VIRTUAL DESIGN AND CONSTRUCTION IN THE AEC INDUSTRY

An explorative case study on the participation of stakeholders in the design-construction process

MSc Thesis Okke Scholtes
August 2014
Draft report

22 August 2014
Delft University of Technology
Faculty of Civil Engineering and Geoscience
MSc. Construction Management and Engineering (CME)

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Keywords

Virtual Design and Construction, stakeholder management, participation, design-construction process, decision making
PREFACE

This report is my final examination of the MSc program Construction Management & Engineering (CME). In my thesis project I wanted to perform a research in the field of project and stakeholder management. Royal HaskoningDHV provided me with the opportunity to execute a research on the application of Virtual Design and Construction in coherence with stakeholder management. I was directly intrigued with the concept of VDC and the various possibilities entailed with this new method. The VDC concept is still in its fancy and therefore little is known about its process and implementation in practice. This made it difficult to perceive data from projects and project managers. However, since the open and informal atmosphere at Royal HaskoningDHV I was able to obtain all the data that was required for this research. Without this data, I could not have completed my research. Therefore, I am the people of Royal HaskoningDHV truly grateful for answering all my questions.

Despite the fact that I did all the work by myself, this thesis could not have been completed without the contribution of others. First, I would like to thank all involved project managers at Royal HaskoningDHV that allowed me to question them about various projects and stakeholder management in general. Not only were they open for improvements, they also placed themselves in a vulnerable position by letting me analyze their performance on stakeholder management. In addition, I would like to thank my two supervisors at Royal HaskoningDHV: Niek Jenniskens and Daniel Schiffelers, for the critical and thoughtful views which often helped me in making my own decisions.

In particular, I was very pleased with the assistance I was given by my graduation committee, consisting of Paulien Herder, Telli van der Lei, and Sander Nederveen. I want to thank all of them for the feedback I received during my project.

Finally, I would like to conclude with a more personal note by thanking my family and friends for supporting me the last few months.
ABSTRACT

Research problem and approach

The productivity of the AEC industry has gradually declined. Numbers of structural issues within the AEC industry are mentioned as reason for this decline. One of them is the inefficiency of the design-construction process which is partially caused by the fragmentation of the AEC industry and partially by the phased and iterative characteristic of the process. In response to these challenges Royal HaskoningDHV is seeking for improvements to make their design-construction process more effective and efficient. This has resulted in the implementation of Virtual Design and Construction, a method that makes use of integrated multidisciplinary project performance models of design-construction projects to achieve the project objectives. For VDC to succeed input is required from all relevant involved stakeholders as early as possible in the design-construction process. Knowing who the stakeholders are and how they are related to the project, helps to determine when and how they need to participate in the design-construction process. Identification of and insight into project stakeholders can be achieved through a structured process and approach, also known as Stakeholder Management. Stakeholder management theories, processes and tools described in literature today are designed for a broad range of projects but are not specified for projects that will use the VDC method. A formal approach and a systematic framework for stakeholder management in VDC projects are absent. In order to establish a formal approach and to develop a basic stakeholder management framework an analysis must be done of the current knowledge on stakeholder management, how stakeholders are involved in the design-construction process, and how stakeholder management is performed.

The main objective of this master thesis is to gain insight into how stakeholder management can contribute to enhance the integration of project stakeholders in the VDC process. The main research question of this master thesis is:

“In what way can stakeholder management contribute to enhance the integration of project stakeholders in a Virtual Design & Construction based integrated design-construction process in the AEC industry?”

In order to provide an answer to this research question interviews with project managers and case studies were used. First, interviews were held with various project managers from the business lines ‘Buildings’ and ‘Infrastructure’ in order to gain insight into how they perceive stakeholder management and how they perform stakeholder management. Second, six projects were analyzed in order to gain insight into how stakeholder management is performed in VDC projects and to indicate project characteristics that affect the performance of executing stakeholder management.

Results and analysis

From the findings of the interviews it can be concluded that there is a disparity in the performance of executing stakeholder management between the project managers of the business line ‘Buildings’ and ‘Infrastructure’. The project managers from the business line ‘Infrastructure’ perform better on stakeholder management then their colleagues from ‘Buildings’. This disparity can be explained by the difference in type of stakeholders and number of stakeholders involved. In building projects, the project managers have to deal with a small group of internal stakeholders, while in infrastructure projects, the project managers also have to deal with multiple external stakeholders and therefore perform stakeholder management.
From the case studies can be derived that stakeholder management is not performed by the project managers in any of the VDC projects. The low number of stakeholders involved, no variety of stakeholders’ perspectives, and no dependencies on other stakeholders, are the main reasons why stakeholder management is not performed. The integration and level of participation of the involved stakeholders was not determined with the support of stakeholder management, but was determined by the client and based on the delivery method and the contractual agreements between the internal stakeholders.

**Conclusion and recommendations**

Stakeholder management, as defined in this research, cannot always contribute to enhance the integration of project stakeholders in a VDC based integrated design-construction process. The VDC method supports the use of integrated project teams, which implies that the involved internal stakeholders are acting as one entity with the common overriding goal of successfully designing and constructing the project. Therefore, when a few internal stakeholders are involved, stakeholder management brings no added value. When multiple external stakeholders are involved in the design-construction process, stakeholder management becomes an essential process that provides insight into the behavior and attitude of the stakeholders in relation to the project. The steps of the stakeholder management process do not need to be specified for VDC projects and can be used right away. The approach to perform stakeholder management however does change. Stakeholder management in VDC projects is performed in the iRoom in consultation with the project team members. By making the stakeholder management process virtual and visual, an interactive setting is created in which the stakeholder analyses, maps and frameworks are developed in collaboration with the team members and displayed on screens. The stakeholder management process thereby becomes a more interactive process which provides the project team with a variety of insights in the involved (external) stakeholders. This enhances the knowledge about stakeholders at an early stage in the design process and helps the project manager better to determine the level of involvement of each stakeholder during the course of the design-construction process.

With this conclusion in mind, some recommendations are given on the use of stakeholder management within the VDC process which should be considered by Royal HaskoningDHV to further enhance the integration of stakeholders in the design-construction process.

- Make use of visualizations and develop collaborative editable documents
- Perform stakeholder management in the iRoom in collaboration with all project team members
- Use an analytical and structured approach
- Determine if stakeholder management is required

There are also some recommendations given on further research and development:

- Development of project criteria
- Delivery model for VDC projects
- Involvement of external stakeholders in the AEC industry
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Chapter 1  RESEARCH PROBLEM

This chapter provides an overview of the problem that this research will focus on. First the background of the problem will be discussed in section 1.1. The research question will be formulated in section 2.2, the objectives and scope in 2.3, the research approach in 2.4, the contribution in 2.5 and the thesis structure in 2.6.

1.1 Problem background

The Architecture, Engineering and Construction (AEC) industry provides essential services to society by designing and constructing buildings. Over the past 50 years the productivity of non-farm industries (which includes AEC) has increased steadily and yet the productivity of the AEC industry has gradually declined (Teicholz, 2013). Figure 1.1 shows the productivity difference between the construction industry and the manufacturing industry in value added per employee. It shows a decline of the real value added per employee in the construction industry in comparison to a growth thereof in the manufacturing industry.

![Value Added per Employee](image)

Figure 1.1 Value added in $ per employee for construction and manufacturing industries from 1998 - 2011 (Teicholz, 2013)

There are a number of structural issues within the AEC industry that are mentioned as reasons for this decline. Teicholz (2013) argues that each construction project is unique and executed by a multitude of teams under varying conditions, which makes it difficult to optimize knowledge and take advantage of “lessons learned”. According to Farinha et al (2007), the decline of productivity is a result of the fact that the AEC industry in comparison to other non-farm industries is highly project oriented and the business relationships are temporary and often short term. Many other researchers, stakeholders and companies blame the inefficiency of the design-construction process (Churchill & Thoren, 2009; Bektas, et al., 2008; Rezqui, et al., 2009). They address the need to increase the quality of building design while simultaneously decreasing costs and duration of AEC projects to increase productivity.
Fragmentation of the AEC industry

The inefficiency of the design-construction process is partially caused by the fragmentation of the AEC industry (Baiden, et al., 2006). Introduction of new construction technologies, new building materials, new structural tools and techniques on the one hand and more demanding clients, more complicated and ambitious design intents, stricter legislation and building regulations, and a growing awareness of the lifespan of the building on the other hand have increased the complexity of the AEC industry (Wood, et al., 2013). Due to the growing complexity of the industry, a lot of knowledge and expertise is required, which is scattered over different disciplines within the industry (Alashwal, et al., 2009). The AEC industry is characterized as a project based organized industry, which is associated with the involvement of many different actors such as architects, engineers, contractors and owners (Anumba, et al., 2005). This makes project teams multidisciplinary, in which every actor has its own field of expertise, delivers unique services and has specific individual objectives. Each actor delivers a partial contribution to the final result. To achieve a successful final result is however difficult as individual objectives can be conflicted. Project success is often defined in terms of individual rather than collective project success and the composition of project teams is often based on individual professional capabilities instead of on the ability to integrate and work together (Baiden, et al., 2006). This may lead to poor interaction between team members, resulting in poorly managed knowledge and conflicting interests, causing considerable rework, delays and cost overruns (Bektas, et al., 2008).

Phased and iterative design-construction process

Besides being fragmented the AEC industry is also characterized by a phased and iterative design-construction process. Throughout the phases of the design-construction process, various decision moments take place. At such a moment, project alternatives are made and presented to a client on which the client bases a decision. These decision-making scenarios take place continuously during the whole life cycle of a design-construction process; the project developers compare property sites to make informed investment decisions; the client compares proposed designs looking at aesthetics, costs and life-cycle performance to arrive at a development decision; the contractors compare different acceleration programs to limit unforeseen delays (Kam & Fischer, 2004). Decisions made
during a design-construction process are based on the information gathered on forehand. The more extensive and balanced the input of information (options, alternatives, predictions and criteria) is, the more informed the decision becomes (Kam & Fischer, 2004). In a process which is characterized by different phases and actors it is difficult to gather and evaluate information and make well-informed decisions. In the beginning of the design process little project information is available and it is scattered over all the different actors. As the design process moves on more and more information becomes available through design iterations facilitating better-informed decisions (Serginson, et al., 2013). Unfortunately, the influence of the actors on the design decreases as previous decisions closed alternative design options and subsequent changes to existing designs become more expensive as the project matures (Koo, et al., 2010). This is shown in figure 1.2.

**Challenges Royal HaskoningDHV**

Royal HaskoningDHV is an international consultancy and engineering firm, which is often involved in the various phases of the design-construction process. The company acknowledges the challenges facing the AEC industry. In recent years Royal HaskoningDHV has been confronted with several additional challenges, beside the aforementioned fragmentation, phased and iterative processes. The economic circumstances in the Netherlands are fragile and uncertain and the Dutch real estate market is shrinking (CBS, 2013). This has forced Royal HaskoningDHV to execute projects in a smaller time-window, with lower cost overruns and at the lowest possible price.

In response to these challenges Royal HaskoningDHV is seeking improvements to make their design-construction process more effective and efficient. This has resulted in the implementation of the ‘Virtual Design and Construction’ method (VDC), which attempts to overcome the challenges in the design-construction process (Kunz & Fischer, 2012). VDC is the use of integrated multidisciplinary project performance models of design-construction projects to achieve the project objectives. The models are multidisciplinary in the sense that they take all relevant parties involved in the process into account. The models predict and measure project performance and compare this to the project objectives (Kunz & Fischer, 2012). VDC models are virtual and focus on three aspects in the process and these can be designed and managed: the product, the organization (which defines, designs, constructs and operates the project), and the process the organization will follow (POP) (Kunz & Fischer, 2012). The models are integrated and related to each other so that every change in, or addition to, a model is implemented in all the related models. VDC uses interactive rooms, so called iRooms, to support the collaboration between the different stakeholders (figure 1.3). With the use of the iRoom and interactive visualization you can show the stakeholders what they can expect as the end result: “What you see is what you get”.

![Figure 1.3 iRoom setting](image)
In September 2012 Royal HaskoningDHV and the faculty of Technical Policy and Management of the TU-Delft started a cooperation agreement to further develop the VDC method for the Dutch market. This collaboration was focused on the organizational embedding and further development of the concurrent design concept (AIDA, 2013). Analyses of the method showed that VDC is promising. The interaction with the client and other stakeholders, supported by models, simulations and visualizations, increases the efficiency of the design-construction process. Using the method has the potential to increase the overall quality of the design while at the same time decrease the overall process time. However to achieve these objectives a change is needed in the way of working throughout the whole design-construction process (AIDA, 2013).

Stakeholder management in the VDC method

For VDC to succeed input is required from all relevant involved stakeholders as early as possible in the design process. Different disciplines from various organizations involved at different phases in the design-construction process make this complicated. The method requires an intense interactive process with more interaction and collaboration between the project stakeholders than was necessary in traditional processes (Kunz & Fischer, 2012). Knowing who the project stakeholders are and how they may influence the project, helps to determine when and how they need to participate in the design-construction process. Stakeholder management is therefore a crucial aspect for the VDC method to succeed (Kunz & Fischer, 2012).

Several project stakeholder management theories and analyses are proposed by scholars. However these are not coherent and detailed enough for practical use in VDC projects. According to Olander (2003) stakeholder management is about managing and influencing the expectations of both external and internal stakeholders to ensure a successful project by identifying the stakeholders and determining their needs and expectations. Bourne & Walker (2005) address the importance of the identification of the key stakeholders and which strategy the management team can use to maximize a stakeholder’s positive influence and minimize any negative influence. The importance of stakeholders’ involvement in the decision-making process is covered by Reed (2008). According to him stakeholder management comprises of several stakeholder analyses, which define aspects of a social and natural system, and identify stakeholders and prioritize stakeholders for involvement in the decision-making process. Ackerman and Eden (2011) divide stakeholder management into three elements supported by stakeholder management techniques: (1) identify who the stakeholders really are in the specific situation, (2) explore the impact of the stakeholders on the project and, (3) develop a stakeholder management strategy. In their book Project Stakeholder Management, P. Eskerod and A. Lund Jepsen define project stakeholder management as ‘all the purposeful activities carried out in connection to the project stakeholders in order to enhance project success’ (2013: 17). According to Eskerod & Lund (2013) proper stakeholder management is the understanding of what drives the behavior of all the project stakeholders and how this behavior can be influenced. The literature is comprehensive in addressing all kinds of stakeholder management theories, analyses and tools, but a formal process approach has not yet been developed (Freeman, 2010).

Stakeholder management theories, processes and tools described in literature today are designed for a broad range of projects however not specified for projects that will use the VDC method. Kunz & Fischer (2012) elaborate on how VDC changes the design-construction process and they point out that input from relevant stakeholders plays an essential role. However, a formal approach and a systematic framework for stakeholder management in VDC projects however is absent. Royal HaskoningDHV is progressive with the implementation of VDC and is the first consultant and engineering firm implementing this method in the Netherlands. While VDC is used for projects the
company leaves stakeholder management to the experience of the project manager. In order to develop a formal approach and a systematic framework the current knowledge on stakeholder management and the participation of stakeholders in the design-construction process need to be analyzed.
Chapter 2 RESEARCH METHODOLOGY

The previous chapter presented the research problem of this master thesis. This section presents and discusses the research methodology. First, the research question and the related sub-research questions will be discussed, followed by the research objectives and scope. Furthermore, the research approach will be explained and how this thesis contributes to both the scientific and business perspective on VDC and stakeholder management.

2.1 Research question

A research question is formulated which comprises the problem as described in the problem description.

“In what way can stakeholder management contribute to enhance the integration of project stakeholders in a Virtual Design & Construction based integrated design-construction process in the AEC industry?”

In order to provide an answer to this research question several sub-research questions are formulated:

SRQ1: What is the use of stakeholder management and what are the essential elements of the stakeholder management process?

SRQ2: What is the use of the method Virtual Design & Construction and how do stakeholders participate in an integrated design-construction process?

SRQ3: What do project managers understand by stakeholder management and how do they perform stakeholder management?

SRQ4: How is stakeholder management applied in VDC projects and what project characteristics can be identified that affect the performance of stakeholder management?

SRQ5: What guidelines can be made for stakeholder management and how can this be implemented in the VDC method?

2.2 Research objectives and scope

The following research objectives were developed from the research questions:

Objectives 1 and 2 – from sub research question 1
1. To describe and explain stakeholder management
2. To explain the stakeholder management process and steps

Objectives 3 and 4 from sub research question 2
3. To describe and explain the method VDC
4. To determine how stakeholders should participate for VDC to succeed

Objectives 5 and 6 from sub research question 3
5. To identify how project managers perceive stakeholder management
6. To determine how the project managers perform stakeholder management
Objective 7 and 8 from sub research question 4

7. To determine how stakeholder management is currently performed in VDC projects
8. To identify project conditions that affect the performance of stakeholder management

Objective 9 from sub research question 5

9. To define a basic stakeholder management framework that can be used in VDC projects

The scope of this research, as elaborated in the problem description, is too broad and the following paragraphs shall refine it by focusing on-and describing-the relevant sectors related to the research problem.

**Business lines & industry**

Royal HaskoningDHV is a large company that focuses on a multitude of industries divided in several business lines. The business line that focuses on the AEC industry is named ‘Buildings’ and this will therefore be focused upon in the research.

**Project phases**

In the traditional construction projects, projects start with an initiation phase, followed by a research phase, a programming phase, a schematic design phase, a design development phase, a construction documents phase, a procurement phase, a construction phase and a close out phase. The scope of this thesis corresponds with the main design task of engineering firms in the AEC industry and therefore focuses on the research phase until the procurement phase. In addition, it is expected that stakeholder management starts in the early beginning of the design process and is most valuable during these phases.

**Disciplines**

Royal HaskoningDHV has several consultancy disciplines within the business line ‘Buildings’ that can be consulted by a customer. This research focuses on projects in which the discipline ‘Project Management’ is consulted. In these projects the project manager is responsible for the participation of the project stakeholders.

**Virtual Design and Construction**

Royal HaskoningDHV has implemented Virtual Design and Construction as the new integrated design method and it is therefore central to this research. The method is used in several projects but it is still in its infancy and needs further research and development to reach its full potential. Currently stakeholder management is not yet interwoven with the principles of VDC and this research will thus focus on stakeholder management within VDC projects.
2.3 Research approach

To answer the research question and the accompanying sub-questions an exploratory research approach is needed. This is achieved by doing a qualitative case study. The approach of the research is set out below.

![Research framework diagram]

**Figure 2.2 Research framework**

2.3.1 Literature review

The first step in this research is a literature review that will be performed in order to create an understanding of stakeholder management and its process and steps and in what way stakeholder integration plays a role in the VDC method. This review will provide the required knowledge from which a theoretical framework will be developed that is used throughout the rest of this thesis to compare theory with practice. The literature review will provide an answer to the first two research questions.

**Approach to literature review**

- **Academic literature on stakeholder management**
  
  A template of a complete project stakeholder management process is absent in literature and this is noted as the first gap in literature. An in-depth literature review on project stakeholder management is required to develop a theoretical framework for a complete project stakeholder management process. The input from the literature will be gathered and structured.
Academic literature on Virtual Design & Construction

Academic literature will give an understanding of how VDC is developed and what the concept of VDC entails. The importance of stakeholder integration in the design process will be described.

Outcome of the literature review

- Understanding of stakeholder management and the different theories, processes and steps.
- Understanding the method Virtual Design & Construction and the participation of the project stakeholders
- Understanding of the importance of stakeholder integration in the design process.

Based on the stakeholder management literature review a stakeholder management process framework is developed that will be used to examine how project managers of Royal HaskoningDHV perceive and perform stakeholder management. Based on the VDC literature the necessary involvement of stakeholders will be discussed to successfully perform the VDC method.

2.3.2 Stakeholder management analysis

The theoretical framework for stakeholder management will be used for interviewing the project managers and will provide an answer to research question 3. According to Royal HaskoningDHV the business line ‘Infrastructure’ is a step ahead of ‘Buildings’ with the implementation of stakeholder management. As this may give interesting insights into stakeholder management in the Royal HaskoningDHV environment various infrastructure project managers are interviewed as well.

Approach to stakeholder management analysis

- Interviews of project managers
  
  In order to examine how the project managers of Royal HaskoningDHV perceive and perform stakeholder management, various project managers are interviewed. The interview framework is based on the theoretical framework. The project managers are all senior project managers, with experience in managing large complex projects. Most of them have some experience with the VDC method.

Outcome of the analysis

- Understanding of how project managers perceive and perform stakeholder management
- Insight into the differences in approach of stakeholder management between the business lines ‘Buildings’ and ‘Infrastructure’.

2.3.3 Case study

The acquired theory of the VDC method provides knowledge about the importance of stakeholder integration in the design process. The acquired theory of stakeholder management provides knowledge on how stakeholder management should be performed. To examine the participation of stakeholders in practice and how stakeholder management is performed, six projects are examined. Depending on the project, the project manager and other Royal HaskoningDHV project participants are interviewed to understand how project stakeholders were involved in the project and how they performed stakeholder management.
Approach to observations and interviews

- **Selection of projects**
  The projects that are used for the case study are selected based on a project list provided by Royal HaskoningDHV. This list contains all projects that utilize the VDC method according to Royal HaskoningDHV. Six of these projects are chosen and will be examined further. Some of these are on-going projects while others are completed. Four of the six projects have explicitly been indicated as having been conducted stakeholder management.

- **Interviews of project managers and participants**
  The project managers and several participants of the selected cases will be interviewed based on the theoretical framework. The interviews aim to determine how project stakeholders participate in the project.

Outcome of the interviews

- Insight into the manner in which stakeholders are involved in VDC projects and how the project managers perform stakeholder management.
- Understanding of the integration of project stakeholders in the design process of several indicated VDC projects.

2.3.4 Evaluation

After the analysis of stakeholder management and the cases the outcome will be evaluated and discussed. First a stakeholder management guideline will be made based the theoretical framework and the results of the case studies and interviews with project managers from both business lines. Furthermore, advice and recommendations will be given to Royal HaskoningDHV on how to proceed with stakeholder management in coherence with VDC projects.

2.4 Research contribution

This project thesis is relevant for both the scientific and business perspective. From a scientific perspective this thesis will provide a contribution to the knowledge of stakeholder management in a VDC based design-construction process. First, the literature review will give understanding of the stakeholder management process and the added value of the VDC method. Second, with the help of the interviews and case studies, the research results give understanding of how project managers perform stakeholder management and how stakeholders participate in the design-construction process. This will provide insight into the possibility of how stakeholder management can enhance the participation of stakeholders in the design-construction process. Besides the scientific relevance, this thesis will provide information and knowledge for the company Royal HaskoningDHV. The results of this research can be used by Royal HaskoningDHV to further improve their design processes.
Chapter 3  THEORETICAL FRAMEWORK

In this chapter a review is given of the existing literature concerning stakeholder management and Virtual Design & Construction. The focus in this review will be on the collaboration between project stakeholders in the VDC design-construction process. Section 3.1 will elaborate on stakeholder management theory, its use and the content of the stakeholder management process. Part 3.2 will elaborate on the background, principles and process characteristics of the VDC method with the focus on stakeholder collaboration.

3.1  Stakeholder management

Central to this research is stakeholder management. This section will provide an overview of what stakeholder management is according to various scholars. Stakeholder management is first introduced, where after the stakeholder management process is discussed and structured in a template. This part gives an answer to sub research question 1:

What is the use of stakeholder management and what are the essential elements of the stakeholder management process?

3.1.1  Introduction to stakeholder management

Various stakeholder management theories, approaches and methods have been developed in different fields of expertise for different purposes. This thesis focuses on stakeholder management within the AEC industry. Stakeholder management is a broad concept and many different views and interpretations are given by various scholars. According to PMI (2004), a project is: “a temporary endeavor undertaken to create a unique product, service, or result”. Temporary means that every project has an explicit starting point and an ending point, a time span; and a time before and after the project (Eskerod & Jepsen, 2013). The end is reached when the project’s objectives have been met or the project is terminated for whatever reason. Project activities require input from and integration of work of different specialists, disciplines and other actors involved in the project (Anumba, et al., 2005). Project success or failure is therefore strongly related to the perception of each project stakeholder and their willingness and ability to contribute either for or against the project (Bourne, 2005). These perceptions are not based on logic but often based on the quality of the relationship between the project and its stakeholders (Bourne, 2005). This implies that it is important to manage project stakeholders to support the success of the project (Bourne, 2005; Eskerod & Jepsen, 2013). The realization of the importance of the involvement of stakeholders on project outcomes and the recognition of stakeholder management has grown in recent years (Bourne, 2005; Newcombe, 2003; Olander & Landin, 2005). As a consequence thereof different perspectives on stakeholder theory have been developed (Yang, et al., 2010). In recent years, several scholars have tried to classify stakeholder management into different themes, processes and approaches. A variety of techniques and methods are developed to establish and organize insight into stakeholders, which create the foundation for the stakeholder management activities (Eskerod & Jepsen, 2013). The following section will elaborate on what a stakeholder is, and the process of stakeholder management.
3.1.2 What is a (project) stakeholder

There are different views on who or what stakeholders are. Many recent definitions of stakeholders are based on Freeman’s (1984) work, which defines a stakeholder as “any group or individual who can affect or is affected by the achievement of the organization’s objectives”. This definition provides the basis for various definitions of what a project stakeholder is. The various definitions of a project stakeholder are displayed in table 3.1.

<table>
<thead>
<tr>
<th>SCHOLARS</th>
<th>PROJECT STAKEHOLDER DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>McElroy and Mills (2000)</td>
<td>Project stakeholders are a person or group of people who have a vested interest in the success of a project and the environment within which the project operates.</td>
</tr>
<tr>
<td>Newcombe (2003)</td>
<td>Project stakeholders are groups or individuals who have a stake in, or expectation of, the project’s performance and include clients, project managers, designers, subcontractors, suppliers, funding bodies, users and the community at large.</td>
</tr>
<tr>
<td>PMI (2004)</td>
<td>Individuals and organizations that are actively involved in the project, or whose interest may be affected as a result of project-execution or project completion.</td>
</tr>
<tr>
<td>Bourne (2005)</td>
<td>An individual or groups who have an interest or some aspects of rights or ownership in the project, can contribute in the form of knowledge or support, or can impact or be impacted by, the project.</td>
</tr>
<tr>
<td>Olander (2007)</td>
<td>A project stakeholder can be defined as a person or group of people who has a vested interest in the success of a project and the environment within which the project operates.</td>
</tr>
<tr>
<td>Trimble (2007)</td>
<td>Any person or organization with an interest in a project.</td>
</tr>
<tr>
<td>Reed, et al. (2009)</td>
<td>Individuals, groups and organizations who are affected by or can affect decision or actions in the project.</td>
</tr>
<tr>
<td>Eskerod and Jepsen (2013)</td>
<td>Individuals or entities represented by individuals who can affect or who can be affected by the project process or the project outcomes.</td>
</tr>
</tbody>
</table>

Table 3.1 Project stakeholder definition

As can been seen there are broad and narrow definitions of stakeholders. Bourne’s (2005) and Eskerod & Jepsen’s (2013) definitions are seen as a broad view, because all groups or individuals can in some sense be defined as a stakeholder. A broad view results in a wide range of possible stakeholders. A more narrow view is proposed by scholars such as McElroy and Mills (2000) and Olander (2007), where only those people who have a vested interest in the success of a project, are called project stakeholders. A ‘vested interest’ can be seen as the same as a ‘stake’, wherein a stake could be defined as actual or perceived benefits, or risk/harm from, project activities (Olander, 2007). As there is no consensus on who or what a project stakeholder is it is necessary to choose one definition in order to further this study. It is most useful to adopt the broader definition of stakeholders. This gives the project’s organization the possibility to identify a wider range of stakeholders that could influence the project. Therefore this research adopts the definition formulated by Eskerod and Jepsen (2013): Individuals or entities represented by individuals who can affect or who can be affected by the project process or the project outcome. In the course of this thesis, the words stakeholder and project stakeholder will be used interchangeably but will refer to the same broad view.
### 3.1.3 A framework for project Stakeholder Management

The previously selected definition of a stakeholder leads to the question how this should be used and how project specific stakeholders are identified. Identification of and insight into project stakeholders can be achieved through a structured process and approach, also known as Stakeholder Management. Stakeholder management is defined as the effective management of relationships with stakeholders by taking into account the interest and motivations of persons and entities that can affect or be affected by the project (Bari, et al., 2007; Eskerod & Jepsen, 2013). The idea behind project management is that the project manager can increase the likelihood of project success through a process of thoughtful activities in connection to the stakeholders. These activities are based on careful analysis of the project stakeholders and their interests. Stakeholder management therefore requires a structured process and approach to establish insight into the interests and behavior of the project stakeholders (Bryson, 2004). In recent years a diverse variety of stakeholder management process models have been proposed (Yang, et al., 2010). The following table shows a structured list with analyses proposed by various scholars.

<table>
<thead>
<tr>
<th>PHASES</th>
<th>STEPS</th>
<th>ANALYSES (SCHOLARS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stakeholder Identification</td>
<td>Identifying stakeholders</td>
<td>All stakeholders (Eskerod &amp; Jepsen, 2013; Bourne &amp; Walker, 2005; Olander, 2007).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal and external stakeholders (Atkin &amp; Skitmore, 2008; Olander, 2006; Olander, 2007).</td>
</tr>
<tr>
<td>Stakeholder Assessment</td>
<td>Analyzing stakeholders</td>
<td>Define stakeholders’ basic information; Power, Stake in the project, Project role (Bourne &amp; Walker, 2005; Gilmour &amp; Beillin, 2006; Ackermann &amp; Eden, 2011).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Determine stakeholders’ issues and interrelationships (Ackermann &amp; Eden, 2011)</td>
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<td></td>
<td></td>
<td>Determine relationships between stakeholders (formal and informal)</td>
</tr>
<tr>
<td></td>
<td>Mapping stakeholders</td>
<td>Attitude/Position towards project (Mcelroy &amp; Mills, 2000)</td>
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<td></td>
<td></td>
<td>Stakeholder Commitment Matrix (Eskerod &amp; Jepsen, 2013; Mcelroy &amp; Mills, 2000)</td>
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<tr>
<td></td>
<td></td>
<td>Stakeholder Classes (Power, Legitimacy and Urgency) – Dormant, Discretionary, Demanding, Dominant, Dangerous, Dependent, Definite (Olander, 2007; Mitchell, et al., 1997; Walker, et al., 2008)</td>
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<tr>
<td></td>
<td></td>
<td>Stakeholder-Issue Relationship Map (Bryson, 2004)</td>
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<td></td>
<td></td>
<td>Problem-Frame Map (Power vs Support) – Weak Supporters, Strong Supporters, Weak Opponents, Strong Opponents (Bryson, 2004; Olander, 2007).</td>
</tr>
<tr>
<td>Stakeholder Engagement</td>
<td>Determine required participation</td>
<td>5 levels of participation – Information, Consultation, Collaboration, Co-decision, Empowerment (Bryson, 2004; Luyet, et al., 2012; Gilmour &amp; Beillin, 2006).</td>
</tr>
</tbody>
</table>

Table 3.2 Stakeholder management analyses
Stakeholder Identification

The starting point of the stakeholder management process is the identification of stakeholders. According to Eskerod & Lund (2013) all individuals and groups who can affect or can be affected by the project process or the project outcomes should be listed. Both current and potential stakeholders must be identified. The determination of all the stakeholders involved in the project cannot be completely defined at the beginning of the project. The identification process should therefore be an iterative process during the complete lifecycle of the project (Caputo, 2013; Eskerod & Jepsen, 2013; Reed, et al., 2009). Eskerod & Lund emphasize the importance of involving key stakeholders in identifying stakeholders. By involving others a broader range of possible stakeholders are identified and not only those who are perceived by the project manager. By using the opinion of experts, brainstorm sessions, focus groups, semi-structured interviews of key stakeholders, or a combination of these, stakeholders can be identified (Caputo, 2013; Eskerod & Jepsen, 2013).

There are essentially two categories of stakeholders: internal and external stakeholders (Atkin & Skitmore, 2008; Olander, 2007). The internal stakeholders are those who form the project team, finance the project or have a legal contractual relationship to the project, such as the client, contractor, architect and end-user. The external stakeholders are those who influence or affect, or are influenced or affected by the project and are not contractually engaged with the project, such as interests groups, local authorities and nearby residents (Olander, 2006). External stakeholders have the capacity to support and hinder the project by mobilizing public opinion. Conflicts with external stakeholders may arise if they are not regarded during the project process which could lead to time delays, cost overruns and negative publicity (Olander, 2007). Figure 3.1 shows a schematic picture of potential external and internal stakeholders involved in a construction project. The output of the identification phase is a list of all possible internal and external entities during the complete lifecycle of the project.

![Figure 3.1 Internal and external stakeholders (Olander, 2006)](image-url)
**Stakeholder assessment**

Once the stakeholders are identified they are assessed. The assessment of stakeholders consists of two steps: *analyzing stakeholders* and *mapping stakeholders*. The first step aims to gather information about stakeholders by analyzing them. This analysis consists of various sub-steps. The first sub-step is to define how powerful or influential each stakeholder is in respect to the project. Power can be derived from the ability to provide or withhold resources, their ability to influence decision-making, their access to information and knowledge required for the project (Ackermann & Eden, 2011; Mitchell, et al., 1997; Walker, et al., 2008). Second, the stake each stakeholder has in the project is defined: what is the basis of their interest (economic, political, cultural, scientific or technical) and how significant is it to them (Gilmour & Beillin, 2006). Thirdly, the role is defined of each stakeholder in the project. In addition to the first three sub-steps, the relationships between the stakeholders can be defined. These relationships can be both formal and informal, where formal relationships are typically line relationships, while informal relationships are more socially based (Ackermann & Eden, 2011). Another important aspect that should be defined is the issues each stakeholder may have with the project. By defining the issues and linking the issues to the stakeholders, it becomes clear which issues are most important and who are involved with each issue. Defining the attitude each stakeholder has towards the project generate insight which stakeholders might hinder the project and who might help the project to succeed. On the basis of the information gathered in the previous step a *Stakeholder Analysis Framework* can be established (Gilmour & Beillin, 2006). This framework gathers all the information into one organized document.

Once the analysis has been completed and the Stakeholder Analysis Framework has been developed it becomes possible to develop various stakeholder maps. The mapping of stakeholders gives insight into the relationship of the various stakeholders with the project. The often complex interplay of stakeholders is thus made visually uncluttered. McElroy and Mills (2000) suggest mapping stakeholders based on the commitment they hold toward the project as well as the commitment needed for project success at a given point in time, by creating a *Stakeholder Commitment Matrix*. They determine five possible states of commitment: Active Opposition, Passive Opposition, Neutral, Passive Support and Active Support. The matrix enhances the project manager’s awareness of the different commitment levels needed. Figure 3.2 presents a schematic example of a Stakeholder Commitment Matrix.

![Figure 3.2 Stakeholder Commitment Matrix](Eskerod & Jepsen, 2013)

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*States of commitment*:
- **Active Opposition**
- **Passive Opposition**
- **Neutral**
- **Passive Support**
- **Active Support**

*Stakeholders*:
- **Stakeholder A**
- **Stakeholder B**
- **Stakeholder C**

*Note:* X = current position, O = necessary/wanted position by the project
Another way of mapping stakeholder is defined by Olander (2006), Mitchell et al (1997) and Walker et al (2008). They define different stakeholder classes based on the possession of three attributes: Power, Legitimacy and Urgency. Power is seen as one of the major attributes a stakeholder can possess to influence the project and therefore an important aspect in the mapping of stakeholders. Legitimacy refers to the perception or assumption that the action of a stakeholder is desirable, proper or appropriate within the socially constructed system of norms, values and beliefs (Yang, 2013). Urgency is defined as “the degree to which a stakeholder claims call for immediate attention” (Mitchell, et al., 1997). By combining the three attributes, seven types of stakeholders can be distinguished: Dormant stakeholders, Discretionary stakeholders, Demanding stakeholders, Dominant stakeholders, Dangerous stakeholders, Dependent stakeholders and Definitive stakeholders (Olander, 2006; Mitchell, et al., 1997). Figure 3.3 shows the different categories of stakeholders based on the attributes: power, legitimacy, and urgency.

Dormant stakeholders possess the power of opposing their will on the project, but there is a lack of urgency and legitimacy and their power remains unused. Dormant stakeholders have little to no interaction with the project, but the project manager should be aware of their potential impact on the project since they might acquire a second attribute. Discretionary stakeholders possess the attribute of legitimacy, but have no power to influence the project and have no urgent claims. For project managers there is no pressure to engage in an interactive relationship with them. Demanding stakeholders have urgent claims but do not have the power to influence the project nor possess the attribute of legitimacy. When stakeholders are unable to move their claim into a position of more salient status, their urgency is insufficient to receive attention from the project manager. Dominant stakeholders have the power to influence the project and are legitimate. Any stakeholder who is both powerful and legitimate require the attention of the project manager. Dangerous stakeholders possess the attributes power and urgency, but have no legitimacy. These stakeholders can be coercive and violent, which makes them a threat to the project and therefore require attention from the project manager. Dependent stakeholders are characterized by the possession of urgency and legitimacy. They depend on other stakeholders’ power to carry out their will. They require less attention of the project manager, however when they acquire power they become definitive stakeholders. Stakeholders who belong to the ‘Definitive’ stakeholder class are those who possess all three attributes. When a stakeholder possesses power and legitimacy and has an urgent claim, the

Figure 3.3 Stakeholder classes (Mitchell et al., 1997)
project has immediate attend to the claim of this stakeholder. This makes definitive stakeholders the most important stakeholders there are (Olander, 2007; Mitchell, et al., 1997; Walker, et al., 2008).

Those stakeholders that may not have power to influence the project themselves, may be able to exercise influence through their connections and links with other stakeholders. Mapping and visualizing the stakeholders in conjunction with their relationships and issues provides insight into possible coalitions that are likely to form around the issues. An example of an Issues-Relationship Map is given in figure 3.4: the relationships between the stakeholders (A-G) are depicted by lines and the significance of these relationships can be shown by the relative weight of the connecting lines (Gilmour & Beillin, 2006).

A Problem-Frame Map (see figure 3.5) can be developed to identify the position or attitude of the stakeholders versus the project. This map is useful to identify potential coalitions that could develop around support for or opposition to the project (Bryson, 2004). Four possible categories can be defined: Weak Supporters, Strong Supporters, Weak Opponents and Strong Opponents. Particular attention needs to be given to those stakeholders in the right-hand quadrants, since those stakeholders can boost the project or hinder the projects (Gilmour & Beillin, 2006).

Bryson (2004), Eskerod & Jepsen (2013) and Newcombe (2003) combine power with interest to map stakeholders (see figure 3.6). The interest axis measures the significance of the project to the
stakeholder. Interest can be economical, political, cultural, scientific or technical, and it is likely a combination of those. The power axis measures the level of influence that the stakeholder has on the project. Stakeholders are placed on the matrix relative to each other. Four categories can be distinguished: Subjects, Crowd, Players and Context setters. ‘Subjects’ are the stakeholders with low power, but have a high interest in the project. Depending on interest (negative or positive) management could try to encourage or neutralize a group of stakeholders. The ‘Crowd’ is those stakeholders with low power and low interest and can be seen as potential rather than actual stakeholders. The attention should be focused on the ‘Players’ and the ‘Context setters’ according to Ackerman & Eden (2011). ‘Players’ are those with a high degree of power and high interest in the project. ‘Context setters’ also have the power but they have a low interest in the project. Both groups have the possibility to influence the future of the project (Ackermann & Eden, 2011). Those stakeholders that fall under the category ‘Players’ are clearly critical to the success of the project. Those stakeholders with high interest and low power level are however also important to the project since, through alliance, they may be able to exercise greater influence. The same goes for the stakeholders with high power level and low interest.

![Power vs Interest Map](Newcombe, 2003)

**Stakeholder engagement**

Stakeholder engagement is the process by which the project involves the identified and analyzed stakeholders. The insights gained by assessing the stakeholders can be used to identify the role of each stakeholder in achieving project objectives and to determine how to involve them in the project. Through implementation of an appropriate participation level, stakeholders are aligned to projects’ desired outcomes (Gilmour & Beillin, 2006). There are five levels of participation described by Luyet et al (2012): Information, Consultation, Collaboration, Co-decision and Empowerment. In the participation level “Information” the only action performed is to inform the stakeholders about a particular decision made. In “Consultation” the issue(s) is presented to the stakeholders individually, their suggestions noted, and then make decisions made. “Collaboration” is the presentation of the issue(s) to the stakeholders in a meeting, collecting their suggestions and basing the decision-making on the input of the stakeholders. The next level of participation, “Co-decision”, is involving the stakeholders in the decision-making process. The issue(s) and the boundaries within which the decisions must be made are presented during a meeting. The objective of the meeting is to get an agreement on the issue(s). “Empowerment” is the fifth and final level of participation, which consist
of stakeholders making the decisions within prescribed limits, based on their diagnosis of the problem and developed alternatives (Luyet, et al., 2012). The outcome of the stakeholder assessment does not make explicit how to manage stakeholders or how to determine the degree of participation, but provides better insights into the stakeholders. This insight can help the project manager determine required participation levels.
3.1.4 Essential project characteristics

When you perform stakeholder management in projects, you need to take a number of project characteristics into consideration.

The project organization

A project is a temporary organization created by its base organization to carry out an assignment on its behalf (PMI, 2004). A project is therefore an undertaking approved by a permanent organization, and the members of the project organization act on behalf of this organization. The base organization delegates authority and responsibility to the project organization. The members of the project organization are expected to execute and accomplish the project in ways that create benefits for the base organization. As project team members they serve the base organization and have the common interest in successfully realizing the project (Eskerod & Jepsen, 2013). Project stakeholder management therefore focusses on the interaction between the project organization and its environment, the external stakeholders (Bourne & Walker, 2005; Olander, 2003). The project manager, the person responsible for accomplishing the project, typically performs stakeholder management in conjunction with others; for example the project team members. The project team members provide the project manager with valuable information about the stakeholders and their environment (Walker, et al., 2008).

A temporary and unique process

The project is a temporary organization. It has an explicit starting point an ending point, a certain time span, a time before the project (pre-project), and a time after the completion of the project (post-project). The project life cycle covers the time during which the project is undertaken (figure 3.7). When doing stakeholder management it is important to consider the whole project life cycle when you assess who will be stakeholders of the project, including people who will be involved after the project is ended (Eskerod & Jepsen, 2013).

In the project formulation phase, the project is set up and the scope of the project is determined. In this phase the project manager will perform the first stakeholder analysis on which he will base further activities and interaction with the key stakeholders. In the project planning phase, the project manager will further identify and analyse stakeholders. You map the stakeholders and determine how to involve each stakeholder during the project. During the execution phase the project manager will be working to sustain all the relationships with stakeholders. In the close-out phase the involvement of the stakeholders will be dissolved and the stakeholders’ role in the project disengaged (Eskerod & Jepsen, 2013). During the course of the project stakeholders involved in the project change (Reed, et al., 2009). This means that the project manager needs to be aware that the composition of project stakeholders change over the course of the project and that he must frequently repeat the stakeholder management process steps.
Every project has some elements that are unique. Some projects are very similar to one another, while others may have many new elements. Construction projects may be virtually identical, but they differ in construction techniques, challenging environments, firm deadlines, and how to approach stakeholders. A project with many unique elements may have to start from scratch on a number of issues, which makes it hard to transfer knowledge from previous projects. The nature of the projects means that most of the project stakeholders change from project to project. This makes it difficult for the project manager to identify all of the stakeholders in the project, work out their interests and how to involve them to ensure project success. The more new issues and stakeholders, the more important it is to allocate time for analytical and well-structured processes for stakeholder management involving more people.

**Project complexities**

Since every project is unique, every project has different project complexities. Project complexities can be divided into technical, organizational and environmental complexities. Here environmental complexities referred to stakeholders involved, their interest and the risks and consequences of the project in relation to its environment (Bosch-Rekveldt, et al., 2011). Three elements concerning stakeholder management are defined that contribute to project complexity: number of stakeholders, variety of stakeholders’ perspectives, and dependencies on other stakeholders. These three elements can be used to assess the complexity of engineering projects concerning stakeholders, and subsequently adapt the stakeholder management process in order to better allocate management attention (Bosch-Rekveldt, et al., 2011; Eskerod & Jepsen, 2013). For example when the variety of stakeholders’ perspectives is high, the number of stakeholders is significant and the success of the project highly depends on other stakeholders, it is important to allocate more time and effort to stakeholder management than when the variety of perspectives is low, only a few stakeholders are involved and the success of the project does not depend on others.


3.1.5 Stakeholder management conclusion

Through a review of existing literature this theoretical framework provides an understanding of the use of stakeholder management and the essential elements of the stakeholder management process. In every project, various stakeholders are involved during the project life time. Some are involved with the realization of the project, while others are only indirectly involved by the developed construction. All stakeholders have an interest in the project and may contribute and share their knowledge and expertise to support or hinder the project (Atkin & Skitmore, 2008; Bourne, 2005; Olander, 2003). The structured process of identifying stakeholders, assessing them and determine the level of involvement is known as stakeholder management.

A project cannot be successfully accomplished without considering and dealing with the project stakeholders. It is necessary to figure out who can affect or who will be affected by the project – Stakeholder identification, how they contribute to the project and whether and why they contribute as they do – Stakeholder assessment, and how they need to participate in the project – Stakeholder engagement (Eskerod & Jepsen, 2013). To do so, various stakeholder analyses should be performed during the course of the project. Based on various scholars a stakeholder management framework was developed which comprises those analyses. The first step in the stakeholder management process is the identification of all possible stakeholders. A first distinction can be made between internal and external stakeholders (Olander, 2003; Bourne, 2005). After identification of both internal and external stakeholders, the stakeholders are assessed. First, a preliminary analysis of the stakeholders provides the project with essential information on stakeholders’ interests, power, role, issues, interrelationships, and attitude towards the project. Second, based on this analysis, various stakeholder management maps can be developed. The last step in the stakeholder management process is to determine the participation level of each stakeholder. Five levels of participation are determined: information, consultation, collaboration, co-decision and empowerment. A high level of participation is recommended when the client depends on other stakeholders or when local support is required. The project stakeholder management process thus consists of two types of activities: conducting analyses to provide the information about the involved stakeholders, and based on the results of these analyses, determine the required participation level. This stakeholder management framework can be used by project manager to analyze project stakeholders and determine the desired level of involvement during the project.

There are a number of project characteristics which need to be considered when performing stakeholder management. A project is a temporary organization to carry out a predefined assignment on behalf of the base organization. The appointed project manager, who is responsible for the realization of the project, is in charge of the stakeholder management process. In consultation with the project team, the project manager determines how to interact and involve the stakeholders into the project. Stakeholder management starts at the beginning of the project life cycle, the project formation phase, and ends at the close down phase. During the project life cycle the stakeholder management process needs to be repeated frequently since the composition of stakeholders might change over the course of the project. Every project is also unique, which makes it hard to transfer knowledge from previous projects, especially the knowledge gained from stakeholders since stakeholders change from project to project. Three project characteristics can be defined as elements which contribute to project complexity: variety of stakeholders’ perspectives, number of stakeholders, and dependencies on other stakeholders. These elements can be used as indicators to determine to what extent stakeholder management should be performed.
3.2 Virtual Design & Construction

Central to this research is the newly developed method Virtual Design & Construction. This section examines the general concept of this method and the integration of stakeholders in the design-construction process. This section will provide answer to sub-research question 2:

*What is the use of the method Virtual Design & Construction and how do stakeholders participate in an integrated design-construction process?*

3.2.1 Introduction to Virtual Design & Construction

The AEC industry is characterized as being fragmented, phased and iterative, which lead to a time-consuming and costly design-construction process (Alashwal, et al., 2009; Wood, et al., 2013). Successful completion of a construction project depends on the communication and collaboration between the multidisciplinary stakeholders (Becerik, 2004). Companies and research institutions undertake a multitude of initiatives to increase the performance of the design-construction process (Farinha, et al., 2007). These initiatives mainly focus on the integration and collaboration of stakeholders (Churchill & Thoren, 2009; Farinha, et al., 2007). Two of the most important strategies developed in recent years are the Integrated Project Delivery (IPD) and the tool Building Information Modeling (BIM).

**Integrated Product Delivery**

As projects became more complex, contracts were developed between different project participants to define their responsibilities and to protect the individual team members against risks. Resulting in two traditional project delivery models: the design-bid-build and the design-build models. These delivery models created tense relationships among the owner, architect and contractor, as they transfer possible risk between one another (Bongiorni, 2011). This developed an atmosphere of fear and distrust among the key project participants, resulting in a shifted focus of the individual participants by valuing their own interest and profit above the common goal of completing the project together. In an attempt to counter this process and improve the design-construction process, the American Institute of Architects (AIA) introduced a new contract form called Integrated Project Delivery, IPD, which is a formal collaborative agreement (Thoren & Churchill, 2009). IPD is described as “a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication and construction” (AIA, 2007). The integration between the team members is reached through agreements and contracts as well as through methods, which define and measure project goals (AIA, 2007). IPD is built on collaboration between stakeholders. The focus is on collectively achieving shared goals and not on achieving personal goals. Project success is based on the achievement of the common goals (Churchill & Thoren, 2009). In an integrated project, the decision making process is improved due to the increase of knowledge and expertise of the involved participants. Decision making takes place in the early stages of the project, where the informed decisions have the greatest effect, resulting in an early involvement of all key participants in the beginning of the project (Bongiorni, 2011). As a result of the increased integration and collaboration between the different disciplines and an increased amount of design effort during the design phase, IPD has the potential to save project time, money and ultimately avoid litigation (AIA, 2007). IPD focuses on collaborative business structures and technological systems and recommends the use of Building Information Modeling (Bongiorni, 2011).
Building Information Modeling

In the last 15 years, design tools have been improved in the AEC industry from 2D modeling to 3D modeling. With the emergence of the computer, CAD was developed as a new 2D design tool. The technology developed from 2D to 3D simulations which considerably improved the design process. Beyond 3D modeling, Building Information Modeling (BIM) emerged as a new powerful technology (Yan & Damian, 2007). Building Information Modeling (BIM) is a digital three dimensional model which is linked to a database containing all the project information and is one of the recent and rising trends regarding innovative tools in the AEC industry (Monteiro, et al., 2014). With BIM, multiple virtual models of a building can be digitally constructed to support the design through its phases. The computer-generated models contain all the information and data needed to support the planning, design, construction, fabrication and procurement processes of a building project (Eastman, et al., 2011). It helps the architects, engineers and constructors to visualize every phase of the project and to identify potential problems in design, construction or operation (Azhar, et al., 2007). The primary purpose of BIM is to visualize the end product. Current BIModels are however capable of integrating and processing more information, resulting in a BIModel for multiple usages, such as clash detection, automatic design drawing generation, material takeoffs, construction schedule planning, etc. BIM is a unique way to integrate information directly into the design schematic (Monteiro, et al., 2014).

Virtual Design & Construction

In BIModels, projects normally do not model, visualize or analyze the organization and the processes of the project accurately and effectively. Methods to manage and communicate multidisciplinary information and processes lag behind (Kunz & Fischer, 2012). Virtual Design and Construction (VDC) contributes to this gap by creating a framework and a set of methods to manage the project, including those aspects which can be designed and managed, which are the building, the design-construction process and the organizations that follow the design, construction and operations (Kunz & Fischer, 2012). VDC was introduced in 2001 by the Center of Integrated Facility Engineering (CIFE) at Stanford University (Kunz & Fischer, 2012) and is defined as; “The method of Virtual Design and Construction is the use of multidisciplinary performance models of design-construction projects, including the Product, Process and the Organization of the design, in order to support business objectives” (Kunz & Fischer, 2012). VDC allows project participants to build models of the product, organization and the process (POP) early on in the project lifecycle before any large commitment of time and money is made. With the use of virtual models, VDC supports the description, explanation, evaluation, prediction, alternative formulation, negotiation and decision about the product, organization and process (Khanzode, et al., 2006). The product, organization and the process are the three main components in every design-construction process (Khanzode, et al., 2006; Kunz & Fischer, 2012). In the VDC process these components are made visual and measurable with the use of models, drawings and simulations. A crucial role in the development of these models, drawings and simulation is the input generated by the different stakeholders (Kunz & Fischer, 2012). An integrated delivery method, such as proposed by AIA, is therefore desirable.
3.2.2 Principles of Virtual Design and Construction

Virtual Design and Construction consists of several characteristics. The first characteristic is the use of Virtual models. Virtual models are computer based, flexible, visual and interactive (Kunz & Fischer, 2012). Paper documents can provide a high-end description of project elements including a lot of information about the designs and plans. Paper based documents however hinder the collaboration between the different disciplines and simple changes require hours of rework. Therefore, VDC models are computer based. The visualization of the models makes the content of each model accessible for all the different disciplines and stakeholders. Interaction between the different stakeholders is enhanced by the projection of the models on multiple screens (Kunz & Fischer, 2012). VDC is designed to support the multidisciplinary project teams, which consists of various disciplines, such as architects, engineers, contractors and client. Due to the multidisciplinary nature of the project teams, design processes are fragmented. To support the collaboration and coherence between the disciplines, VDC aims to integrate product, organization and process (Kunz & Fischer, 2012). VDC models are performance based models, which implies that the project objectives are determined in advance and can be measured and checked during the process. Performance indicators have to be identified and measured during the process to monitor the progress and to intervene when necessary (Kunz & Fischer, 2012). The POP metrics are used in the VDC method to measure the performance of the design, supported by the POP visualization. As shown in figure 3.8, the VDC spectrum consists of various POP models and methods. Various models and methods can be used in the spectrum of VDC, such as BIM, System Engineering (SE) and the use of the iRoom. The iRoom is given a central role in the VDC process. This room is specially developed for the process of Integrated Concurrent Engineering (ICE). The ICE process supports the interaction in terms of communication and collaboration among stakeholders (Garcia, et al., 2003).

![VDC spectrum](image_url)

*Figure 3.8 VDC spectrum (Royal HaskoningDHV, 2012)*
Visualization of POP

An important component of VDC is the visualization of the product, organization and the process. Traditionally, the AEC industry focuses only on the visualization of the product, resulting in technologies such as CAD and BIM (Yan & Damian, 2007). Kunz and Fischer (2012) mention that the modeling, visualizing and analyzing of the organization and the process is equally as important as of the product to successfully execute the project. Visualization is the most effective way for stakeholders to clearly express themselves and to understand and analyze the work of others (Kunz & Fischer, 2012). Therefore, Kunz and Fischer (2012) argue that it is important to visualize not only the product, but also the organization and the process. To make the visualization more flexible and interactive, the visualizations are solely virtual and computer based.

**Visualization of the product**

The visualization of the product is the representation of the end product: the building. These visualizations contain the components and systems of the building, such as floors, walls, beams, and equipment. Traditionally drawings of the product are a set of lines, which the producer of the drawing interprets as elements and components of the building. These models are in 2D and difficult to understand for those who are not educated in reading these technical drawings. With the modern 3D models, the drawing is built by using “objects” that the computer recognizes as physical elements, such as doors, columns and beams, which will appear in the users interface as meaningful visual representations of the elements (Kunz & Fischer, 2012). According to Kunz and Fischer (2012) most stakeholders find interactive 3D models more understandable than 2D static drawings. The visualization of the product can be used in collaborative design sessions to improve the communication and trust between stakeholders and enables enhanced decision making. It even helps to overcome language barriers in projects with stakeholders who speak different languages (Kunz & Fischer, 2012). Per discipline multiple visualization models may be developed (see figure 3.9) in order to quickly identify and resolve system conflicts, resulting in cost savings and avoiding months of potential delays (Yan & Damian, 2007).

![Figure 3.9 Visualization of various designs in BIM](image-url)
Visualization of the organization

The visualization of the organization is a representation of the organization involved in the design-construction process of the product. The organization consists of multiple actors from different disciplines, such as architects, engineers, contractors, and suppliers. Stakeholders, like the client, end-user(s), and governmental organizations, are part of the visualization of the organization. The organizational model represents all the parties involved in the design-construction process with their responsibilities and tasks to develop the project. Kunz and Fischer (2012) also suggest using organizational models to resolve latency, involve organizational design and management in an early stage, by documenting the organization in such a way that all stakeholders understand the organization, organizational backlogs and to predict direct and hidden work.

Visualization of the process

Strongly related with the visualization of the organization is the visualization of the process. The process visualization represents the process the organization follows to evolve the product. It represents the in advance defined milestones, deliverables, activities, actions and tasks to develop the project (Kunz & Fischer, 2012). The process is visualized in a process diagram, which includes all the elements of the process including the tasks’ interdependencies and deadlines. Combining the process and the organizational visualizations, multiple types of relationships are established and made explicit (Kunz & Fischer, 2012).

Figure 3.10 shows a simplified schematic visualization that combines the process and the organization. The links between the actors show the communication relationships. The links between the actors and their task show the responsibility of each actor, and the links between the tasks show the interdependencies among tasks. The purpose of visualizing the process and organization is to get better understanding and insight to indicate and prevent bottlenecks on forehand (Kunz & Fischer, 2012).

Figure 3.10 Visualization of schematic process and organization (Schrama 2011)
**POP metrics**

Besides the visualizing of the product, organization and the process, the VDC method imposes the use of POP metrics. Metrics are a set of parameters or measures which can be used to measure, compare or to track performance of the product, organization and process (Kunz & Fischer, 2012). Metrics are used by stakeholders to analyze the project’s status at any moment in the design-construction process to judge how well the project is progressing and to steer the process in the desired direction. POP metrics are placed in a POP model, which have different levels of detail (Kunz & Fischer, 2012). At the highest level of detail the model represents the function, scope and behavior of the product, organization, and process, as shown in table 3.4. Lower level POP models describe sub components and are more detailed. The first aspect of the highest level POP model, *function*, represents the requirements or objectives of the product, organization and process. These requirements or objectives originate from the Program of Requirements, regulations, stakeholders’ requirements and agreements with the design team. The second aspect, *Scope*, describes how the functional objectives are shaped. The last aspect, *behavior*, indicates how the scope reaches the objectives or requirements values (Kunz & Fischer, 2012).

![Table 3.4 POP model (Kunz & Fischer, 2012)]
3.2.3 Implementation of VDC

VDC can be seen as a new design-construction method wherein Kunz and Fischer shapes the lines of the method, but does not deliver standardized visualizations, metrics or design steps (Kunz & Fischer, 2012). How the method is used depends on the needs of the individual project teams. Kunz and Fischer (2012) define a maturity model based upon the implementation of VDC by various users. Three phases can be distinguished with each its own value proposition and strategy.

Visualization and Metrics

The first phase is the visualization and creation of the models of: the product in 3D, the organization and the process the project follows. The performance metrics that are predicted by the project participants are based on the models and tracked during the process. In this first phase most of the elements of the product, organization and process are modelled and visualized based on the input from the involved stakeholders. Information and data sharing is necessary between the stakeholders for a complete model (Kunz & Fischer, 2012). Due to the involvement of multiple stakeholders, more than in the traditional approach, it is important to clarify the project objectives, values, responsibilities, design and expectation at the beginning of the process.

Integration

In the second phase, the POP models become integrated. Computer-based methods are developed to exchange data among models and applications. Building Information Modeling is such a method, which means that data and information from one model can be exchanged with other models. For integration to work, stakeholders have to collaborate in information and data sharing and agree on the exchange standards (Kunz & Fischer, 2012).

Automation

The last phase is the automation phase, wherein the project uses automated methods for routine design tasks. With automation, less time and effort is spent on the routine tasks, allowing more focus on high-value design and analysis. It facilitates a decrease in construction duration and an increase in design efficiency and effectiveness. Automation needs strong integration of the different disciplines (Kunz & Fischer, 2012).

Figure 3.11 Implementation of VDC (Kunz & Fischer, 2012)
3.2.4 The integrated design process of VDC

With the use of multidisciplinary performance models, VDC tries to move the decision-making process in the design-construction process forward. The decision-making in the conventional design-construction process starts at the early beginning of a project. In the traditional design workflow, the process starts with a small design team and over time the actors involved, the information available and the effort increases (the **black line** in figure 3.12). The ability to change a design is high at the beginning of the process and decreases as the project proceeds (**blue line**). As more of the design is documented, changes become more difficult and costly (**red line**). The costs of design changes are therefore low at the beginning and increase gradually (PMI, 2004). Early decision-making is desired in order to keep the costs low. In the conventional design-construction process the effort is at its maximum at construction documentation. During the procurement phase, the effort is greatly reduced and finally a small effort is expanded during the construction phase (Koo, et al., 2010). With the integrated approach, VDC intends to move the decision-making process forward in time. By moving the decision-making process upstream as far as possible, the decisions become less costly and more effective (**green line**) (AIA, 2007).

![Macleamy Curve](image)

**Figure 3.12 Macleamy Curve (AIA, 2007)**

In order to move the decision-making process forward in the design-construction process, more effort is required in an earlier stage of the process. More effort in the beginning of the process implies earlier input and integration of stakeholders who are traditionally involved later in the process. To facilitate this, VDC supports early involvement of stakeholders in the design process, and supports the integration by forming multidisciplinary integrated project teams and facilitates integrated concurrent engineering sessions in the iRoom (Kunz & Fischer, 2012).

**Early stakeholder involvement**

The conventional design process consists of five distinct phases: research phase, programming phase, schematic design phase, design development phase and the construction documents phase. After the design process the construction phase starts in which the construction parties are assigned to realize the designed construction. The various process phases and the moment of participation per stakeholder are shown in figure 3.13. In the conventional design process the client starts, in cooperation with an architect, with the outline of the project in the research phase, followed by the development of the Program of Requirements in the programming phase, in which the objectives,
conditions and limits of the project are defined (AIA, 2007). In the subsequent design phases the design develops from a rough sketch in the schematic design phase to multiple detailed designs of each subsystem by various design consultants. When the various design phases are completed the construction parties take over and start with the realization of the project.

![Figure 3.13 Involvement of stakeholders in the conventional design-construction process (AIA, 2007)](image)

The parties involved are the client, architect, project manager, design consultants, building contractors, suppliers, and authorities. It can be noted that there is no involvement of external stakeholders in the design-construction process. From figure 3.13 can also be derived that the construction parties are only involved during the realization of the construction and do not participate in the design process.

VDC supports early involvement of the stakeholders in order to deliver input for the multidisciplinary performance models. This results in a redefinition of project phases and participation of stakeholders. Figure 3.14 presents the preferred moment of involvement of stakeholders in the design-construction process.

![Figure 3.14 Involvement of stakeholders in an integrated design process (AIA, 2007)](image)
The first four stages are redefined into: conceptualization, criteria design and detailed design. In comparison to their conventional counterparts: research, programming, schematic design, and design development, these stages are more interwoven and involve more effort in order to develop the required multidisciplinary performance models on a high level (AIA, 2007). To develop these models on a high level, knowledge and expertise is required, which is scattered over various stakeholders. Early involvement and input of stakeholders is therefore essential. Design consultants are involved earlier to deliver specific information about their field of expertise. The construction parties are involved half-way through the criteria design phase to deliver information about constructability, specific construction cost, delivery time, energy efficiency, and construction planning (Churchill & Thoren, 2009). Since the use of 3D-models and visuals in the VDC process, the end-user(s) is more able to understand the design and therefore can be actively involved in the development of the design and implement their requirements into the design from the conceptualization phase onwards.

**Multidisciplinary integrated project team**

In the conventional design process, the process often begins with the architect and client agreeing on the design concept. During the course of the project design consultants are asked to implement the design and to suggest appropriate systems. When the design is ready, the construction parties take over and reconstruct the design into design working documents. This process has a mainly linear structure due to the successive contribution of the parties (Evbuomwan & Anumba, 1998). This process can result in several disadvantages. First, design flaws may not be recognized until the actual realization of the construction has begun. This can lead to redesign or design modification during the construction phase that impacts the productivity, lead-time and project costs (Veeramani, et al., 1998). Second, since less flexibility is available for redesign and design modifications during the construction phase, less optimal design changes are made to overcome the construction problems that can result in longer-term problems (Veeramani, et al., 1998). For example, a building consists of multiple subsystems which need to be placed within the available space. Due to the complexity of each subsystem, each is designed sequentially by various disciplines from different organizations, which often lead to conflicting space requirements or difficult-to-construct configurations. The tendency is to make local modification during the construction, which solves the immediate construction problem but may create longer-term issues regarding performance and operating costs (Veeramani, et al., 1998). Integration of the various disciplines is required in order to resolve these issues.

VDC therefore supports the use of multidisciplinary integrated project teams. The team brings together multiple disciplines with various project skills, expertise and knowledge and removes the traditional barriers between those disciplines thus supporting inter-disciplinary work between design parties and construction parties. This team comes together with the common overriding goal of designing and constructing a successful project. They are responsible for the success and failure of the design and construction of the project, however remaining individually responsible for his or her defined work scope (AIA, 2007). According to Baiden, et al (2006), a project team is fully integrated when it: has a single focus and common objectives for a project, operates without limitations of involved organizations, shares achievements throughout the team and members support each other, shares information freely among its members such that access is not restricted to specific disciplines and organizations, and operates in an atmosphere where relationships are equitable. The composition of a multidisciplinary integrated project team depends on the involved internal stakeholders and may include: the client, end-user(s), architect, design manager, various design consultants, construction contractors, suppliers and the operation & maintenance team (AIA, 2007;
The team members are selected based on their ability to contribute to the product, organization and process of the project by identifying possible issues as early as possible in the design process. The success of the project team relies on the participation of its members and on the open sharing of knowledge and expertise. Therefore a high participation level is required from all involved parties (AIA, 2007; Luyet, et al., 2012). The role of the team members slightly change due to the integrated design process. The client and the end-user(s) take a more active role in evaluating and influencing design options. In addition, the client is required to participate in establishing project metrics at an earlier stage than usual, will be more involved in project-related specifics and will be required to act adequately and quickly to allow the project to continue efficiently (AIA, 2007). The project manager takes a more active role as an independent design facilitator. The designers are required to perform design services in an earlier stage, which are traditionally performed later. The construction parties’ role is primarily affected by the early involvement in the design process. They are brought into the design process early to provide expertise and strategic services such as cost estimates, time schedules, and constructability reviews (AIA, 2007).

**Integrated concurrent engineering (ICE)**

In order to support the integration of the different disciplines involved in the various phases of the design process, the VDC method suggests the use of Integrated Concurrent Engineering (ICE) in the iRoom. NASA (National Aeronautics and Space Administration) developed a project development method, Extreme Collaboration (XC), to design complex and highly reciprocal interdependence task oriented projects rapidly (Garcia, et al., 2003). The goal of XC is to create a project solution for a standard problem specification in a short amount of time instead of the usual 6-12 months. By increasing face-to-face meetings, share knowledge and data, and open and transparent decision-making, misconceptions and misunderstandings that lead to rework is reduced (Garcia, et al., 2003). Researchers now call this method *Integrated Concurrent Engineering (ICE)* and Kunz & Fischer (2012) adopted the ICE method as a basis for the collaboration and integration of the stakeholders. The idea of the ICE method is to group different disciplines who’s tasks are reciprocal-dependent, in multiple design meetings. In order to facilitate such meetings an interactive room, called the iRoom is used. This room is especially designed for ICE sessions and consists of multiple interactive screens. The interactive displays support the team members to explain and evaluate their models and ideas, and to formulate alternatives in front of the other participants (Kunz & Fischer, 2012). Different disciplines from different organizations and with various backgrounds collaborate at the same time in one place, which makes the design sessions integrated and multidisciplinary. Combining the several disciplines and discussing the product, organization and process of the project together will trigger the team members to think beyond their own field of expertise, resulting in a broader supporting design process (Kunz & Fischer, 2012). In essence, ICE is a method to effectively integrate all aspects required to develop the design models by performing simultaneously a variety of activities that in the conventional design process are done sequentially (Love, et al., 1998).
3.2.5 Conclusion Virtual Design and Construction

The literature review provides an understanding of the use of the method Virtual Design & Construction (VDC) and how stakeholders are involved in the integrated design-construction process.

VDC is a new design method, developed by Kunz & Fischer, to increase the efficiency of the design-construction process. VDC focuses on three main components, which are present in every design-construction process: the product, the organization and the process. With the use of integrated multidisciplinary performance models these components are made visual and measurable. Visualization of the product, organization and process are the most effective way for stakeholders to clearly express themselves and way for them to understand and analyze the work of others. Metrics are used to analyze the project’s performance at any given moment in the design-construction process to judge how well the project is progressing and to steer the process in the desired direction.

In the early stages of the design-construction process it is easy to change the design and the costs of design changes are low. By shifting the design effort forwards the design decisions become less costly and more effective (AIA, 2007). In order to shift the design effort forwards and in order to develop the multidisciplinary performance models, an integrated design process is required (Kunz & Fischer, 2012). In an integrated design process, stakeholders, which are involved with the design and construction of the building, are involved at an earlier stage of the design process than in a conventional process. To realize an integrated design process the use of a multidisciplinary integrated project team is required (AIA, 2007). The composition of such a multidisciplinary integrated project team varies from project to project and depends on the contribution that each participant makes to the project. It can be noted that these project team members are all internal stakeholders. The participation of external stakeholders in the integrated design process is not addressed in the literature and therefore it seems that external stakeholders do not actively participate in the integrated design process.

The multidisciplinary character of the project team provides the project with a wide range of expertise and knowledge, which makes the design models more accurate and detailed. The whole team is responsible for the success and failure of the project, which encourages the collaboration between team members and gives an incentive to strive to achieve the common project goal instead of individually defined objectives (Baiden, et al., 2006). The success of the project team relies on the participation of its stakeholders. To support the participation of stakeholders VDC suggests the use of Integrated Concurrent Engineering (ICE) (Kunz & Fischer, 2012). With the ICE method, all activities that are required to develop the design models are simultaneously performed with the support of the iRoom. With the integration of the involved stakeholders the multidisciplinary performance models can be brought to a higher level of detail in an earlier stage of the design process, which provides the ability to make design decisions earlier in the design-construction process. By moving the decision-making process forward in the design process, the decisions and design changes become less costly and more effective (AIA, 2007; Kunz & Fischer, 2012).

From the literature it can be concluded that the VDC method stimulates the early engagement of internal stakeholders in order to develop the multidisciplinary performance models at an early stage in the design-construction process. With the introduction of “A multidisciplinary integrated project team” and the “ICE method” the collaboration and involvement of the stakeholders changes. They are required to take on a more active role in an earlier stage of the design process, which implies that they work together as a team to achieve common goals instead of working separately and sequentially with the focus on individual tasks and objectives.
Chapter 4 STAKEHOLDER MANAGEMENT BY PROJECT MANAGERS

The previous chapter elaborated on the literature of stakeholder management, Virtual Design and Construction and the participation of stakeholders in the integrated design process. Based on the theoretical framework interviews were conducted with project managers of Royal HaskoningDHV in order to determine how project managers perceive stakeholder management and how they perform stakeholder management. This chapter presents the results of these interviews and gives answer to the third sub-research question:

*What do project managers understand by stakeholder management and how do they perform stakeholder management?*

### 4.1 Research method

Through a series of interviews with project managers of Royal HaskoningDHV the perception on stakeholder management and how they perform stakeholder management is studied and determined based on the theoretical framework from chapter 3.

#### 4.1.1 Instruments and perspectives

The perception and the performance on stakeholder management at Royal HaskoningDHV has been researched through a series of interviews with project managers. This has not only the purpose to make conclusions on the way stakeholder management is performed but also to identify differences between two business lines: Buildings and Infrastructure. From this analyses the effectiveness and usefulness of stakeholder management in the VDC process could be examined from the perspectives of the project managers. On the basis of these interviews results possible recommendations for further improvement of the stakeholder management process could be derived.

A qualitative interview method is used. The main task is to get an understanding of how stakeholder management is used and the underlying thoughts behind it. A combination of standardized open-ended questions and closed fixed-response questions were asked in an open face-to-face meeting with the project manager. Standardized open-ended questions are asked to get an understanding of the perception on stakeholder management and closed fixed-response questions to determine how project managers conduct stakeholder management. The same questions are asked to all interviewees based on applicability.

A total of eleven interviews were executed with project managers from the business line ‘Buildings’ and ‘Infrastructure’. According to Royal HaskoningDHV the business line ‘Infrastructure’ is a step ahead of ‘Buildings’ with the implementation of stakeholder management in VDC projects. As this may give interesting insights into stakeholder management in the Royal HaskoningDHV environment, project managers from both business lines are interviewed. From both business lines project managers are selected who have experience with the VDC method. Table 4.1 presents the selected interviewees.

Seven of the eleven interviewees are VDC certified, which indicates that they have completed a seven day course on VDC given by Professor Martin Fischer from Stanford University. Some of them are part of the VDC knowledge group which align and further develop the VDC method within the company. Nine of the eleven interviewees have indicated that they actually applied VDC in practice.
4.1.2 Analytical framework

In order to interview the project managers in the same manner and to make results comparable an analytical framework is developed. The framework consists of two parts as presented in figure 4.1.

First the understanding of the project managers on stakeholder management is examined. The project managers are examined on their understanding of what a stakeholder is and the content of the stakeholder management process. Second their performance on stakeholder management is examined by elaborating on the four stakeholder management process steps: identifying stakeholder, analyzing stakeholders, mapping stakeholder, and determining stakeholder participation. This will provide insight into the manner of how stakeholder management is performed in a VDC process and if there are differences with the conventional design process.

Since project managers from the business line ‘Buildings’ and ‘Infrastructure’ are interviewed, differences and similarities can be indicated and lessons learned can be derived. Per step various questions were asked in order to obtain the required information. The complete interview framework is presented in Annex I.

Table 4.1 Interviewees

<table>
<thead>
<tr>
<th>BUSINESS LINE</th>
<th>PRIMARY FUNCTION(S)</th>
<th>VDC EXPERIENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM A</td>
<td>Buildings</td>
<td>Project manager, VDC advisory</td>
</tr>
<tr>
<td>PM B</td>
<td>Buildings</td>
<td>Project manager</td>
</tr>
<tr>
<td>PM C</td>
<td>Buildings</td>
<td>VDC advisory</td>
</tr>
<tr>
<td>PM D</td>
<td>Buildings</td>
<td>Project manager, VDC/BIM advisory</td>
</tr>
<tr>
<td>PM E</td>
<td>Buildings</td>
<td>Project manager</td>
</tr>
<tr>
<td>PM F</td>
<td>Buildings</td>
<td>Project manager</td>
</tr>
<tr>
<td>PM G</td>
<td>Buildings</td>
<td>Project manager, structural designer</td>
</tr>
<tr>
<td>PM H</td>
<td>Infrastructure</td>
<td>Project manager, Head Rail advisory</td>
</tr>
<tr>
<td>PM I</td>
<td>Infrastructure</td>
<td>Project manager</td>
</tr>
<tr>
<td>PM J</td>
<td>Infrastructure</td>
<td>VDC advisory</td>
</tr>
<tr>
<td>PM K</td>
<td>Infrastructure</td>
<td>Head Infrastructure advisory</td>
</tr>
</tbody>
</table>

Figure 4.1 Analytical framework
4.2 Research results

This section presents the results of the interviews that were conducted with the project managers from the business lines ‘Buildings’ and ‘Infrastructure’. The summary of the results are displayed in various tables per interview step. The icons from the table on the right are used in the tables to indicate the perception and performance of the interviewees on the questioned subject.

4.2.1 Understanding of stakeholder management

In the literature review conducted in chapter 3 we have seen that there are various views on the definition of stakeholders and the stakeholder management process. This section presents the interview results of the different perceptions on stakeholder management.

Definition of a stakeholder

Project managers with different backgrounds have varying views on what a stakeholder is. In the following table the different definitions given by the project managers are presented.

The table shows that there are minor differences in the definitions formulated by project managers. Some make a distinction between stakeholders directly, while others also indicate that a stakeholder must have some sort of influence or must be influenced by the project. The project managers all indicate that a stakeholder can be a single person or a group. Some directly make a distinction between stakeholders, while others maintain a broader view. However, all definitions tend towards the broader definition defined in the literature framework. The broader view gives the possibility to identify all possible stakeholders, who are involved during the complete life cycle of the project, at the beginning of the project. This way the possibility is reduced that an important stakeholder is not identified.

Stakeholder management process

Stakeholder management is a broad concept and as we have seen in the literature various processes and steps can be identified. In chapter 3 the different processes are ordered and grouped into three processes: identification, assessment, and engagement. The following table presents the results of the different perceptions of the project managers on the stakeholder management process and indicates if they perceive stakeholder management as a stepwise process.

The results show a slight variety in perceptions on the stakeholder management. The majority of the project managers have the perception that stakeholder management is a process to gather understanding of the involved stakeholders, which is used in order to involve stakeholders in the right way and at the right moment in time. Some of the project managers emphasize the importance of obtaining the required input from the stakeholders to successfully complete the project. Most of the perceptions are close to the formulation of stakeholder management as derived from the literature. This indicates that the project managers have a proper understanding of what stakeholder management entails. They understand the importance of stakeholder management and understand how to perform stakeholder management. However, there are some differences between the business lines ‘Buildings’ and ‘Infrastructure’. The answers given by the project managers of the business line ‘Infrastructure’ are similar to one another and have a stepwise approach in which they all emphasize the importance of indicating the influence and interest of the stakeholders. The answers given by the business line ‘Buildings’, on the other hand, differ more from one another and do not indicate a structured stepwise approach. This suggests that the business line ‘Infrastructure’ has a more standardized, stepwise approach, which they perform more often than the project.
managers of the business line ‘Buildings’.

4.2.2 Performance on stakeholder management

The following section elaborates on how project managers perform stakeholder management; this is achieved by asking them how and when they perform stakeholder management. The stakeholder management process can be subdivided into three major elements, as explained in chapter 3, namely: stakeholder identification, stakeholder assessment and stakeholder engagement. Each element consists of several steps: identifying stakeholders, analyzing stakeholders, mapping stakeholders, and determining stakeholder participation.

Identifying stakeholders

The first step in the stakeholder management process is the identification of the project stakeholders. Table 3.4 presents a short summary of the answers given by the project managers on the questions related to whom they identify as stakeholders and how they identify them.

From the answers can be derived that there are a number of significant differences between the two business lines, namely who they identify as stakeholder and how they identify them. The project managers from the business line ‘Buildings’ make a distinction between internal and external stakeholders. Unfortunately what the project managers mean by ‘internal’ and ‘external’ stakeholders differs. When talking about internal stakeholders some project managers refer to their colleagues in the design team, while others refer to the complete project team and those stakeholders assigned by the client to realize the project, such as the architect, contractors and suppliers. The project managers from the business line ‘Infrastructure’ make a clear distinction between internal and external stakeholders. Internal stakeholders are those who are directly involved with the realization of the project and therefore part of the project team, while external stakeholders are those surrounding the project team. According to them, stakeholder management is about the interaction between the project team and its environment.

The majority of the project managers from the business line ‘Buildings’ argue that the identification of stakeholders is done once at the start of the project in consultation with the client. Common stakeholders identified at the start of the project are: the client, end-user(s), local authority, architect, project manager and design consultants. It depends on the delivery model whether the contractor, suppliers and subcontractors are involved in the design process. The various disciplines, required for the realization of the project, are identified by the client and the project team is composed at the start of the project. The composition of the project team is formed by the project manager in consultation with the client based on the project objectives. The interviewees indicated that in most cases the project team consists of the architect, client, and required design consultants. Local authorities and end-user(s) are in most cases only informed and do not play an active role in the design process. Some project managers, from both business lines, do however argue that active involvement of end-user(s) is desirable to develop an integrated design.

In contrast to the project managers from the business line ‘Buildings’, the project managers from the business line ‘Infrastructure’ mainly focus on stakeholders who are not directly involved in the project. They indicate that they start the identification of stakeholders at the start of a project by composing a list in collaboration with the client. This list contains mainly stakeholders such as: nearby residents, environmentalists, water boards, local community, and interests groups. They argue that identification of stakeholders involves identifying those stakeholders who are not directly involved in the realization of the project but could influence or affect the project success. As one interviewee stated: “As project manager you can have a more direct influence on the behavior of the
internal stakeholders, since they are part of the project team; therefore you essentially identify external stakeholders, since they have other interests and influences on the project you cannot control”.

The answers given by the project managers from the business line ‘Buildings’ indicate that the identified stakeholders are mainly internal stakeholders who are directly involved with the realization of the design of the project. End-user(s) and local authorities are identified as external stakeholders. The project managers from the business line ‘Infrastructure’, on the other hand, identify stakeholders based on the project’s environment. They are external stakeholders who are not directly involved in the realization of the project. They first identify key stakeholders, which are subsequently involved to identify all other potential stakeholders. In the VDC process this is performed in one of the first kick-off meetings in the iRoom. With the use of the interactive screens a stakeholder list is composed in front of all present key stakeholders. In consultation with all key stakeholders the list is developed. This transparent and interactive way of identifying stakeholders results in a more complete stakeholder list at an earlier stage of the design process. This allows the project manager to involve stakeholders earlier in the design process if needed. All stakeholders are listed at the end of the session and the list is distributed amongst the key stakeholders so that they all know the involved stakeholders. This is in contrast to the project managers from the business line ‘Buildings’ who do not list the stakeholders or involve key stakeholders to identify other stakeholders. This indicates that there is a discrepancy in who is identified by the project managers and how they are identified.

Analyzing stakeholders

Once the stakeholders are identified a preliminary analysis of the stakeholders can be done. Basic information about the identified stakeholders is defined by analyzing each stakeholder, their relation to the project and to each other. Table 4.5 shows what the project managers in general define of each stakeholder.

From the table can be derived that all project managers from both business lines define the power each stakeholder possesses to influence the project, their stake in the project and the role they fulfill in the project. To understand possible coalitions and behaviors of stakeholders it is essential to define network relationships by determining formal and informal relationships between stakeholders (Ackermann & Eden, 2011). The project managers from the business line ‘Buildings’ indicate that informal relations are difficult to define and are not determined. Some project managers determine formal relations but only when the project organization consists of multiple stakeholders from one organization. The project managers from the business line ‘Infrastructure’ on the other hand always determine formally relationships. They argue that they have to deal with stakeholders who are not from the same organization but are formal related in the sense that they are government agencies. They agree that defining informal relationships is difficult but emphasize the importance of them. During the course of the project more and more information about stakeholders becomes available, revealing underlying informal relations. The interviewees argued that informal relationships are essential to determine the underlying motives of stakeholders and to obtain insights into possible coalitions.

All project managers from the business line ‘Infrastructure’ define the attitudes of stakeholders towards the project, while none of the project managers from the business line ‘Buildings’ define them. They do so because it reveals which stakeholders support and which may hinder the project and in combination with the defined relationships it reveals potential coalitions. Insight into who may support and who may hinder the project supports the project manager in the decision who to involve
in the process and how to approach them. Since none of the project managers of the business line ‘Buildings’ define the attitude of stakeholders towards the project this might indicate that there are no opposing attitudes towards the project and that all identified stakeholders are always in favor of the project. This could be the case when only internal stakeholders are involved since they have the common goal of realizing the construction and are in favor of the project right from the start of the project. An opposing position towards a building project could be expected from nearby residents or interests groups; however, they are not mentioned by the interviewees. Project issues are sometimes defined by the project managers from both business lines. They explain that at the start of each project a kick-off meeting is held with the client and key stakeholders. During the kick-off meeting possible project issues from the participants are addressed and discussed.

On the basis of the information obtained, a stakeholder analysis framework could be developed, which implies that the obtained information is processed and made explicit in a working document. Only two of the project managers from the business line ‘Buildings’ develop such a framework. They indicate that in most cases the amount of stakeholders is insufficient to compose a list or a framework. The project managers from the business line ‘Infrastructure’ argue that they develop a stakeholder list for every project. They start by recording involved organizations, underlying individuals and personal information. During the course of the project this framework is extended and the defined information is added. Depending on the amount of stakeholders and the organizational complexity of the project the framework contains information about relationships, project issues and attitude of the stakeholders towards the project.

**Mapping stakeholders**

The third step in the stakeholder management process is mapping the stakeholders. Once the analysis has been completed it becomes possible to construct various stakeholder maps. With the development of these maps insights are obtained into the relationships among the various stakeholders and their coherence to the project. Table 4.6 shows the maps used by the various project managers. As can be seen in the table only the project managers from the business line ‘Infrastructure’ always develop a Power vs Interest Map and a Problem-Frame Map. The Power vs Interest Map provides the project managers with the required knowledge to determine who the key stakeholders are.

Those stakeholders with a high interest in the project and with the power to influence the project outcome are the key stakeholders and they are involved from the early beginning of the project. A Problem-Frame Map is developed when various stakeholders are involved with different attitudes towards the project. This map provides information about which stakeholders might have a negative attitude towards the project and could hinder its outcome by utilizing their power.

Only three project managers from the business line ‘Buildings’ have indicated that they develop Power vs Interests Maps and only in some cases. They argue that when a project consists of multiple (external) stakeholders with various power levels and stakes in the project, such a map is useful to preserve overview. According to the project managers, in most conducted building projects, the interests of the involved stakeholders were roughly the same and the power distributions were straightforward. According to the project managers the client is by far the most powerful actor and the contracted parties support him. A Power vs Interest Map is therefore, in most cases, not
required.

Stakeholder-Issue Relationship maps are used by two project managers from the business line ‘Infrastructure’. They develop the maps before a meeting to obtain a first insight into the stakeholder field and their possible issues concerning the project. Since multiple external stakeholders are involved in an infrastructure project multiple issues may arise. The maps are shown to the client and key stakeholders in order to check whether the identified issues are correct and if there are possible other issues or stakeholders involved with those issues. Mapping the issues and relationships and presenting them in the iRoom provides insight into the problem complexity by connecting all project issues to each stakeholder. The Stakeholder Commitment Matrix and the Stakeholder Classes are not known by the project managers and are therefore not used.

It can be noted that the step mapping of stakeholders is only performed by the project managers from the business line ‘Infrastructure’. In the conventional process they develop the maps on their own, based on the analysis of the stakeholders, and they communicate the map with the client. In the VDC process the stakeholders are mapped by the project manager and the key stakeholders. Based on the mapped stakeholders you position the stakeholders and determine their level of participation. It is essential that you map the stakeholders in the right way. By involving key stakeholders with the mapping of stakeholders, the chance of positioning stakeholders wrongly reduces, according to the project managers.

The project managers from the business line ‘Buildings’ do not perform the step Mapping stakeholders, neither in the conventional nor in the VDC process. It seems that the small amount of stakeholders and lack of variety of stakeholders are the cause of not performing this step.

Determine required participation

The last step in the stakeholder management process is determining the participation level of the stakeholders. The insights gained by assessing the stakeholders can be used to identify the role of each stakeholder in achieving project objectives and to determine how to involve them. Table 4.7 summarizes the given answers by the project managers on the overall participation level of stakeholders and how the participation levels of stakeholders are determined.

The answers show that the client largely determines the participation level of the stakeholders. At the beginning of a project the client consults the project manager to determine who to involve in the design-construction process. Some of the clients completely follow the advice of the project manager however the majority of the clients determine the participation level of the stakeholders on their own.

According to the interviewees, most clients want to limit the participation level of the stakeholders. They are concerned about the influence the stakeholders might get when they participate in the design process. They fear to lose control and provide the other stakeholders with too much power that could lead to cost and time overrun. However, the project managers from the business line ‘Infrastructure’ do emphasize the importance of determining the appropriate participation level. Based on the stakeholders’ level of interest, power and influence the stakeholder has on the project, the participation level of each stakeholder needs to be determined. When the participation level is determined the appropriate way to involve the stakeholders can be derived.

Some project managers from the business line ‘Infrastructure’ argue that the overall participation level of all stakeholders rises when performing a project according to the VDC method. In the
conventional process some stakeholders are involved at the end of a project when crucial design decisions are already made or they are not involved at all, which, in infrastructure projects, often leads to project resistance. According to the project managers the VDC method prevents this by letting all stakeholders participate in a more active role in the design process. With the use of the iRoom various design sessions are held with all the involved stakeholders. The neutral environment of the iRoom minimizes the power inequalities, which provides stakeholders with the feeling that they have influence in the design process. Applying visuals creates an understanding among the stakeholders about problematic situations, which might help to create public support. These project managers argue that public support is essential in infrastructure projects because of the impact it can have on the projects end result. In addition, the client in infrastructure projects is in general a public party with multiple interests. The client has on the one hand interest in the smooth realization of the project but on the other hand he has to represent the interests of the people. Public clients are therefore more willing to provide stakeholders with a higher participation level during the design process. They realize the importance of public support and understand the effect of active participation. In most building projects, the client is a private party that has little to do with the interests of the public and their environment if they do not interfere with the project objectives. Most private clients however are concerned about empowering stakeholders too much and do not support the participation of stakeholders in the same iRoom sessions, especially not of those who might oppose the project. The project managers however strongly emphasize the participation of all stakeholders in the iRoom, especially those who might have a negative attitude towards a project. They argue that through a higher participation level of those stakeholders the negative attitude might change towards a neutral or even positive attitude when they are heard and taken seriously within the project. However, the client is still too conservative to accept a higher level of stakeholders participation. With a higher level of stakeholders’ participation, the client will also need to be more actively participating in the design process and actually provide input in the process. To retain the position the client has in the conventional process, the attitude of the client needs to change from a passive attitude towards an active attitude in which open collaboration is essential.
4.3 Conclusion

This section elaborates on the results derived from the interviews on the understanding of stakeholder management and how the project managers from both business lines: “Buildings and Infrastructure” perform stakeholder management.

In general it can be concluded that the perception of stakeholder management among project managers and among the business lines ‘Buildings’ and ‘Infrastructure’ is similar to one another. They both define stakeholder management as a process to gain understanding of the involved stakeholders, their relation to each other and to the project. The definitions of a ‘project stakeholder’ given by the project managers are similar to one another and contain the essence of what a project stakeholder is. The following table presents the overall performance of the various stakeholder management process steps. The results of the steps combined shows how well each project manager performs on stakeholder management.

Table 4.8 shows, that all project managers identify the stakeholders in every project. There is however a major discrepancy between both business lines in who they identify as a stakeholder. The project managers from the business line ‘Buildings’ identify mainly internal stakeholders, while the project managers from the business line ‘Infrastructure’ identify mainly those stakeholders who are not directly involved in the realization of the project or contracted by the project: the external stakeholders. Internal stakeholders are identified at first but are not taken into account in the following process steps: analyzing stakeholders, mapping stakeholders, and determining required participation. The project managers argue that the internal stakeholders are contracted by the client and participate and contribute to the project according to the agreements made in those contracts. The project managers from the business line ‘Infrastructure’ perform well on the rest of the stakeholder management process steps. They execute all aspects of the process step ‘Analyzing stakeholders’ and they map stakeholders when required. When allowed by the client, the project managers determine the appropriate stakeholder participation level. However, in most cases the level is determined by the client. The project managers from the business line ‘Buildings’ perform low on the various process steps. They all identify the (internal) stakeholders and analyze some characteristics of them, but do not make the analysis explicit by developing frameworks or lists. None of the project managers map the stakeholders and only sometimes a few determine the required participation level.

This discrepancy can be explained by the difference in the type of stakeholders, the number of stakeholders involved, the variety of interests in the project, and the dependencies on other stakeholders. Projects carried out by the business line ‘Buildings’ are characterized by the involvement of a small common group of internal stakeholders who are contracted by the client. This small group of internal stakeholders forms the project team with the overriding common goal and objective to successfully design and construct the project. The participation and contribution to the project is jointly agreed upon and written down in a project plan. There seems to be little to no involvement of external stakeholders. Nearby residents, the local community, and interest groups are not identified as stakeholders nor involved in the design-construction process. The project managers from the business line ‘Infrastructure’, on the other hand, indicate that with infrastructure projects multiple external stakeholders are involved. In the majority of the projects, the client is a public authority which has multiple interests. The construction does not only need to be executed within a certain time window, a budget, and conform quality standards, but it also needs to integrate with the local environment. Consequentially, external stakeholders get involved in the design-construction process and the client depends on their contribution. In a building, the client is not concerned with its environment and therefore is not interested in the involvement of external stakeholders.
parties in the design-construction process.

The stakeholder management process does not change with the introduction of the VDC method. The same steps are followed by the project managers as defined in the theoretical framework and the same analyses and maps are produced. However, there is a difference in approach. In the conventional process the steps are performed by the project managers themselves in consultation with the client. The frameworks and maps are not developed in consultation with others nor distributed among other team members. With the introduction of VDC, the introduction of integrated project teams, and the use of the iRoom, the process steps become more open and transparent. In the first iRoom session the project stakeholders are identified, analyzed and mapped by the client, project manager and project team members. Lists, frameworks and diagrams are produced on interactive screens, which make the process transparent to and understandable for everybody. During the course of the project those frameworks and maps are further elaborated in iRoom sessions in order to have an up-to-date overview of the stakeholders. Due to the input of other stakeholders the assessing of the stakeholders improves in quality, which leads to better understanding of the project stakeholders in an early stage of the project. In addition, the answers given by the project managers show that the open and transparent approach ensures that other stakeholders are more aware of each other and their position in the project. In general the participation level of the stakeholders is higher than in the conventional process according to the project managers. When the client allows, stakeholders are invited to various iRoom sessions which gives them the opportunity to directly communicate with the client and other stakeholders.
Chapter 5  STAKEHOLDER MANAGEMENT IN VDC PROJECTS

This section aims to examine how stakeholder management is applied in VDC projects and to determine the project preconditions for conducting stakeholder management. By examining various VDC projects the following sub-research question could be answered:

*How is stakeholder management applied in VDC projects and what project characteristics can be identified that affect the performance on stakeholder management?*

### 5.1 Research method

In order to examine how stakeholder management is applied and to determine what project conditions affects the performance on stakeholder management, six VDC projects are evaluated.

#### 5.1.1 Analytical framework

To examine how stakeholder management is performed in VDC projects the theoretical framework, developed in chapter 3 is used. Interviews were held with project managers of completed and currently ongoing projects. A combination of standardized open-ended questions and closed fixed-response questions was asked in an open face-to-face meeting with the project manager. Standardized open-ended questions are asked to get an understanding of the perception on the progress of the project and closed fixed-response questions determine how project managers involved stakeholders in the process. The main task in this part of the research is to extract data from the different project managers, which have or are currently managing VDC projects. The evaluation framework used for the analysis is presented in figure 5.1. The complete interview framework is presented in Annex III.

![Analytical framework](image)

*Figure 5.1 Analytical framework*

The results on stakeholder management in VDC projects can be derived from the performance on stakeholder management and the identified project conditions. First all projects will be examined if stakeholder management is performed and in what way. Subsequently, project conditions will be identified in order to examine if stakeholder management was required. For the project conditions, the project organization and the project phase(s) in which Royal HaskoningDHV was involved with are considered. Subsequently the project complexities, consisting of the number of stakeholders, the variety of stakeholders’ perspectives, and the dependencies on other stakeholders, were examined.
5.1.2 Introduction of the projects

Six projects were chosen from a list of VDC indicated projects by Royal HaskoningDHV. The choice of these six projects is based on availability of projects. From the six projects four projects were indicated by Royal HaskoningDHV as projects that have applied stakeholder management. The following six projects have been selected for this research.

**Corporate Learning Center RWS (CLC) (Stakeholder management applied)**

The Corporate Learning Center is a facility of learning and development for the Dutch Department of Public Works (RWS). RWS wants to house this learning center in their own building instead of leasing external training areas. Within the existing building of RWS an area is appointed and made available to locate the learning center. Internal reconstruction of the area is required to develop a tailor-made learning center. Royal HaskoningDHV is assigned by RWS to deliver and facilitate an Integral Program of requirements, an integral design, and the construction documents.

**Shell Technology Centre Amsterdam (STCA)**

Shell wants to expand their technology center in Amsterdam, the Shell Technology Center Amsterdam (STCA), by adding a new wing to an existing building. The required area on the outskirt of the building is property of Shell and made available for the expansion. Royal HaskoningDHV is assigned by Hurks (main contractor) to develop detailed and technical designs by various disciplines.

**CSmart (CS) (Stakeholder management applied)**

Carnival, an American company, operates a maritime training facility located in Almere, which contains navigational bridge simulators, engine room simulators and instructional classrooms. Due to the success of this training facility Carnival intends to develop a new and larger maritime training facility in the Netherlands. The required area and location for the new facility have been determined and were purchased by Carnival. Royal HaskoningDHV is assigned by Carnival to develop a master plan for the complete design-construction process.

**Call center RWS (CcR) (Stakeholder management applied)**

The call center of the Department of Public Works (RWS) is struggling with a shortage of workplaces and climate control problems of the area. RWS wants to locate all her call center activities in one area. Within the existing building RWS has allocated an area which needs to be reconstructed to resolve the various issues and make the area suitable for call center activities. Royal HaskoningDHV is consulted to develop a feasibility study and an integration plan.

**Hermes City Plaza Rotterdam (HCP) (Stakeholder management applied)**

Hermes City Plaza is a vacant building in the center of Rotterdam owned by a global financial services company Credit Suisse. Redevelopment of the outside and inside of the whole building is required in order to reposition the building on the market. In conjunction with the architect: De Mannen van Schuim, Royal HaskoningDHV is assigned to carry out a feasibility study on the possible re-development of the building, including investment costs and revenues.

**Panladio Almelo (PAN)**

The central warehouse of PANalytical is currently housed in a 60-year old building in Almelo. PANalytical is planning to demolish the building and build a new one on the same spot. PANalytical has requested Royal HaskoningDHV to take care of the entire engineering project, including the preliminary design, detailed design and technical design.
5.2 Research results

This section will present the results of the evaluation of the six VDC projects. First the performance on stakeholder management is discussed based on the stakeholder management process steps. Second, the project conditions and the affect they have on the performance of the stakeholder management process will be identified.

5.2.1 Application of stakeholder management

The stakeholder management process is analyzed based on the performance of three elements of stakeholder management: stakeholder identification, stakeholder assessment, and stakeholder engagement. The following table shows which stakeholder management steps are performed during the projects.

From the table can be derived that stakeholder management is not performed according to the process steps defined in the literature framework by any project manager of the analyzed VDC projects. The following section will elaborate on why stakeholder management is not performed according to the interviewees.

CLC project

According to the interviewees of the CLC project, only internal stakeholders were involved in the complete course of the project, from initiation till project closeout. Two major parties were involved: the Rijksgebouwendienst, and RWS. Prior to the start of the project a two-year discussion was going on between those two parties on how to approach the project. This resulted in a clear view on who they wanted to involve and how they wanted to be involved in the project. The other stakeholders involved in this part of the project were: two architects, end-user(s) of RWS, the operation & maintenance team of RWS, and the design consultants of Royal HaskoningDHV. The architects and Royal HaskoningDHV were assigned by the client and chosen based on their tender. The internal stakeholders of RWS were mapped by the client before contracting Royal HaskoningDHV to deliver and facilitate the various designs and act as project manager during the design phases. Royal HaskoningDHV was commissioned to formalize the design process and implemented an integrated design approach, which implied that the internal stakeholders of RWS (end-user(s) and O&M team) were actively involved in the design process. With the use of the iRoom, various integrated design sessions were held multiple times a week. One of the stakeholders: the Rijksgebouwendienst, did not support the integrated approach and abstained from participation. They were briefed every two weeks to approve the developed designs, which resulted in an additional 4 weeks project time. The required participation level of the stakeholders was determined by the client in consultation with the project manager of Royal HaskoningDHV. Together with the consultants of Royal HaskoningDHV and the architects they formed the project design team. At the beginning of the project they determined the project goals and objectives, which were stated in the project plan. No conflicting interests or various attitudes towards the project among the stakeholders were encountered.

STCA project

The interviewees of the STCA project indicated that at the first kick-off meeting with the client, stakeholder management was mentioned by Royal HaskoningDHV as a tool which could be used during the design process. However, during this meeting the client made clear that stakeholder management was performed in-house without interference of Royal HaskoningDHV. The construction team was formed by the client in consultation with their project manager. One main contractor was assigned by the client who assigned a design partner, and a technical installation contractor. Royal HaskoningDHV was assigned as the design partner and was concerned with the
development of the various technical designs. As a subcontractor, Royal HaskoningDHV had limited control over the project approach and the design process. With two iRoom sessions Royal HaskoningDHV tried to facilitate an integrated design approach with the client, main contractor and subcontractors. These sessions became information sessions instead of the desired interactive design sessions. This was due to insufficient decision-making power of the representatives of the client and the passive attitude of the technical installation contractor. The integration of the construction parties was also restrained by the hierarchical communication structure. All communication between the construction parties had to go via the main contractor and the client to the designated person. This made the communication slow and indistinct. The contribution and the participation of the subcontractors (including Royal HaskoningDHV) were not clear and no official contracts were signed. This made the participation of the parties low and no effort was made to contribute to the project. According to the interviewees of the project, stakeholder management was not performed by Royal HaskoningDHV since they were not assigned to do so and were only concerned with the delivering of technical designs.

CS project

In the case of the CS project, Royal HaskoningDHV was assigned to act as project manager and therefore should have performed stakeholder management. However, according to the interviewees no stakeholder management was performed since no significant stakeholder was involved in this phase of the design process. The only stakeholder next to the client and design parties involved during the design process was the municipality at the early beginning of the project. The municipality gave permission and set boundary conditions to develop the new building on the plot of land purchased by the client. No attention was further given to possible external stakeholders. Internal stakeholders, the involved disciplines of Royal HaskoningDHV and the end-user(s), were identified by the client in consultation with Royal HaskoningDHV. Analyzing or mapping the stakeholders was not required since the internal stakeholders consisted of the client and various disciplines of Royal HaskoningDHV, which were contracted by the client. The participation of the disciplines was determined at the beginning of the project in consultation with the client and described in the project plan. The architect of Royal HaskoningDHV developed the schematic design in consultation with the project manager of Royal HaskoningDHV who, in turn, consulted with the client and the end-user(s). The iRoom was used to show the progress of the design to the client and to obtain essential information for further development of the design.

CcR project

In the case of the CcR, stakeholder management was not performed since only a few disciplines of Royal HaskoningDHV, the client and the end-user(s) were involved. The stakeholders who were involved were known and only consisted of internal end-users. The internal repositioning of the call center involved various departments and therefore different end-user(s) were involved. With the use of integrated sessions in the iRoom the requirements of the various departments were gathered and discussed. Based on those requirements the design consultants performed a feasibility study. Since there was no involvement of other stakeholders there was no urge to perform stakeholder management.

HCP project

The HCP project was concerned with the redevelopment of a complete six-story building in the center of Rotterdam. Considering the location and the size of the building you would expect multiple external stakeholders to be involved in the project, such as nearby residents, local community, interest groups and local businesses. The end-use of the building was not yet determined by the
client and therefore a consultant was assigned to identify the potentials of the building within its environment. This consultant indicated possible trends in the development of the area. The type of residents, local businesses, visitors of the area and the land use plans of the municipality were taken into account. Further elaborating or involvement of those possible stakeholders was not yet relevant given the indistinctness of proceeding with the project. Royal HaskoningDHV was only assigned to elaborate on the schematic designs developed by the architects during the research phase of the project.

PAN project

The assigned disciplines of Royal HaskoningDHV in the PAN project were concerned with the development of various designs. The project management was assigned to a third party. According to the interviewees, no stakeholder management was performed because of a lack of external stakeholders. The municipality and the fire department were the only two external stakeholders involved in the project. Communication with those parties was done by the project manager and therefore no stakeholder management was required. The municipality was involved to grant various building permits and the fire department was involved to set specific safety requirements. When the requirements were set and the permits were issued, the project continued without further participation from those two stakeholders. The internal stakeholders were identified and assigned by the client and consisted of the end-user(s), who were from the same organization as the client, the disciplines of Royal HaskoningDHV, a project manager, and a technical installation contractor. The end-users were given the possibility in the beginning of the design process to deliver their input and requirements. When their requirements were within the boundaries set by the client, the requirements were granted.
5.2.2 Project conditions

This section presents the project conditions of the evaluated VDC projects that affected the performance of stakeholder management. First the project objectives and the role Royal HaskoningDHV performed in the projects will be discussed, followed by the project phase(s) Royal HaskoningDHV was assigned in, the project complexities, and the type and participation of involved stakeholders.

Project organization

Royal HaskoningDHV can be assigned by the client to perform various project activities during the complete life cycle of a project. The following table provides an overview of the project objectives and the role Royal HaskoningDHV performed to achieve these objectives.

From the table can be derived that Royal HaskoningDHV was primarily assigned to develop various design models. Royal HaskoningDHV was responsible for the development of design models, depending on the design-construction phase the project was situated in. In case of the CcR and HCP project, Royal HaskoningDHV was responsible for the development of a feasibility study and the associated specific design models. In the PAN project Royal HaskoningDHV was assigned per phase to develop the associated design models. In case of the CLC project, Royal HaskoningDHV was, in addition to being responsible for delivering various designs, also in charge of the design development process itself. With this project management role, Royal HaskoningDHV had the responsibility to facilitate the design development process and determine the involvement of the stakeholders. In the CS project Royal HaskoningDHV was assigned to act as the project manager of the project. This involved the development of the conceptual design, establishment of the Program of Requirements, and the assisting of the client with the contracting of the design and constructing parties.

As argued in the theoretical framework, stakeholder management is part of project management and needs to be performed by the project manager in consultation with the client. In two VDC projects, Royal HaskoningDHV was assigned to act as project manager. However, in both cases they were assigned as project managers of the design development process and not of the overall project. It can be noted that Royal HaskoningDHV is involved in various aspects of the internal organization and development of the design process, however, Royal HaskoningDHV was not assigned to perform stakeholder management in any of the projects. This might indicate that stakeholder management is not a task Royal HaskoningDHV has to perform in their projects. But since there is no information about whether or not stakeholder management is performed by the client or another third party, this cannot be substantiated.

Project life cycle

The design-construction process consists of eight distinct phases. This research focusses solely on the phases of the design process, since this is the core business of Royal HaskoningDHV. The following figure presents the projects in comparison to these design-construction phases in which the projects are situated.

From figure 5.2 can be derived that the projects ranged from the initiation until the closeout phase. The light colored part indicates the complete project life cycle and the dark colored part the design phases Royal HaskoningDHV is participating in. It can be noted that Royal HaskoningDHV is involved in various phases of the design-construction process. In the HCP and CcR project they are involved in the research phase to develop a feasibility study for the client. Other projects are assigned later on in the design-construction process. In only two cases, PAN and CLC, is Royal HaskoningDHV assigned to multiple design phases. The STCA project is currently still ongoing and it is uncertain whether Royal
HaskoningDHV will be involved in the upcoming phases since no contract has yet been signed. In case of the CS project Royal HaskoningDHV was assigned in the programming phase and will be involved until the closeout phase. During the phases following the programming phase, Royal HaskoningDHV will not be involved with the project management task but will act as supervisor and controller on behalf of the client.

Stakeholder management is an iterative continuous process, which starts at the initiation phase and ends after the closeout phase. Since Royal HaskoningDHV was only assigned to a specific phase of the complete project lifecycle it was not the suitable party to have performed stakeholder management for the complete project. They might however perform stakeholder management during the time that they are involved in the project. For example, in case of the CLC project, Royal HaskoningDHV was involved during the complete design process and therefore had the possibility to perform stakeholder management during these phases. It becomes more difficult when Royal HaskoningDHV is only assigned in one phase of the complete design-construction process, since stakeholder management is not phase related and covers several phases.

**Project complexity**

During the interviews three elements which contribute to project complexity concerning stakeholders were examined: number of stakeholders, variety of stakeholders’ perspectives, and dependencies on other stakeholders.

**Number of stakeholders**

Table 5.4 shows both internal and external stakeholders involved in the design process of each project. The number below the table indicates the number of involved stakeholders.

In general it can be noted that the number of involved stakeholders is low, especially the involvement of external stakeholders. From the table can be derived that mainly internal stakeholders were involved. In two projects the fire department was involved with the development of the design requirements. In four other projects the local authority was involved with the issuance of building permits. Both the fire department and the local authority were not actively involved in the design process. They were only asked by the project manager to deliver their input regarding safety regulation at the beginning of the process. In the majority of the cases the construction parties, consisting of the main constructor, (sub) contractors and suppliers, were not involved in the design process. This indicates that the project is performed according to a more conventional design process instead of an integrated design process. The reason for the absence of the construction parties is the structure of the delivery model used by the projects. The PAN, CLC, and CS used a conventional delivery model, which does not allow any involvement of construction parties during the design process. The construction parties become involved in the process when the design is finished and the procurement starts. According to some of the interviewees involvement of construction parties, early in the design process, is not always desirable. Early participation of those parties could result in too many design and price-raising boundary conditions that may reduce the quality of the final design and restrict the architect too much in creating something unique. Participation of a contractor in the design process is only desirable when specific knowledge is required which solely the contractor possesses thanks to their experience. In the majority of the cases their knowledge or expertise was not required according to the interviewees. In case of the STCA project a more collaborative delivery model was chosen by the client after the schematic design phase was completed, in order to develop a more integrated design with the involvement of a main
contractor and sub-contractors. This was chosen since the overlapping expertise was required from both the main contractor and sub-contractor. To integrate the design models an integrated design process was chosen with the involvement of the construction parties during the design process.

**Variety of stakeholders’ perspectives**

The variety of stakeholders’ perspectives is examined by asking the interviewees about different perspectives among the involved stakeholders and whether they perceived conflicting interests. The results from the interviews show that there were no conflicting interests observed nor were major varieties in stakeholders’ perspectives indicated. Between the internal stakeholders minor varieties in perspectives were indicated. In general the client is primarily concerned to realize the project within a certain time frame, within budget and according to predetermined quality requirements. The end-user(s) on the other hand are mainly interested in the usability and layout of the area and are not concerned about budget or time frames. The architect and design consultants are primarily interested in the quality of the design. In general all the involved stakeholders have the common objective of developing design models and realizing the project according to the requirements of the client. This indicates that there were no complexities concerning stakeholders’ perspectives.

**Dependencies on other stakeholders**

To determine how the project depends on other stakeholders, the interviewees were asked to indicate the degree of dependency of each stakeholder on a scale of 1 to 5. The dependency level is laid down in five levels: 1 = not at all dependent, 2 = slightly dependent, 3 = moderate dependent, 4 = very dependent, 5 = extremely dependent. Every interviewee was asked to rate each stakeholder’s dependency level. Based on the ratings of the interviewees the following figures are developed.

From the figures can be derived that the stakeholders have the same dependency level in each project. It can be noted that in each project the client has the highest dependency level. This makes sense since the client is the stakeholder who ultimately has responsibility and takes the major design decisions. The success of the projects is moderately dependent on the contribution of the architect, project manager, and design consultants. They all deliver specific knowledge and expertise on their field of expertise which is required for the project. However, since they are replaceable, the project is less dependent on their personal involvement. The same goes for the main contractors and (sub) contractors. The O&M team, which is involved in the CLC project, delivers specific information about operation and maintenance. This team has knowledge about the building which could not be obtained by others. The end-user(s) have specific requirements and demands concerning the quality and decoration. In case of the CLC and CS, the building had to be tailored to the requirements of the end-user(s), which made the project more dependent on the input of the end-user(s) in relation to the other projects. All projects highly depend on the local authority, and social services: the fire department. Building permits are required from the local authority in order to construct the building and the fire department that sets safety requirements. These requirements should be taken into account when developing the design models. Without the approval of the fire safety inspection, the project will not continue.
5.2.3 Results on stakeholder management in VDC projects

This section presents the results on stakeholder management in VDC projects and what project characteristics affect the performance of stakeholder management.

In general it can be noted that stakeholder management is not performed by the project managers of Royal HaskoningDHV. Based on the identified project conditions the following project characteristics can be indicated as possible indicators why stakeholder management is not performed.

- **Role in the project organization**

  Stakeholder management is a component of project management that should be performed by the project manager. In the majority of the projects Royal HaskoningDHV was assigned by the client to develop design models or to facilitate and organize the design process. With the facilitation of the design process, Royal HaskoningDHV was responsible for the composition of the design team and responsible for the coordination and supervision of the design process. The composition of the design team was based on the required expertise for the project in consultation with the client. The design process only required input from the project team, including the end-user(s) and client and therefore didn’t require any stakeholder management. In none of the cases Royal HaskoningDHV was assigned as overall project manager. In most cases the client took the role as project manager or a third party was assigned.

- **Moment of involvement**

  Stakeholder management is an iterative process which starts at the initiation of the project and ends at the closeout phase. It is a process which involves multiple design phases since stakeholders might change over the course of the project. Royal HaskoningDHV was consulted at various moments in the design process. In the majority of the projects they were only involved during one phase of the process, which makes it hard to perform all steps of the stakeholder management process. When involved half way through the design process, stakeholders should already be identified and assessed. In most cases the stakeholders were already involved in the process at the moment Royal HaskoningDHV got involved.

- **No complexities concerning stakeholders**

  Stakeholder management, as defined in this research, is considered most valuable when the project contains project complexities concerning stakeholders. Three elements were examined: the number of stakeholders, the variety of stakeholders’ perspectives, and the dependencies on other stakeholders. The number of stakeholders involved in the cases was considered as low. Only a few internal stakeholders and one or no external stakeholder were involved in the design process. The external stakeholders were only involved with the issuing of building permits and framing of the safety requirements. They were not participating in the design process itself. There were no noteworthy varieties in stakeholders’ perspective or any conflicting interests. The dependence on other stakeholders was low. The internal stakeholders involved in the project were assigned by the client and are replaceable for other contractors. Changing architects, contractors or project managers half way the project is not desirable since the extra work it entails. The client however does not completely depend on one of these internal stakeholders to successfully complete the project. The low number of involved stakeholders, no varieties in stakeholders’ perspective and low dependencies on other stakeholders, indicate that none of the projects had to deal with complexities concerning stakeholders.
5.3 Conclusion on the case study

This section presents the conclusion of the application of stakeholder management in the observed VDC projects and provides a concise answer to the sub-research question:

*How is stakeholder management applied in VDC projects and what project characteristics can be identified that affect the performance on stakeholder management?*

In general it can be concluded that stakeholder management is not applied in any of the analyzed cases. Several project characteristics can be identified that affect the performance of stakeholder management.

First, the role the disciplines of Royal HaskoningDHV fulfil in the project organization. In the majority of the projects Royal HaskoningDHV is assigned to develop design models and coordinate the design processes in which no stakeholders are involved. Stakeholder management is therefore no task for Royal HaskoningDHV to perform. Second, disciplines of Royal HaskoningDHV are in the majority of the projects only involved in one phase of the design process. This makes performing stakeholder management difficult since the process of stakeholder management covers the complete life cycle of the project and is an iterative process which therefore should be performed by a project manager who is involved during the complete life cycle of the project. Third, project complexities concerning stakeholders are absent. The low number of involved internal stakeholders and no involvement of external stakeholders make stakeholder lists redundant. No varieties in perspectives or conflicting interests indicate that stakeholder frameworks are not required as well. All involved stakeholders have the common objective which is made clear at the start of the project by the client. In addition, the degree on which the project is dependent on the contribution of other stakeholders is low, which makes gaining insight into the interests and motivation of the stakeholders less interesting.

In general it can be noted that stakeholder management, as defined in the theoretical framework, for these kinds of projects is not suitable. The stakeholder management process elaborates on the interaction between the project and its environment. The projects in this case study only consist of internal stakeholders who are part of the project team. There are no external stakeholders involved in these projects since there are no external stakeholders to involve. It therefore must be asked whether stakeholder management is required at all, when only internal stakeholders are involved, or if another kind of stakeholder management should be performed.
Chapter 6  GUIDELINE FOR PERFORMING STAKEHOLDER MANAGEMENT IN VDC PROJECTS

From the last two chapters can be derived that there is a lack of knowledge and know-how on when to perform stakeholder management and how to perform stakeholder management. Therefore, this chapter presents a guideline for performing stakeholder management in VDC projects. This guideline will provide an answer to the following sub-research question:

What guidelines can be made for stakeholder management in VDC projects to support the participation of stakeholders in the design process?

The guideline consists of two elements. The first element elaborates on the preconditions of the project, which determine whether stakeholder management should be applied. The second element examines how stakeholder management should be performed. No one-size-fits-all method can be developed since stakeholders differ per project. A basic framework however is developed based on the stakeholder management process steps as defined in the theoretical framework and several key questions, which determine what elements of the stakeholder management process needs to be performed.

6.1 Project preconditions

Four project preconditions can be identified which need to be present in order to perform stakeholder management:

- **Involvement of external stakeholders**

  The VDC method supports the use of integrated project teams, consisting of internal stakeholders. They have the common overriding goal to successfully design and construct the project. Therefore, they act as one entity, as one actor. Stakeholder management within the VDC process is aimed at the involvement of external stakeholders. Therefore, to perform stakeholder management, external stakeholders should be present.

- **Number of stakeholders involved**

  The more stakeholders involved in the project, the more important stakeholder management becomes. With a small group of stakeholders, it is easy to identify everybody and assess them one by one, without the support of diagrams, frameworks or maps. However, when the number of stakeholders increases it becomes difficult to keep overview and position them in relation to others and to the project. Therefore, when only a few stakeholders are involved, stakeholder management is not required.

- **Variety of stakeholders’ perspectives**

  Stakeholders involved in the project might have different project perspectives. When this is the case, stakeholder management can provide insight into those perspectives and trace possible conflicting issues and interests. Without a variety of perspectives, everybody is in favour of the project and no conflicts or issues will arise which requires stakeholder management.

- **Dependencies on other stakeholders**

  To successfully complete the project, the client might depend on the contribution of other stakeholders. When the client does not depend on others, the client does not have to worry about the relation with its stakeholders or their involvement. Therefore, stakeholder management only needs to be performed if the client depends on other stakeholders to complete his project.
### 6.2 Basic framework for stakeholder management

This section presents a basic stakeholder management process method that can be used by the project manager to perform stakeholder management in a VDC process. This method consists of four basic phases: identification of stakeholders, analysis of the stakeholders, mapping of the stakeholders, and determining the participation of the stakeholders. Each phase can be performed in the iRoom and the working documents can be developed with the use of the interactive screens. Each phase consists of multiple activities and delivers a working document which can be used throughout the project. The basic stakeholder management method is shown in figure 6.1.

<table>
<thead>
<tr>
<th>STEP 1</th>
<th>Identification of stakeholders</th>
</tr>
</thead>
</table>
| **What?** | - List all possible stakeholders (intern/extern)  
- Group stakeholders |
| **How?** | Brainstorming in iRoom, listing all stakeholders on the interactive screens |
| **Who?** | Client, project manager |

<table>
<thead>
<tr>
<th>Working documents:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stakeholder List</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STEP 2</th>
<th>Analysing stakeholders</th>
</tr>
</thead>
</table>
| **What?** | Define:  
- Stakeholders’ basic information  
- Stakeholders’ issues & interrelations  
- Stakeholders’ relationships & dependencies  
- Stakeholders’ attitude towards project |
| **How?** | Brainstorming in iRoom, letting all participants deliver input for the framework |
| **Who?** | Client, project manager, key stakeholders |

<table>
<thead>
<tr>
<th>Working documents:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stakeholder Analysis Framework</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STEP 3</th>
<th>Mapping stakeholders</th>
</tr>
</thead>
</table>
| **What?** | Develop:  
- Stakeholder Commitment Matrix  
- Stakeholder-Issue Relationship Map  
- Problem-Frame Map  
- Power vs Interest Map |
| **How?** | Display empty maps on screen and fill them up with the input of the participants. |
| **Who?** | Client, project manager, key stakeholders |

<table>
<thead>
<tr>
<th>Working documents:</th>
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</thead>
<tbody>
<tr>
<td>Stakeholder MAPs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STEP 4</th>
<th>Determine participation</th>
</tr>
</thead>
</table>
| **What?** | - Determine appropriate level of involvement  
- Determine communication tool |
| **How?** | Display participation level with associate action |
| **Who?** | Client, project manager |

<table>
<thead>
<tr>
<th>Working documents:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stakeholder Analysis Framework 2.0</td>
</tr>
</tbody>
</table>

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Figure 6.1 Basic stakeholder management framework
6.2.1 Identification of stakeholders

The first step in the stakeholder management process is the identification of all stakeholders who have the potential to affect or may be affected by the project. To create an initial list of stakeholders internal brainstorm sessions with the client can be held. The following key questions are useful to create an initial list:

- Who will be affected?
- Who has the power to influence the outcome?
- Who are the potential allies and opponents?
- What coalitions might build around this issue?

A first stakeholder list can be developed in the iRoom during the kick-off meeting. Using interactive screens stakeholders can be listed, which makes the list virtual. After this session the project manager may contact key stakeholders and ask them to identify others whom they think may have an interest in the project, this process is called snowballing. This process needs to be continued until it’s no longer rendering new stakeholders. The result of the brainstorm session in the iRoom and the snowballing process is that all possible stakeholders are identified and listed on a stakeholder list. When all stakeholders are listed, key stakeholders might be indicated. Those key stakeholders will be involved during the complete lifecycle of the project and will be part of the integrated project team.

6.2.2 Analyzing stakeholders

When the stakeholders are listed and the key stakeholders are determined, a first analysis of the stakeholders can be done. The following key questions may be asked to determine various stakeholders' characteristics.

- How powerful or influential is the stakeholder in respect to this project?
- What is the stakeholder’s interest in the project?
- What role will the stakeholder fulfill in the project?
- What issues can be identified concerning this project and which stakeholders are related to these issues?
- Do they have relationships or links with other stakeholders in this project?
- Do the stakeholders depend on other stakeholders and if so, how do they depend on each other?
- What is their position or attitude towards the project?

With the support of the iRoom these questions can be presented in an open atmosphere and answers can be given by all team members. Simultaneously, a stakeholder analysis framework can be developed on one of the SMART boards.

![Stakeholder Analysis Framework](image)

Figure 6.2 Stakeholder Analysis Framework
6.2.3 Mapping stakeholders

The next step in the framework is the mapping of the stakeholders. In consultation with the project team various maps can be developed. The following key questions indicate which maps should be developed.

- Do stakeholders differ in position or attitude towards the project?
  YES → Stakeholder Commitment Matrix
- Are there differences in power level and attitude towards the project?
  YES → Problem-Frame Map
- Are there multiple public issues concerning the project objectives?
  YES → Stakeholder-Issue Relationship Map
- Are there differences in power level and interest level?
  YES → Power vs Interest Map

With the various mapping processes, the project team now has clearly defined which stakeholders are relevant to the project, their relative influence and interest in the project, their patterns of influence that connect them, their shared interest in issues of the project, and has identified those who support the project and those who may hinder the project.

6.2.4 Determine participation

From the insights gained during the analysis and mapping of the stakeholders the appropriate level of involvement can be determined. The initial stakeholder analysis framework can be extended with the participation level and the communication method used per stakeholder. The participation level and the way of communication with the stakeholders is determined in consultation with the client.

<table>
<thead>
<tr>
<th>Participation level</th>
<th>Goal of participation</th>
<th>Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inform</strong></td>
<td>Provide stakeholder with balanced and objective information</td>
<td>- Keep the stakeholder informed (mail/website)</td>
</tr>
<tr>
<td><strong>Consult</strong></td>
<td>Obtain feedback of the stakeholder on analysis, alternatives and decisions</td>
<td>- Focus groups</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Surveys</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Public meeting</td>
</tr>
<tr>
<td><strong>Involve</strong></td>
<td>Work directly with stakeholder throughout the process to ensure that the stakeholder’s issues and concerns are consistently understood and considered</td>
<td>- Workshops (iRoom)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Develop integrated information platform</td>
</tr>
<tr>
<td><strong>Collaborate</strong></td>
<td>Partner with the stakeholder in each aspect of the decision including the development of alternatives and the identification of preferred solutions</td>
<td>- Participate in design sessions (iRoom)</td>
</tr>
<tr>
<td><strong>Empower</strong></td>
<td>Place final decisions in the hands of the stakeholder</td>
<td>- Present in all project meetings</td>
</tr>
</tbody>
</table>

Figure 6.3 Participation level and related involvement
Chapter 7  CONCLUSION, RECOMMENDATION AND REFLECTION

This final chapter presents the conclusion of this thesis project. It provides recommendations for the use of stakeholder management in VDC projects and discussed the followed research approach, methods and results of the research.

7.1 Conclusion

This thesis strives to gain a better understanding of project stakeholder management and the integration of stakeholders in a Virtual Design and Construction based design-construction process. VDC focuses on three main components which are present in every design-construction process: the product, organization and process. With the use of integrated multidisciplinary performance models these components are made visual and measurable. By developing those models in an early phase of the design-construction process earlier informed decision-making can take place so the decisions are more effective and design changes are less costly. To achieve this, input is required from project stakeholders who are traditionally involved later on in the design-construction process. With the use of stakeholder management, insight into the behavior of the project stakeholders and their relation to the project can be obtained. Stakeholder management can be seen as an iterative process consisting of multiple steps that provide insight into various aspects of the stakeholders, which support the project manager in determining how each stakeholder should be participating in the design-construction process.

The interviews and case study show that stakeholder management is not always performed in VDC projects by the project managers. The findings of the interviews with the project managers from the business line 'Buildings' and 'Infrastructure' show a difference in the extent to which the stakeholder management steps are performed. The type of stakeholders, the numbers involved, the variety of stakeholders’ perspectives, and the dependency on other stakeholders seems to be the cause of this discrepancy. With involvement of only a few internal stakeholders, stakeholder management is not performed since the stakeholders’ participation and contribution to the project is based on the client’s requirements and defined in contractual agreements. Insight into stakeholders’ interests and attitudes are of less concern to the project, since they are negated by the contractual agreements. In addition, in the VDC process, the internal stakeholders form one entity as an integrated project team with the common overriding goal, interest, and objective to successfully design and construct the building. The project managers from the business line ‘Buildings’ mainly have to deal with a small group of internal stakeholders and therefore there is no need to perform stakeholder management as defined in this research. The project managers form the business line ‘Infrastructure’ on the other hand have to deal with multiple external stakeholders. Therefore, they perform stakeholder management step by step and make several stakeholder analyses, maps, and frameworks to determine the required participation level of each external stakeholder. They also indicate that the success of the project depends on the contribution of other stakeholders. The number of stakeholders involved in the project is also relevant on how stakeholder management is performed. With only a handful of external stakeholders, insight into those stakeholders is obtained quite easily and their participation level is determined without performing any support of frameworks or maps. When the number of stakeholders increases, more analyses are performed. Another element that influences the performance on stakeholder management is the variety of stakeholders’ perspectives. Without a variety of perspectives, everybody is in favour of the project and no conflicting interests or issues will be present. However, insight into stakeholders’ perspectives can only be acquired when stakeholders are identified and a first analysis is completed. The results of the case study substantiate the importance of involvement of multiple external stakeholders and show that with
only the involvement of a few internal stakeholders with no variety in perspectives, and no dependencies on others, stakeholder management, as defined in this research, is not required. In addition, the case study shows that Royal HaskoningDHV in the majority of the projects is only assigned to develop designs in a particular phase of the project, which is not the best position to be in to perform stakeholder management.

No changes can be observed in the stakeholder management process in VDC projects from the findings of the interviews and case study. The stakeholder management process steps do not change with the introduction of the VDC method. The various stakeholder management analysis, maps and frameworks can be introduced into the VDC process without modifications. However, with the introduction of VDC the approach of stakeholder management does change. In the conventional method stakeholder management is performed by the project manager himself and involves internal and external stakeholders. VDC introduces an integrated project team in which the internal stakeholders are the project team members, with the common overriding goal of designing and constructing a successful project. The project team acts as one entity and stakeholder management therefore becomes a process which is more aimed at the interaction between the project team and its environment: the external stakeholders. The findings from the interviews show that with the VDC method a more open and transparent stakeholder management process is provided in which the project team members are more actively involved in the development of stakeholder analyses, maps and frameworks. Stakeholder management in VDC projects is performed in the iRoom in consultation with the project team members. By making the stakeholder management process virtual and visual, an interactive setting is created in which the stakeholder analyses, maps and frameworks are developed in collaboration with the team members and displayed on screens. The stakeholder management process thereby becomes a more interactive process which provides the project team with a variety of insights in the involved (external) stakeholders. This enhances the knowledge about stakeholders at an early stage in the design process and helps the project manager to determine the level of involvement of each stakeholder during the course of the design-construction process.
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