walls.

3.1 Types of quay walls

There are four main types of quay walls:

1. Gravity walls: the retaining capacity is obtained by the selfweight of the structure, including the soil;
2. Sheet pile walls: Sheet pile obtains the retaining capacity from soil pressures, often in combination with an anchorage system, and the resistance of the wall against bending moments and transverse forces;
3. Structures with relieving platforms: A sheet pile wall with a relieving platform that reduces the tensile forces in the foundation piles and forces in the retaining wall. There are two types of structures: a high relieving platform and a deep relieving platform;
4. Open berth quays: quay walls that look like a jetty: it consists of a deck on piles.

The gravity wall is the first developed quay wall and gains bearing capacity by generating resistance against shearing by his self-weight. This type of quay wall can only be applied on hard subsoil with sufficient bearing capacity, for example rocks or hard sand. It often contains prefabricated elements and can be an attractive solution when the quay wall contains a high repetition factor for formwork, construction dock etc. The gravity wall is not an good solution for an urban quay wall in the Netherlands. The top layers of the ground consist weak soil layers above a strong Pleistocene sand layer. This means that a large gravity wall needs to be built and placed on the Pleistocene sand layer, which is technically and economically not an attractive solution.

Sheet pile walls derive their strength from the fixation capacity of the soil, often combined with anchors. This type of quay wall is suitable for soils with poor bearing capacity and that are easy to penetrate. It is the most applied quay wall in the Netherlands. The sheet pile wall can be separated into two groups: free standing piles and anchored system. Examples of free standing piles are sheet piles, combined wall or diaphragm walls. Anchored systems consist a vertical wall with an upper support: the anchor. The anchor transfers the loads towards the soil with bearing capacity. The anchor can be installed horizontal or under an angle.

Using relieving platforms reduces the horizontal load on the sheet pile walls. Therefore relieving platforms are often applied for high retaining heights, heavy loads on the site, high demands in relation to the deformations and this type is economically more attractive than a single sheet pile wall.

The open berth construction is a similar construction as a jetty and often applied when there is already an installed slope present. The strength of the subsoil should be relative poor and sufficient area should be available to apply this open berth quay wall (SBRCURnet, 2013).

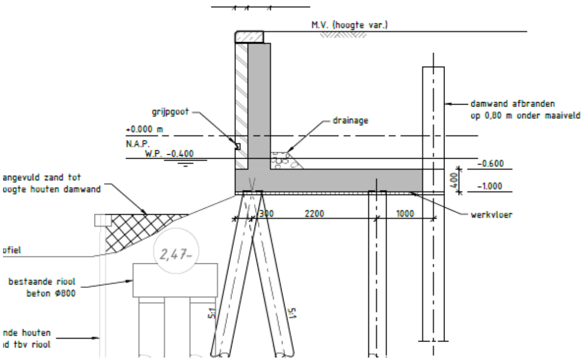
3.2 Quay walls used in matrix

Not all types of quay walls are suitable for urban areas, this depends on the functions of the quay wall, the loads and location of the project. Urban quay wall projects around the Netherlands are investigated in order to select four types for the C&S-matrix. Eventually the following quay walls are chosen:

1. L-wall
2. Combi-wall with inclined piles
3. Combined wall
4. Steel piles wall

The four quay walls are shown below and the cities were they are applied. Next a short explanation will be given for each wall and the required construction phases.

1: L-wall

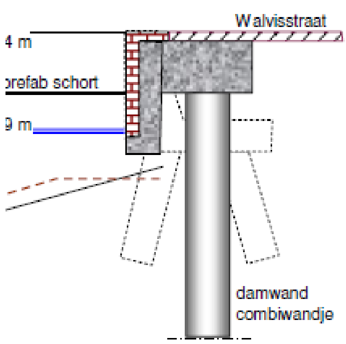


Keizersgracht, Amsterdam
Prinsengracht, Amsterdam
Singel, Amsterdam

2: Combi- wall with inclined piles

Krom Boomssloot, Amsterdam
Herengracht, Amsterdam
Werverhaven, Dordrecht

3:Combined wall



Rottekade, Rotterdam

4: Steel piles wall

Oudegracht, Utrecht
Nieuwegracht, Utrecht
Source: (Gemeente Utrecht)

Figure 12: Quay walls of reference projects

The sources of the above figures are project documents of project of Royal HaskoningDHV except the fourth picture.

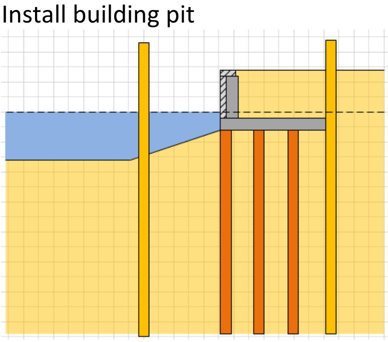
3.2.1 L-wall

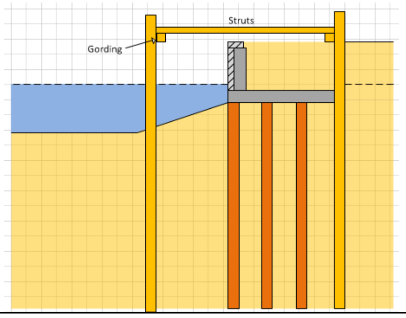
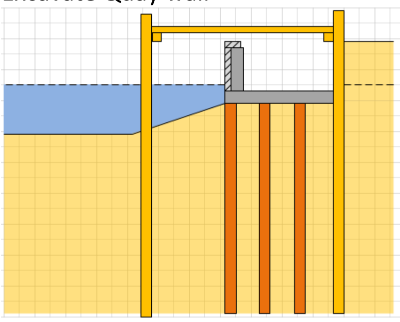
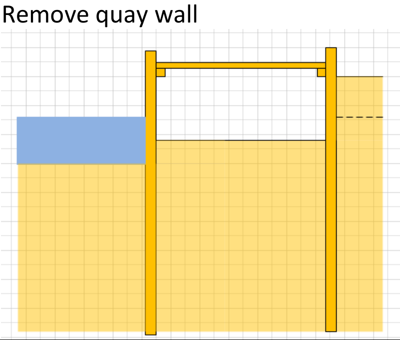
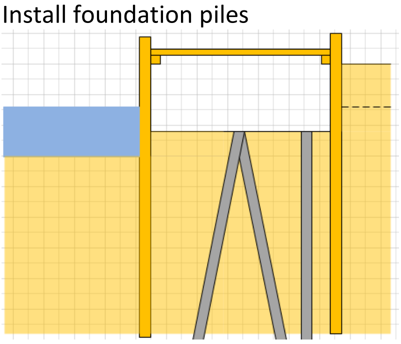
The L-wall is a quay wall with a relieving platform, the function of the relieving platform is reducing the horizontal load o the piles. This type of quay wall is the most applied quay wall in the urban area of Amsterdam. Normally the foundation piles are screwed into the soil and the L-wall is cast in-situ. A building pit with drainage is needed to replace the quay wall. Table 2 describes the different phases that are needed to build the quay wall, per phase different techniques are shortly explained.

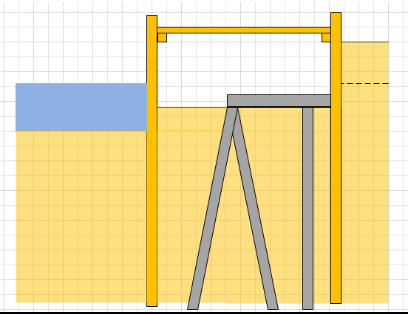
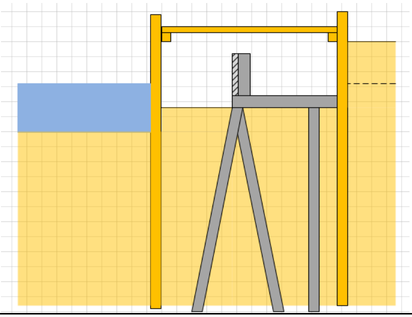
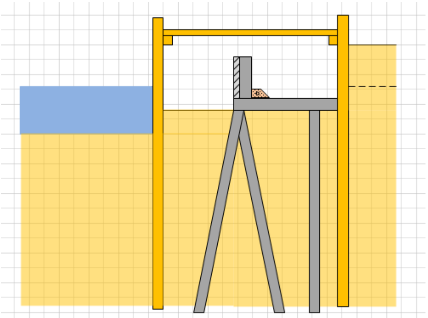
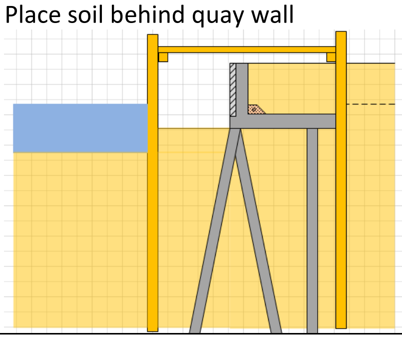
Note:
A method on land means that all the equipment is set-up on the streets of Amsterdam and materials are transported by trucks. When the table mentioned water, then the equipment is set-up on pontoons and materials are transported by small tugs and barges.

The dimensions were already determined for a design in the Prinsengracht.
Dimensions:

- Width concrete floor	3,50	m
- Thickness wall ad floor	0,40	m
- Ground level	+2	m NAP
- Diameter piles	355	mm
- 2 shore piles and 1 vertical pile		

	Phase	Description
1	Set up site	Fences are placed to create a physical boundary between the public area and building pit.
2	Remove pavements	Removing the pavements in the public area. Options: Land and water
3	Install building pit 	Installation of sheet piles in the canals and on land to create a building pit. Options: - Vibrating: land or water - Press-in: Land or water Vibrating: Sheet piles are installed with a vibratory hammer and a crane or hydraulic crane depending on the dimensions. Vibrations hammer lets objects vibrate which looses the soil and makes it possible to install objects in the soil. The vibrations could lead to deformations in the environment. The risk of damage in adjacent buildings is high. A new technique is a resonator, it uses a very high frequency which resonate the sheet pile. The sheet pile becomes a spring which does not produce vibrations. A large disadvantage is that it produces a lot of noise hindrance (much more than a normal vibration hammer). This is unfavorable in an urban area like Amsterdam. Another disadvantage is that this technique cannot be used when other objects are encountered in the soil Press-in: Installation of sheet piles with a press-in machine or silent piler.. First a special start construction must be built, in which the silent piler is set-up. Then it presses the first sheet piles into the soil and then travels on the sheet piles to install the rest of the sheet piles. The silent piler clamps itself on the sheet piles and then presses

		the next sheet pile into the soil. A crane is needed to provide the silent piler with sheet piles. The sheet piles can also be pressed-in with pressure rigs, which are special cranes equipped with a press. It pushes two double sheet piles into the soil at once. A silent piler is preferable due to the small dimensions of the sheet piles and easier to transport
4	Install struts 	Struts are installed to prevent large deformations of the sheet piles of the building pit. The struts are steel beams that are lifted with a crane in the building pit and welded to the sheet piles. Besides struts "gording" are installed in the building pit. These are steel beams that transfer the loads perpendicular to the quay wall Options: Land and water
5	Excavate Quay wall 	The soil behind the quay wall is excavated with an excavator and transported. Hereby two options are applicable: Land and water Land means that the excavator is located on the street and places the soil in the trucks that transport the soil. On water the excavator is set-up on a pontoon and the soil is transported by barges. During the excavation, extra attention should be paid to cables and pipelines in the soil. The risk of damage during excavation is high, therefore trail trenches should be performed before excavation.
6	Remove quay wall 	Removing old quay wall with a hydraulic crane equipped with a grappler. A crusher can be used when the old quay wall is too big to remove. Options: Land and water
7	Install foundation piles 	There are multiple techniques possible to install the foundation piles: - Hammering, land and water - Vibrating, land and water - Screwed, land and water Hammering: The foundation piles are hammered into the soil using a crane equipped with a leader and a hydraulic impact hammer. Hammering creates low-frequency vibrations which is very unfavorable for foundations of building. The risk of damage in the environment of Amsterdam is very high. Vibrating: Installation of sheet piles in the canals and on land to create a building pit. Sheet piles are installed with vibratory hammers and hydraulic crane Screwed: Screwing steel piles is an installation technique without vibrations and noise hindrance. The piles are screwed into the

		soil till the installation depth is reached, then the pile is filled with reinforcement and concrete. Next the steel pile is removed and the concrete pile remains into the soil. Often grout is injected around the pile to penetrate soil layers with a high cone resistance(sand) which also increases the bearing capacity of the pile.
8	Cast concrete floor 	The concrete floor is cast in situ, which means that formwork, reinforcement must be placed in the building pit before the concrete is cast. Temporarily drainage (bemaling) is needed to keep the building pit dry. The activities are executed inside the building pit, therefore the required materials can be transported on land or on water. Options: Land or water
9	Cast concrete wall and brick wall 	The method of the vertical concrete wall is identical as the concrete floor, the only difference is that a brick wall applied to give the quay wall a characteristic appearance. The bricks are placed by hand, this is a time consuming process. There are two transport options: Land or water
10	Install drainage 	Drainage is installed to reduce horizontal water pressures on the quay wall, when the ground water level is higher than the water level of the channel. Drainage consists tubes surrounded with gravel and geotextile and must be installed underneath the ground water level, therefore temporarily drainage (bemaling) is needed to keep the building pit dry. The drainage is build inside the building pit and materials can be transported by car of barge. Options transport: Land or water
11	Place soil behind quay wall 	Next step is to restore the ground level behind the quay wall. An excavator will place the soil. It is important that the soil is vibrated with a vibrating compactor to prevent settlements in the user stage. The excavator is located at the street or on a pontoon in order to place the soil behind the building pit. Just like step 5, there are two options: Land or water
12	Remove building pit	The building pit has to be removed In the project location. The options are: - Remove completely, land or water - Remove partly, land or water The only method to remove sheet piles is vibrating, which works identical as installing the building pit. The sheet piles vibrate which reduces the friction of the surrounding soil, so that the sheet piles can be pulled out of the soil. Vibrating increases the

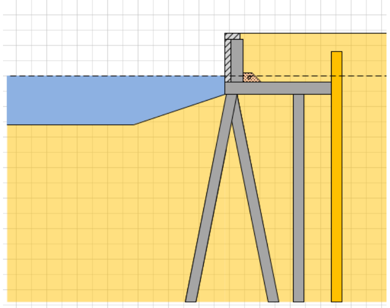
		risk of damage to the adjacent buildings. Therefore two options are possible, completely remove the building pit of partly remove the building pit. Then only the sheet piles, installed in the water, are removed and the land side is partly cut off. The options are: - Remove completely, land or water - Remove partly, land or water
13	Restore pavement	The pavement is placed on top of the soil and restores the appearance of the public area. The pavements can be transported by truck or barge. Options: Land or water
14	Restore site	Final step is removing the fences and ensure that the location is cleaned up and identical as the situation before the project started.

Table 2: Construction methods L-wall

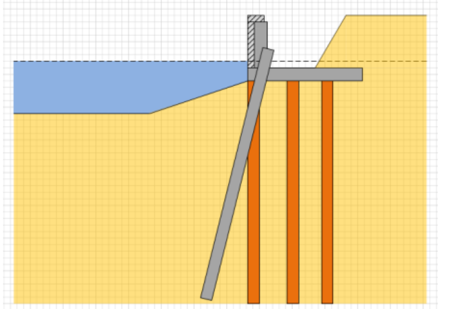
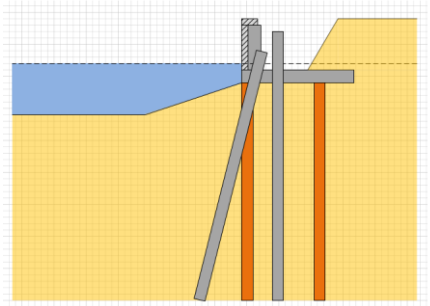
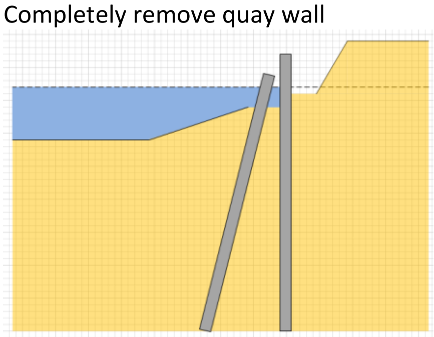
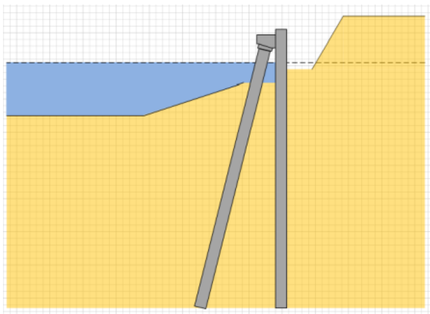
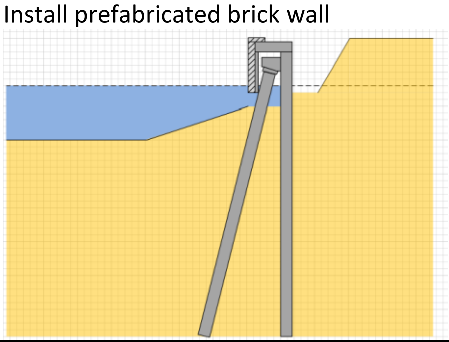
3.2.2 Combi-wall with inclined piles

The combi-wall with inclined piles consists of a vertical wall with sheet piles and steel piles combined with inclined piles in the direction of the canal, this design is favorable for locations with limited area behind the old quay wall. Another advantage of the inclined piles is that a building pit is not needed. This design will be applied in the Herengracht for example, where a strafozuil and monumental tree are located behind the quay wall. Since this design will be used in the Herengracht, a new design was not needed to determine the dimensions.

Dimensions:

- Inclined piles depth	-20	m NAP
- diameter	450	mm
- thickness	25	
- Angle	4:1	
- Steel piles length	26	m
- diameter	457	mm
- thickness	20	mm
- Sheet piles profile	AZ26-700	
- length	8	m
- 2 sheet piles between two steel piles		

	Phase	Description
1	Set up site	See step 1 of the L-wall (3.2.1)
2	Remove pavements	See step 2 of the L-wall (3.2.1)
3	Excavate quay wall	See step 5 of the L-wall (3.2.1)
4	Drill holes for inclined piles	The holes are drilled in order to install the foundation piles for the quay wall. The holes are drilled with a concrete drill and can be constructed from land or water. Options: Land or water
5	Install foundation inclined piles	See step 7 of the L-wall (3.2.1)

		
6	Crush quay wall for steel piles	See step 4 of this design
7	Install steel piles 	See step 7 of the L-wall (3.2.1)
8	Crush quay wall for sheet piles	See step 4 of this design
9	Install sheet piles	See step 3 of the L-wall (3.2.1)
10	Completely remove quay wall 	The next step is to remove the old quay wall. The type of the old quay wall determines whether the entire quay wall should be removed or partly. This depends on the type, for example a quay wall with multiple horizontal loads does not have to remove completely. Also the presence of cables and pipelines can influence the decision of completely or partly removing the quay wall. The quay wall can be removed with hydraulic crane with a grappler or crusher. The equipment can be situated on the street or pontoon(land or water)
11	Install anchor chair 	The anchor chair connects the inclined pile with the vertical steel piles and consist multiple steel plates that are welded together. The welder is positioned on small pontoon to install the plates.
12	Install prefabricated brick wall 	To ensure the classic appearance of the quay wall, a prefabricated brick wall is placed on top of the combined wall with inclined piles. It is important that the brick wall is longer than the lowest water level of the canal, in order to give the quay wall its preferred appearance. There are two options: Land or water Due to the weight of the prefabricated brick wall, a crane is needed. It can be situated in the street or on a pontoon.
13	Place soil behind quay wall	See step 11 of the L-wall (3.2.1)
14	Restore pavement	See step 13 of the L-wall (3.2.1)

15	Restore site	See step 14 of the L-wall (3.2.1)

Table 3: Construction methods combi-wall with inclined piles

3.2.3 Combined wall

The combined wall is a construction wall that consists of steel piles with sheet piles in between. A prefabricated concrete brick wall will be placed on top of the quay wall, this gives the quay wall the required characteristic appearance. The combined wall is much stiffer than a standard sheet pile wall and can bear higher (horizontal) loads. This design is applied in Rotterdam, therefore a new design is made for the boundary conditions referring to the Prinsengracht, the boundary conditions and calculations can be found in Appendix 1: Report of calculations of quay walls and Appendix 2: D-sheet report of Combined wall. The large dimensions of the steel piles can be declared to the absence of an anchor, this leads to large displacement at the ground level. In order to meet the requirement, that the maximum allowed displacement is less than 1/100*retaining height, a large stiffness of the steel piles is needed.

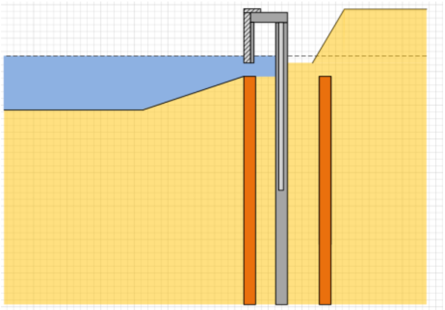
Dimensions Steel pile

Diameter:	1525	mm	
Thickness:	20+3,5	mm	(3,5=corrosion)
Bottom level:	-21,00	m NAP	
Total Length:	23,00	meter	

Dimensions Sheet pile:

Profile:	AZ48	
Width:	580	mm
Thickness:	19	mm
Bottom level:	-7,00	m NAP
Total Length:	9,00	m

Number of sheet piles between piles: 2

	Phase	Description
1	Set up site	See step 1 of the L-wall (3.2.1)
2	Remove pavements	See step 2 of the L-wall (3.2.1
3	Excavate quay wall	See step 5 of the L-wall (3.2.1)
4	Drill holes for steel piles	See step 4 of the combi-wall with shore piles (3.2.2)
5	Install foundation piles	As mentioned in step 7 of the L-wall, there are 3 methods to install the foundation piles: hammering, vibrating and screwing. Nevertheless due to the diameter of 1,5 meter the only feasible solution for this type of piles is vibrating. This is further explained in Appendix 1: Report of calculations of quay walls page 7.
6	Crush quay wall	See step 10 of the combi-wall with shore piles (3.2.2)
7	Install sheet piles	See step 3 of the L-wall (3.2.1)
8	Install prefabricated brick wall 	See step 12 of the combi-wall with shore piles (3.2.2)

9	Place soil behind quay wall	See step 11 of the L-wall (3.2.1)
10	Restore pavement	See step 13 of the L-wall (3.2.1)
11	Restore site	See step 14 of the L-wall (3.2.1)

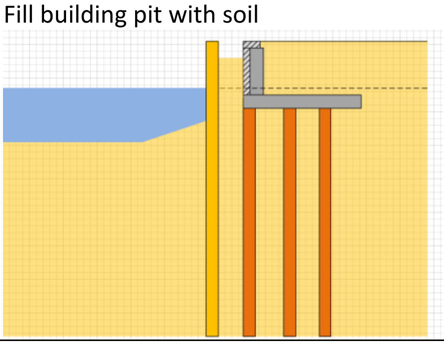
Table 4: Construction methods combined wall

3.2.4 Steel piles wall

The sheet pile wall is applied in Utrecht and consists of a row of steel piles. First step is to build a building pit and prevent to collapse of the quay wall. This can be achieved by filling the building pit with sand. Next holes are drilled in the old quay wall where the steel piles can be installed. Eventually concrete is cast between the piles and a prefabricated brick wall element is installed on top of the sheet piles. Just like the combined wall, a new design had to be made for the boundary conditions of Amsterdam, this can be found in Appendix 1: Report of calculations of quay walls and Appendix 3: D-sheet report of Steel piles wall. The dimensions of the fourth design are comparable to those of the combined wall, both for the same reason, namely the absence of anchors.

Dimensions Steel pile

Diameter:	1520	mm
Thickness:	24,5	mm
Bottom level:	-22,70	m NAP
Total Length:	24,70	meter

	Phase	Description
1	Set up site	See step 1 of the L-wall (3.2.1)
2	Install building pit	See step 3 of the L-wall (3.2.1)
3	Fill building pit with soil 	Sheet piles are only installed on the water side of the quay wall, therefore it is not possible to install struts. In order to prevent further deformations, soil has to be placed inside the building pit to create horizontal counter pressure. The soil will be placed with an excavator, which can be situated in the street or on a pontoon. So the options are: Land or water
4	Remove pavements	See step 2 of the L-wall (3.2.1)
5	Excavate quay wall	See step 5 of the L-wall (3.2.1)
6	Drill holes for piles	See step 4 of the shore piles (3.2.2)
7	Install steel piles	See step 5 of the combined wall (3.2.3)
8	Remove fill in building pit	The piles are installed but the construction is not completely closed. Therefore the soil fill of step 2 has to be removed to create a completely soil tight construction. It is the opposite process of step 2 but the options are the same: Land or water.
9	Completely remove quay wall	See step 10 of the shore piles (3.2.2)
10	Install concrete floor	Steel tubes can only be installed with a small gab in between, this gap has to be closed to create a soil tight construction. When the construction is not soil tight, erosion behind the quay wall could occur which could lead to settlements. Therefore a concrete floor has to be cast and steel plate has to be welded between two piles. First the building pit has to be completely dry using a temporarily drainage. Then a steel plate can be welded between the gaps of the steel tubes and eventually a concrete floor will be casted. The liquid concrete will fill the gaps and create a soil tight construction. The

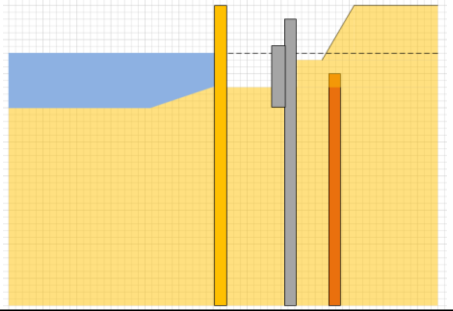
		activities will take place inside the building pit, but the options concern the transport: Land or water.
11	Install prefabricated brick wall	See step 12 of the shore piles (3.2.2)
2	Place soil behind quay wall	See step 11 of the L-wall (3.2.1)
13	Remove building pit	See step 12 of the L-wall (3.2.1)
14	Restore pavement	See step 13 of the L-wall (3.2.1)
15	Restore site	See step 14 of the L-wall (3.2.1)

Table 5: Construction methods steel piles wall

4 Stakeholders

Stakeholders are the internal and external actors which are involved by the project and via interaction influence the progress and imaging of the project (Veenswijk, 2013). An actor is an individual, group of persons or organizations. During the construction process multiple stakeholders are affected while each stakeholder has different interest in the quay wall or construction phase, therefore all the stakeholders and their interest should be identified at the start of the project. Each stakeholder has the ability to influence the outcome of the project, but the amount of influence differs per stakeholder. In this chapter a stakeholder analysis will be used to map the stakeholders and their possibility to influence the project. First the stakeholders in urban areas will be identified with their stakes in chapter 4.2. Then chapter 4.3 describes how the stakes are translated into measurable criteria for the C&S-matrix. Eventually the results of the stakeholder analysis will be discussed in chapter 4.4.

4.1 Stakeholder Identification

Stakeholder identification is the first step of stakeholder management. It helps to identify needs and possibilities for compensation or mitigating measures to satisfy particular actors (Enserink B, et al., 2010). All stakeholders should be identified at the start of the project, not only the stakeholders affected during the construction period but the stakeholders during the entire life-cycle of the object. Identifying the stakeholders means that a line is drawn between the parties to be involved and the parties not to be involved (Vos, 2003). The absence of stakeholders can have large consequences during the construction and operation phase. Failing to identify some stakeholders may introduce bias in the subsequent stages of the process. Another consequence of unidentified stakeholder is the possibility for them to appear later and have a negative impact on the project (Luyet, 2005). In other terms: to produce resistance against the project, this should be prevented. There are different possibilities to identify the stakeholders, the main techniques are (Mitroff I. , 1983):

- Imperative approach identifies actors who feel strongly enough about a certain policy problem or issue to act on their feelings. More general: “who has an interest in or feel the consequences of the issues around which the problem revolves, or the solutions that are being considered”.
- Positional approach reviews the existing policy making structures to identify actors with a formal position policy making.
- Reputational approach uses key informants related to the policy problem and asks them to identify important actors. This list can be extended by asking other informants, this technique is also known as snowballing (Wasserman&Faust, 1994). A variation is asking for any of the seemingly important actors who have important relationships with that actor
- Social participation: identifies actors to the extent that they participate in activities related to a policy issue, for example be part of a committee
- Opinion leadership method identifies actors who tend to shape the opinions of other actors.
- Demographic approach identifies actors by such characteristics as age, sex, occupation, religion etc.
- Problem diagram and causal map offer important leads. Relevant actors can be identified by asking the question: ‘who influences, directly or indirectly, relevant system factors?’.

For this research the positional approach will be used: existing projects will be used to identify the stakeholders. Urban quay wall projects in Amsterdam and other cities will be analyzed to identify the stakeholders and their interests.

Overview of the stakeholders

The following stakeholders have been identified for as stakeholders for the Prinsengracht in Amsterdam:

- Municipality
    - Client
    - Asset-manager
    - Permit Department (Bevoegd gezag)
    - Supervision (toezichthouder)
- Subsidy providers
- Insurance company
- Road users
    - Cars
    - Bike
    - Pedestrian
    - Trucks
    - Touringcars
    - Public Transport
- Emergency services
- Tourism
- Province (Flora and Fauna)
- Adjacencies
    - Houses
        - Residents
        - Tenant
        - Owner
    - "special" residents
    - Housing associations
    - Companies
        - General companies
        - Hospitality
        - Hotels
- Consultancy
- Navigation
    - Commercial navigation
    - Recreational navigation
    - Tour navigation
- Waterway manager
- Regional water authority (Waterschap)
- Cables and pipeline managers
    - Telecom
    - Gas
    - Electric cables
    - Sewer
    - Water

Figure 13 & Figure 14 show an overview of the stakeholders and a side view of the project with the stakeholders. A remark has to be placed by archeology and flora and fauna. Both can have mayor influence on the project but cannot be seen as an individual, group or organization. Therefore they are not treated as stakeholder, they are both themes in the design process and are connected to legislations, guidelines and policies. For example some trees in Amsterdam are important for the image of the canals and labeled as iconic tree (beeldbepalende boom). The policy of the municipality prescribes that iconic trees should be preserved. So the trees are represented by the municipality of Amsterdam and Flora and Fauna are protected by law (Natuurwet).The province controls this law and is therefore a stakeholder for these projects. The same holds for archeology, legislations protect the finding which is controlled by the permit department of the municipality(bevoegd gezag) .

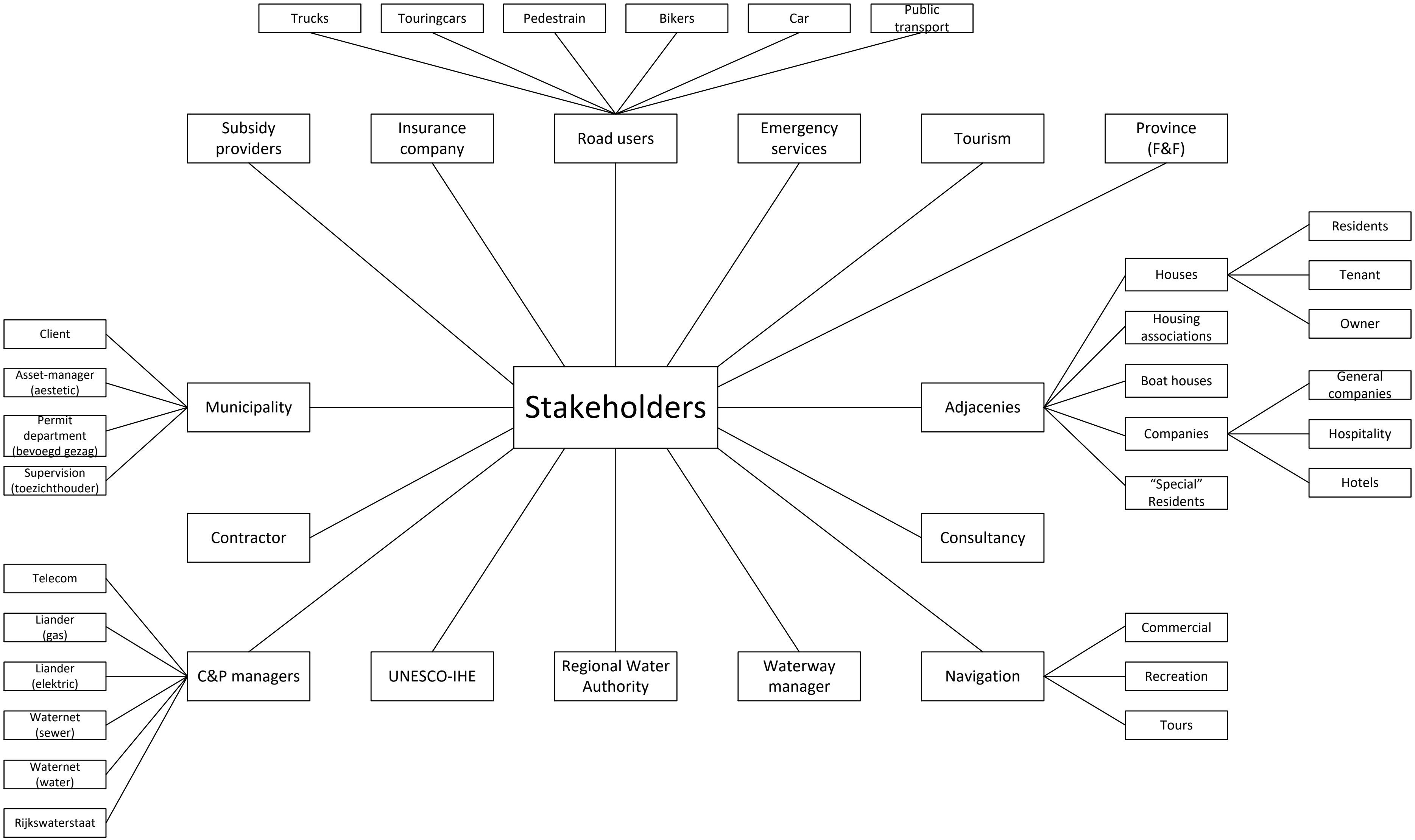


Figure 13: Overview of the stakeholders

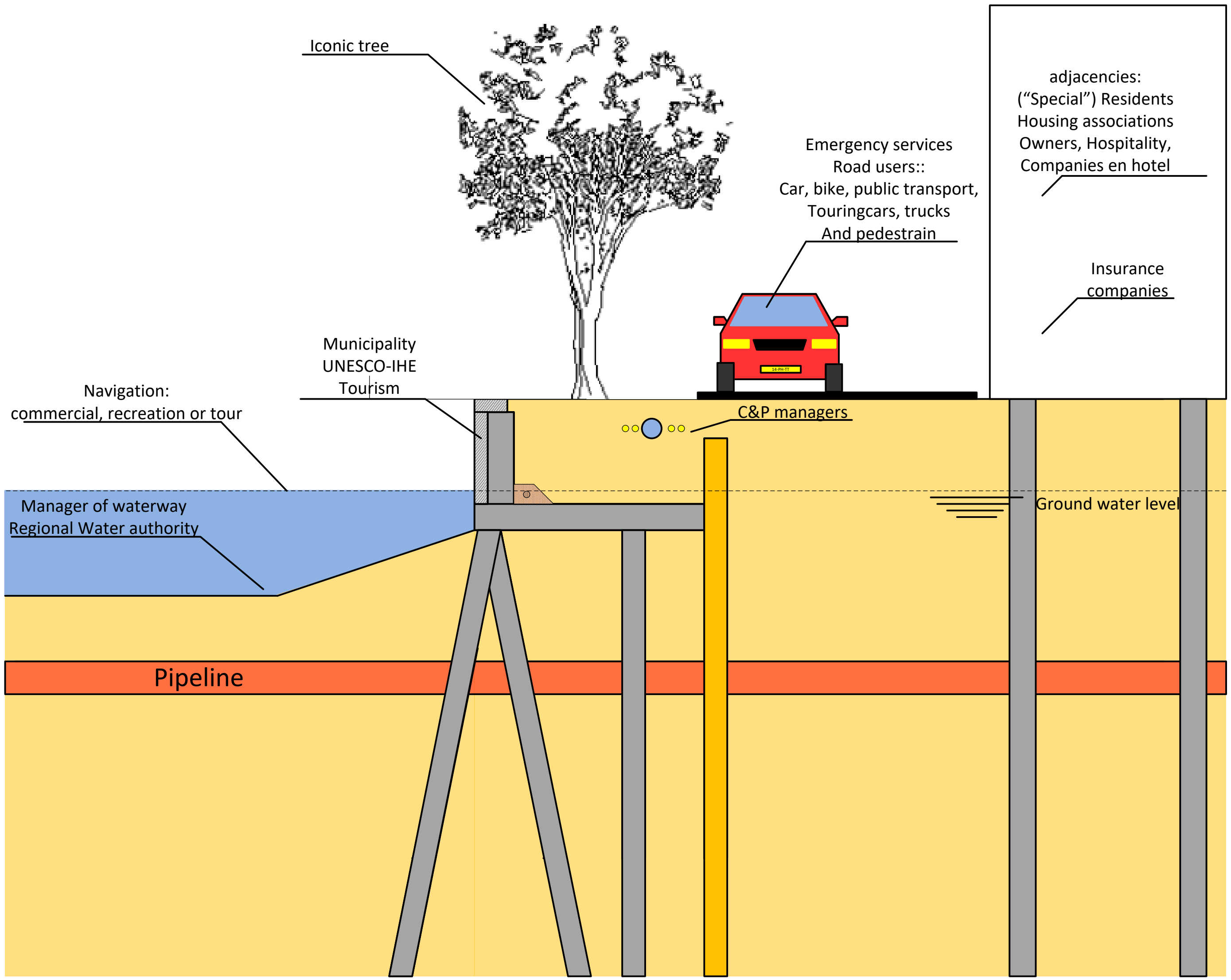


Figure 14: Side view of the situation with different stakeholders

4.2 Stakes of the stakeholders

In this chapter a short description will be given of the stakeholder, their point of view and their stakes.

One thing that has to be mentioned is that the main interest is equal for all stakeholders: *The quay wall has to be safe!* But a safe quay wall is often taken as granted and therefore overlooked by other stakeholders. Following the definition of Veenswijk, a distinction is made between internal and external stakeholders.

4.2.1 Internal stakeholders

The internal or direct stakeholders are the people or organizations inside the project such as project managers, designers and contractors. External stakeholders are the people or organizations that are indirectly influenced by the project activities for example the community. In this chapter the internal stakeholders will be mentioned.

Municipality

The municipality is the owner of the quay walls and therefore responsible for the management and maintenance of the objects. It finances the project and is the employer of the consultancy. Multiple departments within the municipality are involved in the project and these can be divided in four parts:

- Client
- Permit department (bevoegd gezag)
- Asset-manager
- Supervision

Note that each municipality is differently organized, this leads to different internal stakeholders within the municipality. The larger the municipality, the more departments are influenced during the replacement project. These four internal stakeholders are the main stakeholders, which are active in most of the municipalities. Each department has their own responsibilities and different interests in the project. The client consists of the project managers that are involved during the design and execution of the project. Their interest is that the project should be a success. A project success is often defined as a project that meets the technical specifications, and if there is a high level of satisfaction concerning the project outcome among key people in the parent organization, project team and key users of the project effort (De Wit, 1988). The permit department (bevoegd gezag) grants the required permits for the projects. For each project permits have to be required in order to execute the project. The department checks the design and required documents to the (local) legislations, guidelines and policy of the municipality. The asset-manager is responsible for the inspections and maintenance of the quay walls and the aesthetics of the quay walls. The aesthetics of the quay wall is very important since the canals of Amsterdam are part of the World Heritage List since 2010 and the city wants to remain on this list. The department of supervision controls whether the project is constructed conform the permits and legislations of the city.

Stake:

- project success
- Preservation of the characteristic appearance (quay wall and trees)

Consultancy

A consultancy, for example Royal HaskoningDHV, is a contractor of the municipality and performs the engineering of the project which consists of making a design, obtaining the required permits and adjusts the activities to the interests of the stakeholders. A consultancies' interest is to stay a partner of the municipality and offer them services in asset-management.
Stake: maintain partner of municipality

Contractor

The contractor has to execute the project and build the new quay wall. The contractor wants to earn money on the project after winning the tender. Making a design is one thing but building is something else. Therefore the design must be executable for the contractors, otherwise the project can't be build resulting in conflicts. For example the dimensions of the piles should be adjusted to the equipment of the contractors. But the main interest of the contractor is to make profit and this can be accomplished when a project becomes a success. Then the project is realized conform budget which means that the contractor makes money (assuming that the contractor submitted a reasonable price).
Stake: profit

4.2.2 External stakeholders

The external stakeholders are the people and organizations that are influenced by the activities of the project and encounter hindrance.

Subsidy providers

It is possible to get subsidy for replacing urban quay walls in Amsterdam but the requirements of the subsidy should be met. Subsidies are often used to gain additional value in the project or city. An example is paving stones for a cycling lane, these stones gives a better indication of the location of the cycle lane. Subsidy is often provided by the governmental institutions: the municipality or Provence. The interest is that the additional value to the city is obtained which is achieved with the requirements.
Stake: gaining additional value for the city

Insurance company

For each project an insurance has to be concluded for potential damage that can occur during execution: the CAR-insurance. This insurance can only be concluded when the risks are below an acceptable level for the insurance company. Eventually the insurance companies are driven by profit. In order to reduce the risks of the project measurements have to be taken concerning type of design and execution methods.
Stake: Profit

Road users

The public area is used to transport the user to its destination. There are many different types of road users, within the municipality the following users are distinguished:

- Pedestrian
- Bicycles
- Car
- Public Transport
- Touringcars
- Trucks

Other road users are the emergency services, these will be treated separately. The main interest of the users of the public space is accessibility: they want to continue their journey to their destination.

The accessibility is also mainly determined by the adjacencies, when hotels or shops need supplies and there are no alternative roads nearby, then the accessibility will play a larger role in the project. Pedestrian require the least space and there accessibility is (almost) always guaranteed since residents also needs to reach their houses.
Stake: accessibility

Emergency services

As mentioned above, the emergency services are treated separately due to the difference in power. The interest between emergency services and other road users is the same, namely accessibility. Emergency services have much more power than all the other road users, for example that when a road is closed for all traffic, emergency services should be able to pass the construction site. Sometimes special precautions are taken to guarantee that accessibility.
Stake: accessibility

Tourism

Tourist from the entire world visit Amsterdam to see the canals, it is an important source of income for the city and their citizens. The canals are also part of the UNESCO World Heritage list. In order to preserve tourism it is important that the classic appearance of the canals remains the same. It is also important that the hindrance for the tourist is small in order to keep the city attractive. Tourists have one type of interest during their holiday: they want the right value for the money. After their holiday tourists must have the feeling that they paid the right price for their visit. This means that the appearance of the canals remains the same and that the city and their attractions are accessible without much hindrance.
Stake: Right value for their money

Province

Also nature is affected by replacing urban quay walls. There are species that are protected by law in order to prevent their extinction. When one of those species is encountered on site, measures should be taken to guarantee preservation, this can affect the execution method or design. Examples of encountered floras are ferns and fauna are small frogs of fish. Large trees are often part of the appearance of the urban canals and are sometimes labeled as iconic trees (beeldbepalend). This means that the tree should be preserved at all cost. The trees spread a larger area and have mayor influence on local scale, which results that some designs are not applicable near the trees. The flora and fauna are represented by the Province which executes the law (Natuurwet since 2017) and the controls it.
Stake: preservation of protected F&F

Adjacencies

The adjacencies are a collection of multiple stakeholders with interest from the surrounding buildings:
Adjacencies

- Houses
    - Residents
    - Tenant
    - Owner
- “special” residents
- Housing associations
- Companies
    - General companies
    - Hospitality
    - Hotels

The adjacencies is one of the most important stakeholder, they encounter the largest hindrance and can have a large influence on the project when they combine forces. Extra attention is needed for the “special residents”: they live in expensive houses, the residents are highly educated and could have powerful connections. With these connections they have the possibility to influence the project more than the “normal residents”. Beforehand these residents should be investigated so extra attention can be paid to them. Residents often resist against building projects due to lack of technical knowledge and the “not in my backyard” argument. The adjacencies have multiple stakes, their primary stake is accessibility. During the activities they want to be able to reach their house of work. The secondary stake of the adjacencies is the prevention of damage to the buildings since the buildings are extremely sensitive to vibrations. Adjacencies also have a secondary stake which depends on the type of adjacencies. Residents have interests in hindrance while hospitality, hotels and companies are profit-driven. The interest of profit is closely related to hindrance since the hospitality becomes less attractive when activities takes place near the terrace. The boat houses have a different stake: during the construction they will be transported to another location but the demand is the preservation of services (power, water etc).

Stake: 1: Accessibility
2: Damage to buildings
3: Noise hindrance

Navigation

The navigation in the canals of Amsterdam is divided in three categories: commercial navigation, recreational navigation and tours. Especially tours play an important role for the municipality and can have a large influence on projects. Navigation has the same interests as the road users: accessibility. The main interest of the navigation is equal as the road users but focuses on the other side of the quay wall, the canal.

Stake: Accessibility

Waterway manager

The waterway manager is responsible for the canals and their accessibility, it manages the depth of the channels to guarantee the draft of the canals. The waterway manager differs per municipality, it mainly depends on the location of the river or canal. When it is within the municipality, then it is often the responsibility of the municipality itself. For example in Dordrecht some parts are the responsibility of Dutch ministry of infrastructure and environment (Rijkswaterstaat) and in Amsterdam this is part of Waternet. The waterway manager of the canals gives nautical advice for the projects which are translated into requirements for the construction period, it represents the interest of the navigation.

Stake: Accessibility

Regional Water Authority

The regional water authority manages the quality of the water in canals and ground water. It also manages the storage capacity of water in the canals. The preservation of the quality of the water has effect on the execution method, for example that extra measures are needed to prevent the falling of welding drops into the canal. The location of the new quay wall influences the storage capacity of the canals.

Stake: preservation storage capacity and water quality

UNESCO-IHE

UNESCO-IHE launched in 1994 the World Heritage List in order to preserve the world's culture, nature and its value. The canals of Amsterdam have been examined and approved for this list since 2010 and UNESCO-IHE says the following about the canals: “The historic urban ensemble of the canal district of Amsterdam was a project for a new ‘port city’ built at the end of the 16th and beginning of the 17th centuries. It comprises a network of canals to the west and south of the historic old town

and the medieval port that encircled the old town and was accompanied by the repositioning inland of the city's fortified boundaries, the Singelgracht" (UNESCO-IHE, 2010). It's quite logic that UNESCO-IHE's interest is to preserve the canals as much as possible, the failed quay walls should be replaced. Therefore the requirement of UNESCO-IHE is preservation of the characteristic appearance of the canals.
Stake: preservation appearance canals

Cable and pipeline managers

Millions of km of underground infrastructure lies in the Netherlands. When a net is in conflict with the new design the net has to be diverted. All other cables and pipelines will be preserved. The main interest of the cables and pipeline managers is profit and in order to make this profit the network must function continuously. Another interest is to combine the activities. At the start of the design process a consult takes place with the C&P-managers to determine if activities can be combined. This can be used to upgrade the network and the combination of activities can lead to cost reduction.
Stake: Preservation of Cables and pipelines

4.2.3 Stake overview

The following table shows an overview of the stakeholders' interests in the replacement of urban quay walls.

Stakeholder	Interest
Internal stakeholders	
Municipality	- Project success - Preservation of characteristic appearance
Consultancy	Maintain partner with Municipality
Contractor	Profit
External stakeholders	
Subsidy Providers	Gaining additional value for the city
Insurance company	Profit
Road Users	Accessibility
Emergency services	Accessibility
Tourism	Value for the money
Province	Preservation protected Flora and Fauna
Adjacencies	- Accessibility - Prevent damage to buildings - Noise hindrance
Navigation	Accessibility canals
Waterway manager	Accessibility canals
Regional Water Authority	- Preservation storage capacity - Preservation water quality
UNESCO-IHE	Preservation characteristic appearance
Cables and pipeline managers	- Prevent damage to cables and pipelines - Combine activities

Table 6: Overview of the main stakeholders and their stake for the Prinsengracht

4.3 Assessment of Stakes

As mentioned in chapter 2.3 the stakes will be assessed against the consequences of the constructed method to determine the method that can result in the least resistance. But not all stakes are measurable and need to be translated into measurable criteria. In this chapter the translation of the relative stakes into measurable stakes is explained.

The **municipality** has as interests the preservation of characteristic appearance (interest asset manager) and let the replacement project of the urban quay wall become a success (interest client). Another interest of the municipality is stakeholder satisfaction about the project, in this research stakeholder satisfaction is included in the definition of project success: high level of satisfaction between key players and users (De Wit, 1988). The probability that a project will be constructed within budget and time mainly depends on the risks of the project. Smaller risks often mean a smaller probability of the occurrence of certain events that will lead to extra costs or extension of the construction period. A project with smaller risks increases the probability that the project will become a success. This does not mean that the project will become a success, just the probability increases. Note that a risky project can be seen as a success when all the risks are appointed and preventive and corrective measures are accurate defined. So the criteria of project success can be measured by estimating the risks of the method and give the method with the lowest risk the best score.

A **consultancy** is an organization that is profit driven and wants to cooperate with the client (Municipality) by delivering a quality product, in this case a quay wall design. A quality product can be seen as a design that is executed conform the design without problems. This corresponds with the risks of the project: higher risks mean a larger probability that the quay wall will change. Note that the design can change due to circumstances that a consultancy has no influence on, for example deviated position of an underground pipeline. The probability that a design with small risks will change is smaller than a risky project. For this study it is assumed that the risks are well defined. The replacement of quay wall in urban area of Amsterdam is a risky project, methods with low risks are preferred. Mutually grading of the risks of the construction methods is therefore related to the preferred low risk method and probability of changing the design.

The **contractor** constructs the quay and his interest is to make a profit on the project but also construct the project in good harmony with the client. Good harmony can be defined as less conflict on the project with minimal changes in the construction phases. This criteria is closely related to project succes , the probability that changes during the execution will occur is for a risky project larger than a project with small risks. A few changes during the project will often lead to a satisfied client and that the project is considered as a success. Therefore it is assumed that a contractor makes profit when the project becomes a success. This assumption implies that the contractor submitted a realistic tender and that it will make profit when the project is constructed conform the contract of the tender.

Subsidy providers’ stake depends on the subsidy itself, which can affect the appearance of the quay wall, the construction period. For this research it is not possible to create measurable criteria for two reasons:
1: the measurable criteria depend on the type of subsidy, which can have many variations. Also subsidies are not common in the replacement of urban quay walls, 25% of the interviewed members have never encountered subsidy providers in projects.
2: This research focuses on restoring the old situation instead of improving the location, see 1.4.4 Improving public area, while for replacement subsidy is often not needed.

An **insurance** company is driven by profit, they only provide an insurance when the risks are below an acceptable level which is a relative concept. The same method will be applied as the municipality: mutually assessment of the risks of the methods.

Tourist visit Amsterdam to see the characteristic appearance of the city. At the end of their holiday the tourist wants to have the feeling that they paid the right price for their visit. When the accessibility of the attractions is poor and there is a lot of noise hindrance, tourists have a bed feeling of their visit. They want to pay the right price for their visit: the right value for their money. Right for their value can differ per person and is therefore a relative interest. The accessibility of the city and the noise hindrance are measurable criteria's that influence the interest of value of money.

Since January 2017 the law for protecting flora and fauna is reviewed and now the responsibility of the **Province**. When protected flora and fauna are encountered at the site, a permit should be required from the Province. Generally this means that an execution cannot take place during a certain period, for example the breed season of birds. This will not affect the construction methods but only the period of the construction. Another influence of the law is that a specific construction method should be applied to ensure preservation of the environment of the specie, this is a specific requirement which can differ per specie.

The **adjacencie**s include multiple stakeholders: residents, owners, companies and catering industry. The interest of the adjacencies mainly focuses on the construction phase of the life cycle:
1: Accessibility of the buildings
2: Arrangement of the public area
3: Probability of damage of the buildings
4: Noise hindrance
The sequence of interests is determined with the interviews with project members. The accessibility of the street is a measurable criteria. The arrangement of the public area will not be taken into account in the assessment, this thesis focuses on the replacement of the quay wall and restore the old situation. The probability of damage depends on the execution techniques and this will be compared mutually. Damage to the surrounding cannot be prevented, methods should be applied that reduce the probability. Therefore the methods will be mutually compared on the risks of damage to building due to the construction method. The final interests is noise hindrance, this noise production will be estimated and mutually compared and assessed.

Cables and pipeline managers have two stakes: keep C&P operational and combination of activities. In order to keep de cables and pipelines operational damage to these C&P should be prevented or the risks of damage should be reduced as much as possible. The risks can be mutually marked, just like the stakes of the municipality and insurance companies. It mainly concerns the activities that are used to remove or excavate the old quay wall and when constructional elements are driven into the soil. For example when sheet piles are installed, they can pierce through cables in the soil. That objects are installed in the soil is a risk of damaging the C&P while their installation method(vibrations or press-in) is less relevant. The combination of activities is applied to reduce the costs for the managers. These are separate projects and therefore not part of this thesis.

4.3.1 Overview of the measurable stakes

Figure 15, on the next page, shows the overview of the stakeholders, their stakes. It also shows an overview when a stakeholder will have a positive or negative assessment.

Stakeholder	Stake	Measurable stake	Assessment: Negative (-1)	Assessment: Neutral (0)	Assessment: Positive (+1)
Municipality	1: Preservation characteristic appearance 2: Project success	1: Brick wall applied 2: Comparing methods on risks	1:No brick wall applied 2: Method with largest risks	1:No interface 2: Method with average risks	1: Brick wall applied 2: Method with smallest risks
Insurance	Profit	Comparing methods on risks	Method with largest risks	Method with average risks	Method with smallest risks
Road users	Accessibility	Accessibility of public area	No access	Limited access	All road users can pass
Emergency services	Accessibility	Accessibility of public area	No access	Limited access	Access for emergency services
Tourist	Value for money	1: Accessibility 2: Noise production 3: Brick wall applied	1: No access 2: Method with most noise production 3: No brick wall applied	1: Limited access 2: Method with average noise 3: No interface	1: Access 2: Method with least noise production 3: Brick wall applied
Province (Flora and fauna)	Preservation protected species	Influence of the area	Method with most influence on environment (noise, vibrations)	Method with average influence on environment	Method with least influence on environment
Adjacencies	1: Accessibility 2: Damage to buildings 3: Noise hindrance	1: Accessibility 2: Production of vibrations 3: Noise production	1: no access 2: Production of much vibrations 3: Method with most noise production	1: Only pedestrian access 2: Production of small vibrations 3: Method with average noise production	1: Fully access 2: Only vibrations due to general equipment 3: Method with least noise production
Consultancy	Partner of municipality	Comparing methods on risks	Method with largest risks	Method with average risks	Method with smallest risks
Navigation	Accessibility channel	Accessibility of channel	No access	Smaller channel access	No hindrance
Regional Water Authority	1: Quality water 2: Quantity channel	1: Comparing methods on risk pollution channel 2: Width channel	1: Method with largest risks 2:Smaller channel	1: Method with average risks 2: No interface	1: Method with smallest risks 2; Equal or larger width channel
Waterway manager	Accessibility channel	Accessibility of channel	No access	Smaller channel access	No hindrance
UNESCO-IHE	Preservation characteristic appearance	Applied brick wall	No brick wall applied	No interface	Brick wall applied
C&P-managers	1: prevent damage to Cables and pipelines 2: Combining activities	Comparing methods on probability of damage to C&P	Method with largest probability	Method with average probability	Method with smallest probability
Contractor	Profit	Comparing methods on risks	Method with largest risks	Method with average risks	Method with smallest risks

Figure 15: overview of the measurable stakes

4.4 Stakeholder analysis

The identified stakeholders are all affected by the replacement project but their amount of influence on the outcome of the project differs per stakeholder. In order to be able to determine which method can result in the least resistance, it is important to determine which stakeholders can influence the project most and provide the most resistance. This will be determined with the power-vs-interest model, as mentioned in chapter 2.3. Literature describes that a meeting with project members must be held to discuss the power and interest for each stakeholders until all project member agree on the distribution in the grid (Veenswijk, 2013;Bryson, 2003), but for this research is chosen to perform this method with professionals separately in order to gain insight about the different view of professionals on stakeholders.

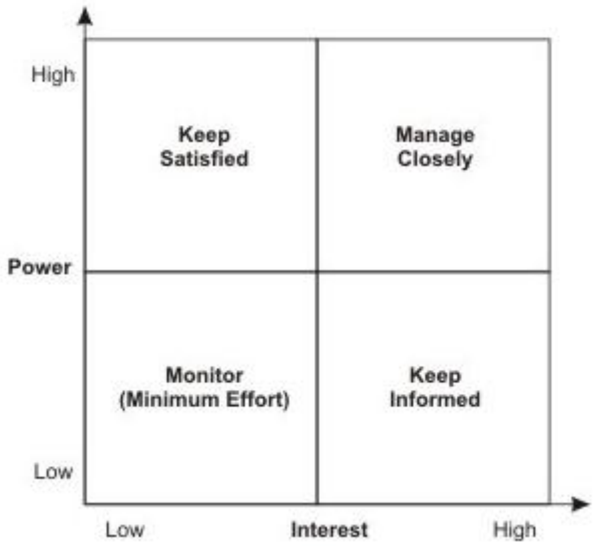


Figure 16: Power-vs-interest matrix and level of participation (Babou, 2016)

The power-vs-interest grid is often used to prioritize the stakeholder and to determine the degree of participation with stakeholders during the project. There are four types distinguished, also see Figure 16:

1. Monitor
2. Keep informed
3. Keep Satisfied
4. Manage closely

The stakeholders with less power and interest(1) need to be monitored and informed at the start of the project. They do not participate in the decision making of the project. The stakeholders with high interest but low power(2) must be kept informed. They have a lot of interest in the project and have a lot of information about the environment, which can be beneficial for the project. Therefore it is important to keep them informed despite the fact that they have a small influence(3). The third group is stakeholder with high power and small influence, they have interest on a small part of the project but the ability to influence this part majorly. The outcome of the rest of the project is not important for them. They have to be satisfied during the project by engaging them in their area of interest. Their participation is high on the specific area of interest but minimal for the rest of the project. The most important stakeholders are positioned in the upper right corner(4) and should be managed closely. There should be collaboration with this stakeholder: during the entire project they have a high level of participation and they should be involved during decision making.

Since the goal for this thesis is to find the a method that determines which method results in the least resistance, the purpose of the power-vs-interest method changes. Normally it is used to determine the degree of participation of the stakeholders, now it is used to identify the stakeholders and the amount of resistance they can produce. This is also explained in 2.1 Explanation of C&S-matrix. A remark is the result of the power-vs-grid and the translation to amount of resistance can result in an equally amount of resistance between two stakeholders while their position on the grid is unequal. For example when stakeholder A has a low interest and a high power while stakeholder B has high interest and low interest. Then both stakeholders can produce an amount of resistance. Nevertheless the difference is that the interest of stakeholder A is focused on a small part of the project and B the entire project. This will affect the assessment of the construction phases. Stakeholder A will have a neutral assessment in the phases that does not affect his interest while stakeholder B can produce resistance the entire project. Despite their equally amount of resistance they can produce, there influence on the outcome of the method is different.

For this research is chosen to interview project members separately. The interview method is to discuss each stakeholder and determine the stake and position in the grid. The position of each stakeholder in the grid is translated into in a numerical value expressing his power and interest in the project. This numerical value is coupled with the assessment of the interests of the stakeholders reached when comparing the different construction methods, to ensure that the assessment of a powerful stakeholder has more influence on the outcome of the C&S-matrix than the assessment of a less powerful stakeholder. The outcome of the matrix is a numerical value expressing how much resistance is expected when performing a particular construction method. As said, the lower the resulting numerical value, the more resistance is to be expected.

The reason to perform the power-vs-interest method separately gives the opportunity to investigate if the project members share the same point of view about the stakeholders. The interviews are shown in Appendix 4: Interviews and the total overview of the interviews combined is shown in Appendix 5: It should be noted that the interviewed members give their opinion whether a stakeholder has “few” or “much” power/interest and which are relative concepts: it is hard to define the boundary between “much” or “few” and this boundary varies per person. Therefore multiple persons are interviewed from different municipalities, contractor and consultancies in order to decrease the deviations in the power-vs-interest grid.

Therefore it is chosen to discuss the stakeholder and their stakes first and then their position in the power-vs-interest grid. Then the interviewed member gives their opinion about the stakeholders first and when they encounter the stakeholder in the process.

4.4.1 Results of the interviews

Table 7 shows the values of the power-vs-interest method and an overview of the grid is Figure 17. As mentioned in Figure 9, the position of the stakeholder in the grid is translated into value for the interest and power (low=1 and high=2) which is performed for each interview. So in sixteen interviews each stakeholder received a value for their interest and power. Next the average is taken for the power and interest for each stakeholder resulting in the power-vs-interest grid of Figure 17.

In the interviews the stakeholders received a value of one for low interest and two for high power, the same holds for the power of the stakeholders. This results that the value of 1,50 is the boundary between "much" and "less" power and interest. Figure 18 shows the variation of the power and interest of a stakeholder. The variance shows the ratio between high or low power or interest of a stakeholder with respect to the total power-vs-interest grids that are performed. A longer horizontal or vertical bar corresponds to a higher variance between a high or low interpretation of power or interest.

Stakeholder	Power	Interest
Municipality	2,0	2,0
Consultancy	1,3	1,8
Contractor	1,2	1,5
Subsidy Providers	1,5	1,3
Insurance company	1,7	1,2
Road Users	1,2	1,6
Emergency services	1,9	1,6
Tourism	1,1	1,3
Province	1,7	1,3
Adjacencies	1,7	1,9
Navigation	1,3	1,7
Waterway manager	1,7	1,4
Regional Water Authority	1,6	1,4
UNESCO-IHE	1,3	1,2
Cables and pipeline managers	1,9	1,7

Table 7: Stakeholders and their power-vs-interest values

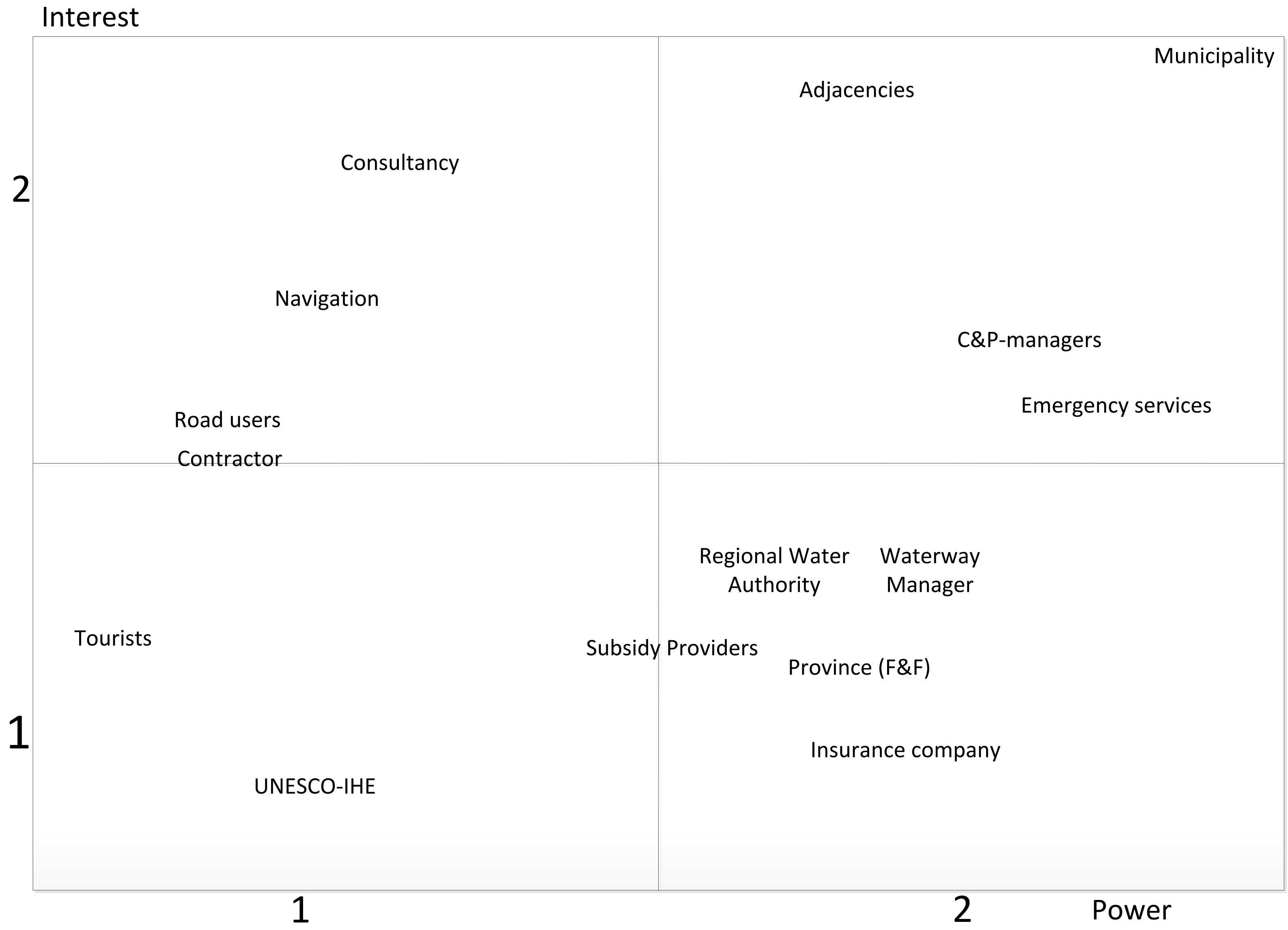


Figure 17: Result of the Power-vs-Interest grid

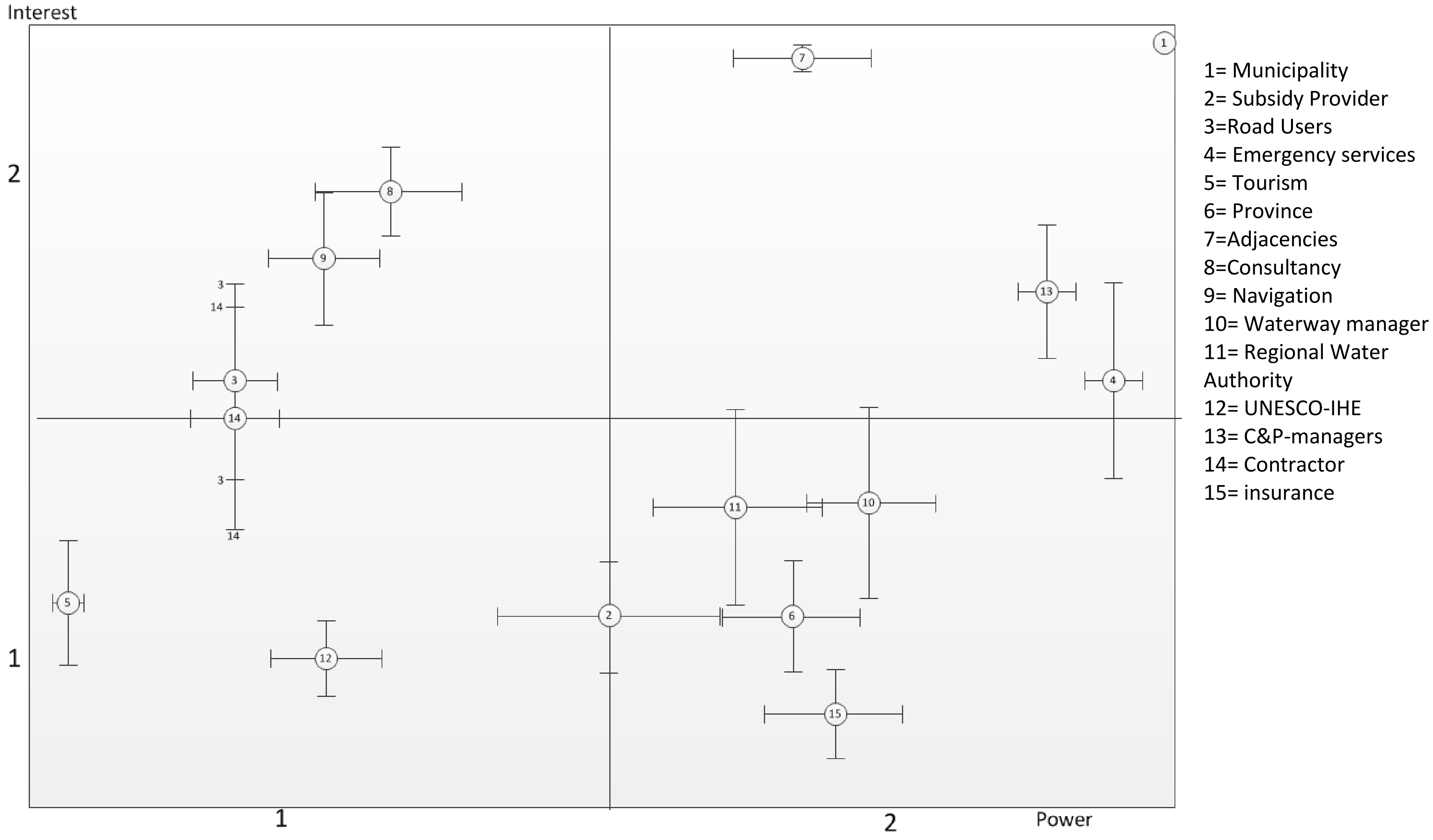


Figure 18: Variation in power and interest

4.4.2 Discussion Power-vs-Interest grid

As mentioned before, Appendix 4: Interviews shows the view of the professionals on stakeholders. It is remarkable that the grid per person varies. This is the result of differences in the definition of stakeholder and the interpretation of interest and power but also their experiences with the stakeholders. A mayor influence on the power-vs-interest grid is the definition of stakeholders and their stake. Some persons make a clear distinction in interest between requirement and desire. This clear distinction creates a completely different power-vs-interest grid. The requirements are made by stakeholders that can use the law to influence the project, while desires are not always necessary. Contractors often see stakeholders as people or organizations in the surrounding as stakeholders that are influenced during the construction phases. The interests of stakeholders, that can use the law to influence the project, are defined as a contractual obligation. As mentioned in the chapter 4.4, “much” and “less” are relative definitions and the interpretation can differ per person leading to a different grid. Finally personal experiences with stakeholders influence the position in the grid. A good relationship with a stakeholder reduces the interpretation of the amount of power, while bad relationships have an opposite effect. This is often encountered with stakeholders that can use the law to influence the project.

The most powerful stakeholder is the municipality, since they are the owner of the quay wall. This is the only stakeholder that received the same values in all the interviews. Nevertheless each municipality has their own organization with different departments, responsibilities and interests. The larger the municipality, the more departments will have an interest in the replacement of the quay walls. More departments mean more internal stakeholders which require more time and effort to reduce their (possible) resistance. Within the municipality the manager and client are the most important departments, but their interest concerns different period in the life cycle of the quay wall. The client focuses on the process of replacing the quay wall while the managers’ interest concerns the end product. The clients ‘interest is that the replacement of the quay wall becomes a success, where success is mostly defined as an project realized within budget, time and meets the demanded quality.

UNESCO-IHE and tourist are the least powerful stakeholders, nevertheless they are a mayor income for the Municipality. This can be explained by the fact that these stakeholders are represented by other stakeholders. The interest of UNESCO-IHE is that the canals appearance remains the same, this interest is represented by the policy of the Municipality since the Municipality wants to remain on het heritage list. The variance of the UNESCO-IHE can be explained in the discussion whether UNESCO determines the appearance of the quay wall or the Municipality represents the UNESCO with the management of the quay wall. The tourists visit the city for sightseeing and travel through the city with tours(navigation), public transport, cab or on foot. From this point of view tourists can also be seen as road users or navigation.

Another important stakeholder is the cable and pipeline managers. There are many cables and pipelines located in the soil in urban areas. Before the project starts, the managers must agree to the project and the construction methods. Managers demand safety precautions to prevent damage during the activities. It costs a lot of effort to get the agreement, the managers are often not cooperative which often leads to delay. The combination between the required agreement and the non-cooperative attitude gives them much power, this is multiple times mentioned by the interviewed.

The stakeholders in the bottom right part of the grid (low interest, high power) are the organizations that can use law or permit to influence the project. These are the Waterway manager, Regional Water Authority and the Province(F&F). A remark is that the role of the waterway manager depends on the location of the project, see description stakeholder in 4.2 Stakes of the stakeholders. Their low interest can be declared in the fact that their interest concerns only a small part of the project. For the Province is this the preservation of the protected flora and fauna while Regional Water Authority concern is the water quality and quantity.

The stakeholders with low power but high interest are all located in the upper right grid: Consultancy, contractor, road users and navigation. These are two groups of stakeholders with comparable interests, navigation and road users ‘interest is accessibility while the consultancy and the contractor want to make profit with the project in good harmony with the Client. Note that the power of the contractor depends on the used collaboration:bid-build(Dutch: RAW bestek) or Design and construct (D&C) since an increase of responsibilities increases the power of the contractor. The contractor has one of the largest variance in interest which is the result of the discussion whether the contractors’ interest is just profit or also in cooperation with the client.

Road users and navigations’ interest is the same but also conflicting. The road user interest focuses on the street while the navigation is focused on the canal. When the activities are executed on the street, it is in favorable for the interest of the navigation but contradictory of the road users and vice versa. The road users and navigation have a high interest in the project because each step in the construction process affects the accessibility for both stakeholders. The power of the navigation is low since they are represented by the waterway manager. Road users have a low power since the accessibility is mainly determined by the adjacencies (companies and supplies), for example when transport is needed to supply a café or hotel. Both road users and emergency have the same stake(accessibility of the road), also their interest in the power-vs-interest grid is exactly the same. The difference is that the emergency services have much more power due to the fact that it is unacceptable when emergency services can’t reach their destination.

The adjacencies have the most interest of the external stakeholders but a relative large variance in power. This can be explained to the difference in the consideration of the power of the adjacencies: some interviewee see the adjacencies as one of the most important stakeholders with the most influence while other reduce the power to the fact that the adjacencies can only object against the permit (duth: omgevingsvergunning).

5 Results Matrix

In this chapter the results of the C&S-matrix will be presented. However, the outcome of the matrix alone is not governing in the decision whether or not to apply a construction method. At least two other factors will usually be taken into account: the duration of the construction period and the costs. The duration of the construction period, which is not taken into account in comparison of the construction methods with respect to the stakes of the stakeholders, also determines the amount of resistance to be expected. Usually, a shorter construction period leads to less resistance. On the other hand, neither the costs are taken into account the comparison. The resulting values of the C&S-matrix yet have to be weighed against the costs of construction methods and the duration of the project.

The construction and stakeholder matrix is applied in a case: a quay wall of 30 meters in the Prinsengracht in Amsterdam has to be replaced. As mentioned before four types of quay walls are selected and calculated for the case. For each design three parameters are determined:

1. Amount of resistance that can be expected by stakeholders
2. Construction period
3. Costs

For the Prinsengracht were two cases investigated:

1. Which construction method results in the least amount of resistance that can be expected by the stakeholders?
2. Which construction is most cost-effective with respect to the amount of resistance that can be expected by the stakeholders?

The total overview of the assessment of the techniques per design can be found in Appendix 6: The Construction and Stakeholder Matrix. A higher positive numerical value implies that the construction method will most likely result in less resistance.

5.1 Least resistance

The result can be found in Figure 19 and Figure 20, each step shows construction method with the highest numerical value, which implies this step will most likely result in the least resistance. The time period is a factor that influences the resistance of stakeholders, a shorter construction period is preferred.

Design 1: L-wall

Phase	Activities	Method	Time round up [days]	Stakeholder [F]
1	Set-up site	Place fences	1	0,0
2	Remove pavements	Water	4	9,5
3	Install building pit	Press,in, water	6	11,6
4	Install struts	Water	5	18,2
5	Excavate building pit	Water	5	9,5
6	Remove quay wall	Water	8	9,5
7	Install foundation piles	Scewed, water	13	14,0
8	Install concrete floor	Water	6	15,9
9	Install (brick) wall	Water	17	17,3
10	Install drainage	Water	2	15,9
11	Place soil behind quay wall	Water	6	15,9
12	Remove building pit	Remove party, Water	7	18,0
13	Restore pavements	Water	4	15,9
14	Clean up site	Remove fences	1	0,0
		Total	**115**	**171,1**
		Weeks	23	

Design 2: Combi-wall with inclined piles

Phase	Activities	Method	Time round up [days]	Stakeholder [F]
1	Set-up site	Place fences	1	0,0
2	Remove pavements	Water	3	9,5
3	Excavate quay wall	Water	3	15,9
4	Drill-holes, piles angle	Water	3	15,9
5	Install piles under angle	Screwing, water	8	16,3
6	Crush for steel piles	Water	2	15,9
7	Install steel piles	Screwing,water	11	14,0
8	Crush for sheet piles	Water	2	9,5
9	Install sheet piles	Press-in, water	1	14,0
10	Completely remove	Water	2	15,9
11	Install "anchor chair"	Water	8	2,5
12	Install prefab brick wall	Water	4	17,3
14	Fill-in soil	Water	6	15,9
14	restore pavements	Water	4	15,9
15	Restore site	Remove fences	1	0,0
		Total	**59**	**178,3**
		Weeks	11,8	

Figure 19: Case 1: Result design 1 and 2

Design 3: Combined wall

Phase	Activities	Method	Time round up [days]	Stakeholder [F]
1	Set-up site	Place fences	1	0,0
2	Remove pavements	Water	3	9,5
3	Excavate quay wall	Water	5	9,5
4	Drill holes for steel piles	Water	5	9,5
5	Install steel piles	Vibrations water	5	-18,9
6	Crush entire quay wall	Water	5	15,9
7	Install sheet piles	Press-in water	1	16,3
8	Install prefab brick wall	Water	4	17,3
9	Place soil	Water	8	15,9
10	Restore pavement	Water	3	15,9
11	Clean up site	Remove fences	1	0,0
		Total	**36**	**90,9**
		Weeks	7,2	

Design 4: Steel pile wall

Phase	Activities	Method	Time round up [days]	Stakeholder [F]
1	Set up site	Install fence	1	0,0
2	Install building pit	Press-in, water	6	18,0
3	Fill building pit with soil	Water	6	15,9
4	Remove pavement	Water	2	15,9
5	Drill holes quay wall	Water	5	15,9
6	Install steel piles	Vibrating, water	7	-18,9
7	Remove fill building pit	Water	6	15,9
8	Remove old quay wall	Water	6	15,9
9	Install floor+drainage	Water	10	-4,5
10	Place soil behind quay wall	Water	2	15,9
11	Install prefab wall	Water	4	17,3
12	Remove building pit	Water	3	7,4
13	Restore pavement	Water	4	15,9
14	Clean up site	Remove fences	1	0,0
		Total	**64**	**130,3**
		Weeks	12,8	

Figure 20: Case 1: Result design 3 and 4

Table 8 shows that the combined wall with the inclined piles is the design that most likely will produce the least resistance when it is applied for the Prinsengracht. The L-wall is proven alternative for the inclined piles, the outcome of the C&S is equal to the inclined piles but the L-wall has a much longer construction period.

Design	Construction period [days]	Stakeholders [R]	Construction Steps [-]
L-wall	115	171	14
Inclined piles	59	178	15
Combined wall	36	91	11
Steel piles	64	130	14

Table 8: Overview results case 1

R= Stakeholder resistance, the higher the value the less resistance can be expected

The combined wall with inclined piles is the best solution with respect to the interest of the stakeholders. This can be declared to the fact that this solution requires no temporarily building pit and uses vibration-free techniques. Another advantage of this quay wall is that is requires the minimum area for the construction.

The numerical value of the C&S-matrix for the L-wall and the combi-wall with inclined piles is almost equally, therefore this quay wall is a good alternative. The disadvantage of this type is that the construction period is much longer than the inclined piles due to the building pit and the cast-in-situ of the concrete wall and floor. Nevertheless the construction method is developed in time for Amsterdam and consists of techniques that have a low risk of causing damage to buildings in the environment.

The combined wall and the steel piles design are not favorable for the case in Amsterdam. More resistance can be expected since the installation techniques have a high risk of causing damage for the environment. Especially for the installation of the steel tubes only a vibrating hammer is the only feasible installation technique. This is the consequence of the large dimensions of the tubes, due to the absence an anchor. This absence results in a large stiffness of the steel tubes in order to meet the displacement requirement of 1/100*retaining height.

In general, construction on water will result in less resistance than when the equipment is set-up in the street. This can be explained with Figure 21. It shows the distribution of the interest of the majority of the stakeholders where a distinction is made in three categories: risks, accessibility land and accessibility water. The stakes of the municipality, consultancy and contractor are all related to project success, which is translated into comparing the risks of the method. The stake of the tourist is value of money, which is translated into accessibility and noise production. The adjacencies, emergency services and road users all have interest concerning the accessibility of the street. On the other side navigation, water authority and the waterway manager have interest in the accessibility of the channel.

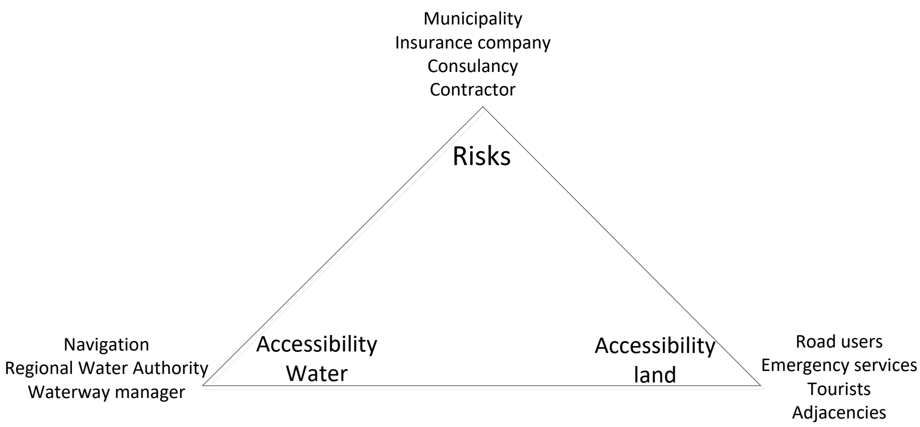


Figure 21: Distribution of the stakes

It is assessed that the construction from a pontoon has lower risks than the construction from land, due to the fact that the transport and equipment on land cause vibrations which can lead to deformations of the sensitive buildings. This means that the category risks and accessibility land prefer the construction executed from a pontoon. The result is that eight stakeholders prefer construction and transport on water versus three stakeholders that prefer land. Also the most powerful stakeholders prefer construction from a pontoon, namely municipality, emergency services and adjacencies.

5.2 Resistance vs costs

The second case is to include the costs to investigate the influence of the costs. Normally the budget is governing in the decision which design or technique will be applied. Figure 22 and Figure 23**Fout! Verwijzingsbron niet gevonden.** show the result of case 2.

The estimation of the costs for each design is shown in Appendix 7: Costs determination. The amount of material is estimated as accurate as possible, but can deviate from the reality. Only the costs of the activities on site are determined, the costs of for example making the design, profit margin, site measuring etc. are not taken into account. It only concerns the construction costs.

Design 1: L-wall

Phase	Activities	Method	Costs [€]
1	Set-up site	Place fences	€ 300
2	Remove pavements	water	€ 5.400
3	Install building pit	Press,in, water	€ 107.600
4	Install struts	Water	€ 21.500
5	Excavatet building pit	Water	€ 7.400
6	Remove quay wall	Water	€ 10.600
7	Install foundation piles	Screwed, water	€ 62.200
8	Install concrete floor	Water	€ 26.300
9	Install (brick) wall	Water	€ 37.700
10	Install drainage	Water	€ 2.800
11	Place soil behind quay wall	Water	€ 9.800
12	Remove building pit	Remove party, water	€ 15.300
13	Restore pavements	Water	€ 4.500
14	Clean up site	Remove fences	€ 300
		Total	**€ 311.700**
		Per m	€ 10.400

Design 2: Combi-wall with inclined piles

Phase	Activities	Method	Costs [€]
1	Set-up site	Place fences	€ 300
2	Remove pavements	water	€ 3.600
3	Excavate quay wall	water	€ 4.400
4	Drill-holes for angle pile	water	€ 4.800
5	Install piles angle	Screwing, water	€ 40.300
6	Crush for steel piles	water	€ 3.200
7	Install steel piles	Screwing,water	€ 43.800
8	Crush for sheet piles	water	€ 3.200
9	Install sheet piles	Press-in, water	€ 24.600
10	Completely remove quay	water	€ 3.200
11	Install "anchor chair"	Water	€ 9.000
12	Install prefab brick wall	water	€ 37.100
13	Fill-in soil	water	€ 9.800
14	restore pavements	water	€ 4.500
15	Restore site	Remove fances	€ 300
		Total	**€ 192.100**
		Per m	€ 6.400

Figure 22: Case 2: result design 1 and 2

Design 3: Combined wall

Phase	Activities	Method	Costs [€]
1	Set-up site	Place fences	€ 300
2	Remove pavements	Water	€ 4.200
3	Excavate quay wall	water	€ 7.500
4	Drill holes for steel piles	water	€ 10.900
5	Install steel piles	Vibrating, water	€ 250.200
6	Crush entire quay wall	water	€ 7.900
7	Install sheet piles	Press-in water	€ 51.500
8	Install prefab brick wall	water	€ 37.100
9	Place soil	water	€ 14.800
10	Restore pavement	water	€ 2.800
11	Clean up site	Remove fences	€ 300
		Total	**€ 387.500**
		Per m	€ 12.900

Design 4: steel pile wall

Phase	Activities	Method	Costs [€]
1	Set up site	Install fence	€ 300
2	Install building pit	Press-in, water	€ 37.900
3	Fill building pit with	Water	€ 6.100
4	Remove pavement	Water	€ 1.400
5	Drill holes quay wall	Water	€ 10.900
6	Install steel piles	Vibrating, water	€ 369.600
7	Remove fill building pit	Water	€ 8.200
8	Remove old quay wall	Water	€ 7.100
9	Install floor + drainage	Water	€ 19.200
10	Place soil behind quay wall	Water	€ 2.400
11	Install prefab wall	Water	€ 37.200
12	Remove building pit	Water	€ 5.700
13	Restore pavement	Water	€ 7.100
14	Clean up site	Remove fences	€ 300
		Total	**€ 513.400**
		Per meter	€ 17.100

Figure 23: Case 2: result of design 3 and 4

Design	Construction period [days]	Stakeholders [R]	Cost per m [€]
L-wall	115	171	10.400
Inclined piles	59	178	6.400
Combined wall	36	91	12.900
Steel piles	64	130	17.100

Table 9: Overview results case 2

R= Stakeholder resistance, the higher the value the less resistance can be expected

Table 9 shows the result of the second case: the result resembles the first case. The combined wall with the inclined piles is the best solution for the Prinsengracht. It will produce the least amount of resistance and has the lowest costs of all the quay walls. Again the L-wall is a good alternative but has a higher price and a longer construction period. The combined wall produces more resistance and has higher costs than the L-wall. The most expensive solution is the steel piles, due to large amount of steel: 63,5% of the total costs is spend on the purchase and installation of the steel piles.

The combined wall with inclined piles has the lowest costs due to two main reasons: no temporarily building pit is needed and small site. The temporarily building pit of the L-wall cost around €100.000 euro, which is €3.333 per meter thus without the temporarily building pit the L-wall would have the same price as the shore piles.

The combined wall and the steel pile design are both expensive alternatives due to the large amount of steel that is installed in the soil. The costs of the steel piles for design combined wall is 64,58% of the total costs while for design four it is 63,5%. Despite that the fourth design consists only steel piles, the percentage is equal as the combined wall (which has 2 sheet piles in between). This is the result that for the fourth design also a temporarily building pit is needed to make the construction soil tight.

L-wall			Shore pile		
Building pit	€ 107.600	34,5%	Steel piles	€ 43.800	22,8%
Foundation piles	€ 62.200	20,0%	Shore piles	€ 40.300	21,0%
Brick wall	€ 37.700	12,1%	Prefab wall	€ 37.100	19,4%
Combined wall			**Steel piles**		
Steel piles	€ 250.200	64,6%	Steel piles	€ 369.600	72,0%
Sheet piles	€ 51.500	13,3%	Building pit	€ 37.900	7,4%
Prefab wall	€ 37.100	9,6%	Prefab wall	€37.100	7,3%

Table 10: most expensive construction steps per design

Table 10 shows the most expensive construction steps per design, which are the foundation construction and the building pit. For the combined wall and the steel piles, the foundation piles are the most expensive steps but also have a total negative assessment (-18,92). It declares the importance to keep the dimensions minimal in order to make vibration less techniques feasible. The foundation piles and the feasible techniques are an important parameter in a project: they determine the majority of the costs and the risks of damage in the surrounding. Eventually the combination between costs and risks determines which technique will be applied. For example when a technique reduces the risk to the minimal but exceeds the budget then this technique will probably not be used.

6 Conclusion

6.1 Research questions

This research should answer the following research question:

How can be determined which construction method for replacing urban quay walls will most likely produce the least resistance of stakeholders in a particular project?

A research method is developed that can be used to determine which construction method and design will most likely produce the least resistance. This research method is called the Construction & Stakeholder matrix (C&S matrix), this matrix connects the stakeholders and the construction method directly, by comparing the extent to which different construction methods are in accordance with the stakes of the stakeholders. Thereby, the matrix takes into account the influence of different stakeholders on the outcome of the project. The outcome of the matrix is a numerical value: the lower the number, the more resistance can be expected. This makes the C&S-matrix unique: it enables to measure the resistance that can be expected of stakeholders. This can be used to make decisions whether a construction method must be applied or an alternative is preferred. Since the construction method also can influence the design, the C&S-matrix can also be used to optimize the design which already takes into account the possible influence on stakeholders on the project.

In the first step of the C&S-matrix, the construction process of multiple designs are decomposed into steps. For each step construction methods are considered and compared if it is in accordance with the stakes or not. If a method is considered to be in accordance with the stakes of the stakeholders, a +1 numerical value is assigned to the method. If a method is considered to be at variance with the interests of the stakeholders, a -1 numerical value is assigned to the method. Methods that have no correspondence whatsoever with the interests of the stakeholders, are assigned a numerical value of 0. Some stakeholders have relative interest which makes them hard to assess, these stakes must be translated into a measurable interest with assessable criteria for the C&S-matrix. In order determine the amount of resistance that can be expected it is vital to identify the power of the stakeholders. When a stakeholder has more power to influence the project it will produce more resistance. Thereby is assumed that when a stakeholder will produce resistance when the interest is not sufficiently taken into account in the construction or operation period of the life cycle of a quay wall. In the C&S-matrix the power-vs-interest is chosen as tool to identify the power of the stakeholders. The power-vs-interest-method in combination with the comparison of step 1 determines the numerical value of the resistance that can be expected from stakeholders.

The C&S-matrix can be a valuable tool in determining the expected resistance of the stakeholders but the method has his limitations. The goal of the method is to find the method that results in the least amount of resistance of stakeholders by assessing each method against the stakes of the stakeholders. The C&S-matrix can also be used to determine which stakeholders' interests are met and which are not, it gives a prediction which stakeholders will most likely produce resistance. This resistance can be reduced by giving extra attention to a stakeholder with communication. Another method to reduce the resistance is compensation for the reduction of revenue during the construction period. Again the C&S-matrix can give information about which stakeholders are negatively influenced by the project. In combination with the power-vs-interest it can provide information for the communication and compensation strategy for each stakeholder: which stakeholder requires additional attention?

However the C&S-matrix also has disadvantages, the effectiveness of the matrix depends on the stakeholder analysis which consists of:

- Identification of the stakeholders and their interest
- Power-vs-interest method

A key factor in stakeholder management is identifying all the stakeholders, after all the unidentified stakeholders will have a negative influence on the project (Luyet, 2005). The effectiveness of the C&S-matrix also depends on the applied power-vs-interest grid and the actual interest and power of a stakeholder.

Case Prinsengracht

This developed method is applied on a case in Prinsengracht in Amsterdam where a quay wall of 30 meters is replaced. The four quay walls that are feasible for the Prinsengracht are:

1. L-wall
2. Combi-wall with inclined piles
3. Combined wall
4. Steel piles only

During the design and construction phase, multiple stakeholders have an interest in the project and can influence the outcome. Each project is unique but also the stakeholders that are involved during the project. The stakeholders that are represented in Table 6 are the stakeholders for the urban area of Amsterdam.

Stakeholder	Interest
Internal stakeholders	
Municipality	- Project success - Preservation of characteristic appearance
Consultancy	Maintain partner with Municipality
Contractor	Profit
External stakeholders	
Subsidy Providers	Gaining additional value for the city
Insurance company	Profit
Road Users	Accessibility
Emergency services	Accessibility
Tourism	Value for the money
Province	Preservation protected Flora and Fauna
Adjacencies	- Accessibility - Prevent damage to buildings - Noise hindrance
Navigation	Accessibility canals
Waterway manager	Accessibility canals
Regional Water Authority	- Preservation storage capacity - Preservation water quality
UNESCO-IHE	Preservation characteristic appearance
Cables and pipeline managers	- Prevent damage to cables and pipelines - Combine activities

Table 6: Overview of the main stakeholders and their stake

The influence of the stakeholders is determined with the power-vs-interest method, see Figure 17. The grid is performed with professionals working at different stakeholders: municipalities, contractors and consultancies. The result is that each person has a different interpretation of the interest and power of the stakeholder, which led to sixteen different grids where only the municipality had always the same position in the grid. The relative variations in power and interest in Figure 18 show that there are different interpretations of the power and interest of the stakeholders, this is the result of the different definitions of a stakeholder and experiences. A good experience with a stakeholder often reduces interpretation of the power or interest of a stakeholder in a project and vice versa.

Eventually two cases were investigated:

1. Resistance
2. Resistance vs costs

Also in both cases time was included in the results of the C&S-matrix because the construction period plays a role in the resistance of stakeholders since a short construction period is preferable. The combined wall with inclined piles is in both cases the most favorable quay wall design for the Prinsengracht, the expected resistance of this design is equal to the L-wall but the construction period of the combined wall with inclined piles is shorter and the costs are lower. The L-wall is a good alternative, the construction method is already developed to reduce the risk of damage in the environment. This also results that less resistance can be expected by stakeholders with an interest in the risk of damage for the surrounding. The building pit is a disadvantage which results in extra cost and construction period, but also the in-situ construction of the L-wall is a time consuming procedure with respect to the prefab wall of the combined wall with inclined piles. The other two designs, combined wall and steel piles, are unfavorable for urban cities. Due to absence of an anchor, the dimensions of the steel tubes increases significantly. The consequences are that only techniques using vibrations are feasible but these methods are not preferred in urban areas.

6.2 Recommendations

The C&S-matrix is developed for the replacement of the quay walls, but it requires additional research whether this matrix is also applicable for other cases, for example new infrastructure project. The method can still be used to determine which method can expect the least amount of resistance but in new infrastructure projects the situation after construction is an important factor in the resistance.

This developed method can predict the resistance that can be expected in a particular project when a certain construction method is applied. Before even the design is completely calculated, this method determines the resistance that can be expected. The outcome of the method can be used to optimize the design, therefore it is recommended to use this method in an early stage of a certain project. It is also recommended to perform the power-vs-interest with many professionals in order to decrease the variations in the power-vs-interest method, this will increase the effectiveness of the project.

All the stakeholders are generalized, which means that mutually relationships with stakeholders are not included in this research but also the differences within one group of stakeholders, for example one resident can produce more resistance than his neighbor(s). Additional research is needed to include the generalization of stakeholders and mutual relationships in the C&S-matrix. These two components only influence the power-vs-interest grid and the final value that is applied in the C&S-matrix. Mutual relations can have a positive or negative effect on the power of a stakeholder, therefore those can be added in the C&S-matrix by including a range in possible resistance of a stakeholder. A good relationship will reduce this resistance and vice versa. This has to be determined for each stakeholder separately and requires additional research. Difference in resistance within a stakeholders group can be determined with a probability calculation, therefore many projects have to be analyzed to determine the probability that a person will resist more within a certain stakeholder group.

Bibliography

Babou. (2016). *Leadership & Project Management Champions*. Retrieved 2017, from https://leadershipchamps.wordpress.com/2008/03/09/what-is-stakeholder-analysis/

Beckers, F., Chiara, N., Flesch, A., Maly, J., Silva, E., & Stegemann, U. (2013). *A risk-management approach to a succesful infrastructure project.* McKinsey&Company.

Bryson, J. (2003). What to do when Stakeholders matter: a guide to stakeholder identification and analysis techniques. *National Public Management Research Conference.* Washinton D.C.: Georgetown University Public Policy Institute.

Cambridge Dictionary. (n.d.). Retrieved 1 20, 2017, from http://dictionary.cambridge.org/dictionary/english/

CUR166. (2008). *Damwandconstructies* (Vol. 5).

De Wit, A. (1988). Measurement of project success. *International Journal of Project Management*, 164-170.

Deltares. (2016). *D-sheet Piling Manual.* Delft: Deltares.

DUIC. (2013, November 21). *Opeenstapeling van factoren oorzaak inzakken kademuur Bemuurde Weerd*. Retrieved March 2017, 21, from DUIC: http://destadutrecht.nl/de-wijk/kademuur-ingestort-door-opeenstapeling-van-factoren/

Dura Vermeer. (2016). *Walmmur Leidsevaart, overzichtstekening.*

Enserink B; Hermans L; Kwakkel J; Thissen W; Koppejan J; Bots P. (2010). *Policy Analysis of Multi-Actor Systems.* Den Haag: Lemma.

Gardner, J.R., Rachlin, R., Sweeney, H.W.A. (1986). *Handbook of strategic planning.*

Gemeente Amsterdam. (2017). *Vervangingsopgave Amsterdamse walmuren.*

Gemeente Utrecht. (n.d.). *Bewonersinformatieavond rak 21.* Retrieved from Herstel werven: https://www.utrecht.nl/wonen-en-leven/bouwen/bouwprojecten/herstel-werven/

Ghaleigh, N. S. (June 2013). *Legal Compensation Frameworks for Wind Farm Disturbance-technical Report.* ClimateXChange.

Goldbohm, P. (2016). *Asset Management in publes urban areas.*

Isolde van de Velden. (2013, November). *de Bomen Ridders.* Retrieved 2017, from www.debomenridders.nl: http://www.debomenridders.nl/2013/nieuwe-kademuren-platanen-gespaard/

Luyet, V. (2005). A Framework for the participative process in a large environmental project.

Mazouz, F. (2015, 7 10). *Five Types of Stakeholder Resistance to Procurement and Strategic Sourcing*. Retrieved from Procurement stories: https://procurementstories.com/2015/07/10/five-types-of-stakeholder-resistance-to-procurement-and-strategic-sourcing/

Mitroff, I. (1983). *Stakeholders of the Organizational Mind. Toward a New View of Organizational Policy Making.* San-Francisco: Jessey-Bass.

Mitroff, I. (1983). *Stakeholders of the Organizational Mind. Toward a New View of Organizational Policy Making.*

Municipality of Amsterdam. (june 2017). Vervangingsopgave Amsterdamse walmuren. *Baanbrekers.*

nu.nl. (2015, October 15). *nu.nl*. Retrieved february 27, 27, from nu.nl: http://www.nu.nl/binnenland/3602449/historische-kademuur-utrecht-ingestort.html

Omroep West. (2016, Augustus 25). *Kastanjebomen Veenkade Den Haag mogen gekapt, bewoners verliezen rechtszaak* . Retrieved Februari 27, 2017, from omroepwest.nl: http://www.omroepwest.nl/nieuws/3224284/Kastanjebomen-Veenkade-Den-Haag-mogen-gekapt-bewoners-verliezen-rechtszaak#

Parool. (2016, Juli 08). *Noord/Zuidlijn gaat pas rijden in 2018*. Retrieved february 27, 2017, from Parool.nl: http://www.parool.nl/amsterdam/noord-zuidlijn-gaat-pas-rijden-in-2018~a4336085/

Royal HaskoningDHV. (2015). *Walmuurvernieuwing Keizersgracht.*
Royal HaskoningDHV. (2016). *Doorsnede Walmuurvernieuwing Herengracht-Amstel.*
Royal HaskoningDHV. (2016). *Walmuurvernieuwing Herengracht.*
SBRCUR186. (2014). *Urban Quay Walls.* Rotterdam: SBRCUR.
SBRCURnet. (2013). *Quay Walls second edition.*
UNESCO-IHE. (2010). *Seventeenth-Century Canal Ring Area of Amsterdam inside the Singelgracht*. Retrieved from UNESCO: http://whc.unesco.org/en/list/1349
Van Belzen, T. (2017, Juli 26). *Amsterdam start innovatief versterkingsprogramma voor 500 kilometer kade*. Retrieved from Cobouw: https://www.cobouw.nl/infra/nieuws/2017/7/amsterdam-start-innovatief-versterkingsprogramma-voor-500-kilometer-kade-101251138
Veenswijk, M. (2013). *Handreiking stakeholder strategie bij vitale infraschakels.* King.
Vos, J. (2003). Corporate social responsibility and the identification of stakeholders. *Coporate Social Responsibility and Envirenmental Management*, 141-152.

Appendices

Appendix 1: Report of calculations of quay walls

Appendix 2: D-sheet report of Combined wall

Appendix 3: D-sheet report of Steel piles wall

Appendix 4: Interviews

Appendix 5: Overview power-vs-interest grids

Appendix 6: The Construction and Stakeholder Matrix

Appendix 7: Costs determination