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Paving the way digitally:

Research about the usefulness of planning support systems for environment management in large-scale infrastructure projects in the Netherlands.

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Summary

Throughout the past decades, planning practices have become increasingly communicative as a reaction to increased complexity of planning issues and the actors involved. This is also the case in large-scale infrastructure projects, which is the reason why such projects in the Netherlands have an environment manager who manages the processes that are required to integrate a project into its social and physical environment. Another development in spatial planning academia and practice is the use of planning support systems, which provide technical support to planners and their tasks. These PSS have increasingly been researched, developed and applied in planning academia and practice, resulting into more and more insight in their usefulness for the planning field. Some findings concern the dependence of usefulness on the context in which it is applied, a mismatch between PSS supply and demand, and the need for more research on the use of PSS in different practical settings. The aforementioned developments regarding participation and technical support in planning are becoming more prominent. Since 2020, digitalisation in society has been in a rapid surge because of the corona pandemic, which required society to switch from physical gatherings to online alternatives. Moreover, at the time of this research, the Netherlands awaits the entry of the new Environment & Planning Act, which will make participation an obligated element in projects.

Based on the aforementioned developments in society and spatial planning, this research is aimed at gaining knowledge on how planning support systems can be useful for the environment management tasks in large-scale infrastructure projects in the Netherlands, and what the current state of this usefulness is in this context. This research is carried out by conducting a comparative case study on three different tools that were used by environment managers in large-scale infrastructure projects in the Netherlands. Comparing these cases enabled generalisation of similarities, while contrasting results provided insight in variations based on specific conditions or the type of tool being used.

Environment management in large-scale infrastructure projects in the Netherlands is about the coordination of multiple types of processes and project-actors, which concerns handling different types of information in different ways. Therefore, this research suggests that the usefulness of planning support systems for environment management in large-scale infrastructure projects in the Netherlands is determined by the extent to which these consist of the required functionalities to support the different ways of handling data between and within the different actor groups that are relevant to the tasks of the environment manager.
Besides determining how planning support systems can be useful for environment management in large-scale infrastructure projects in the Netherlands, this research has also gained insight in the current state regarding the usefulness of PSS in this context. The studied tools were specifically useful in reaching a large and diverse group of external stakeholders, and in organising data in an accessible and traceable way throughout the project's existence. The tools were either oriented to internal or external processes, and were developed for a rather specific purpose in a project.
Finally, this research has determined five more specific main issues that currently affect the usefulness of planning support systems in this research context: limited functionalities in the tools; a lack of flexibility to adjust a tool; insufficient usability for the users within a project organisation; the underuse of functionalities that can provide guidance through the tool; and a lack of experience and trust in tools by project members.

Keywords: planning support systems, usefulness, environment management, large-scale infrastructure projects.

Table of contents

1. Introduction

Throughout the past decades, spatial planning has become an increasingly complex practice in which an increasing variety of actors are involved (Innes & Booher, 2015). Many of the issues that are at stake in these planning processes concern urban challenges that also have an effect on the global scale (e.g. climate change). In this increased complexity, also the amount of actors that considers themselves a stakeholder in these issues has grown (Granath, 2016). In reaction to this, planning has increasingly become a communicative process in which the various stakeholders are being involved. However, there also have been critiques on this 'communicative turn' in planning, which relate to the argument that such collaboration and consensus-building is often poorly done. These processes would not take away power and representation imbalance, and thus would not necessarily result into a better outcome (Innes & Booher, 2015).

The aforementioned complexity has also emerged in large-scale infrastructure projects in the Netherlands, where roles and responsibilities have increasingly fragmented as a result of the growing number and variety of involved actors. For this reason, in such projects an environment manager carries out the processes that are required to integrate the project into its physical and social environment (Wermer, 2018).

However, stakeholders in a project have not only gained a stronger position as a result of fragmentation of roles and responsibilities. Stakeholder participation also increasingly becomes an acknowledged element in spatial planning laws and regulations. During the time of this research, the Netherlands awaits the entry of the new Environment & Planning Act, in which participation will be a formal requirement for every project (Ministerie van Infrastructuur en Milieu, 2017).

The aforementioned developments make spatial planning an increasingly complex practice as a result of increased complexity of planning issues and stakeholders, which in the Netherlands will gain more legal acknowledgement in projects as soon as the Environment & Planning Act will take into effect. Thus, the question for project organisations in the Netherlands will no longer be 'if' to include participation in the project' but rather 'how' to include participation in the project' (Bisschops & Hollemans, 2018).

Besides the trends that have challenged planning practice, there also have been trends during the past decades that can be a potential support to the aforementioned complexity in the work field. The world has rapidly become digitalised in the many layers of society. Computers and the internet increasingly take an important role in people's daily lives and in an increasing number of economic sectors (Granath, 2016).

Also in spatial planning there is a growing attention to technological support, which in planning literature is referred to as 'Planning Support Systems' (PSS). An increasing amount of research has been done on the types of PSS that currently exist, such as Vonk's (2006) categorization of PSS as 'informing', 'communicating' and 'analyzing' PSS.

PSS-theory not only concerns the instruments themselves, but also the way in which these are applied to planning practices. One of such concepts is 'usefulness', a UX-design concept developed by Nielsen (1993) and first applied to PSS-theory by Pelzer (2015). The usefulness of a system such as PSS is defined as 'whether the system can be used to achieve some desired goal.' (Nielsen, 1993, p. 24). The usefulness of PSS for a planning task can be determined by a system's 'utility' (the extent to which the technology of a PSS is suitable to fulfil the planning task) and 'usability' (the extent to which users are able to use the PSS) (Pelzer, 2015).

The growing amount of research that has been done on planning support systems and the way these are applied to practice have matured this topic into 'PSScience' (Geertman & Stillwell, 2020). Moreover, the use of planning support systems has not only remained a concept in planning theory.

An increasing amount of (digital) PSS-tools have been developed and used for various planning tasks and professions. Such tools have the potential to support the aforementioned increasing complexity in planning by being an answer to the aforementioned 'how' question when participation will have become a requirement in Dutch planning projects. However, research on planning support systems have also surfaced several issues regarding the existing PSS and the application thereof. A relatively large share of the PSS that are developed throughout the past decades have not been able to keep their success until this day, as the field of ICT and PSS is still in rapid development. The main reason for this is the focus on the technological functions of the PSS (supply) instead of on the tasks these support (demand). This gap, which affects the usefulness of PSS in practice, is referred to as the 'implementation gap' (Geertman & Stillwell, 2020).

During the time of this research, the aforementioned digitalisation in society is in a rapid surge since the beginning of 2020, caused by the corona pandemic. Businesses, organisations and the rest of society was forced to switch their physical gatherings to online alternatives, which rapidly increased digital working and internet usage (De', Pandey & Pal, 2020). The corona pandemic, and the sudden switch to online activities, also impacted the spatial planning field. Environment managers could no longer physically interact with stakeholders, and therefore needed to switch to digital alternatives (Van Velzen, Verbon & Visser, 2020). In this sense, the role of planning support systems in planning practices has rapidly become more prominent during the corona pandemic.
Thus, digitalisation has influenced a large share of the world's society and economy throughout the past decades, including the field of spatial planning. This digitalisation, the increasing complexity of planning issues, the more recent corona pandemic and the upcoming Dutch Environment & Planning Act make it increasingly relevant to do more research on the usefulness of PSS in spatial planning projects in the Netherlands.

This research is aimed at gaining knowledge in how planning support systems can be useful for the environment management tasks in large-scale infrastructure projects in the Netherlands, and what the current state of this usefulness is in this context. By doing so, this research is aimed to contribute to PSScience by studying PSS-tools that are currently being used for environment management, specifically focussing on large-scale infrastructure projects in the Netherlands. Besides adding new empirical knowledge about the current usefulness of PSS in this context, this research is also meant to provide the work field of environment management with insight about the current state of the use of tools and the potential directions in which to develop tools for more optimal support. In relation to these aims, this research was conducted according to the following main question:

How useful are planning support systems for environment management in large-scale infrastructure projects in the Netherlands?

As aforementioned, the usefulness of PSS can be determined by its utility and usability (Nielsen, 1993; Pelzer, 2015). Therefore, the main research question is answered through the following two sub-questions:

1. *What is the utility of planning support systems for environment management in large-scale infrastructure projects in the Netherlands?*
2. *What is the usability of planning support systems for environment management in large-scale infrastructure projects in the Netherlands?*

Academic relevance

As addressed by Geertman (2008), there is a lack of knowledge about how to evaluate and monitor the use of planning support systems. This is related to a lack of attention for the theoretical part of such research and for the methods that are applied in researching the use of planning support systems. This research is aimed at examining the usefulness of PSS in a specific context, which is for a large part based on existing theoretical concepts. Therefore, this research and its methodology can provide insight in how theoretical concepts can be applied to evaluate the current situation regarding the use of PSS in a specific planning context.

Such additional insight in how to evaluate the use of planning support systems in a specific planning context can become increasingly valuable. Geertman & Stillwell (2020) explained how planning support systems are being used increasingly regularly in planning contexts around the world. Moreover, te Brommelstroet (2013) addressed the need for more research on the use of planning support systems in practical settings to gain insight in the positive and negative factors that come with applying PSS in these different planning contexts. This research provides such knowledge about the use of PSS in a specific planning context: the usefulness of planning support systems for environment management in large-scale infrastructure projects in the Netherlands. According to the usefulness concept, this research provides insight in how planning support systems are currently used in this research context and the positive and negative factors of doing so.

Regarding the aforementioned implementation gap, Vonk & Geertman (2008) addressed how planning support systems are mostly developed and applied to planning practices based on their technical characteristics (supply), instead of considering the demand based on the planning task(s) it is aimed to support. Geertman and Stillwell (2020) addressed more recently that, despite the developments in PSS, this implementation gap is still an issue with PSS to overcome. By examining the usefulness of PSS, this research is specifically aimed at the extent to which planning support systems have a supporting role for the environment management tasks that are carried out in the context of large-scale infrastructure projects in the Netherlands. Therefore, this research not only considers the instrumental characteristics of the PSS-tools (supply), but rather focuses on how these currently (and could potentially) support the environment management tasks that are carried out in such project-contexts and the users that are involved (demand).

Societal relevance

As addressed by Geertman & Stillwell (2020), the aforementioned implementation gap between the existing planning support systems and the demand in planning practice has maintained the need for better planning support systems as planning problems become increasingly complex. This complexity especially increased throughout the past decades as an increasing variety of stakeholder and other professions got involved in planning practices (Geertman & Stillwell, 2020).

As aforementioned, along with this trend of increasing complexity in planning, another trend took place: the digitalisation of society. This trend is believed to become an important factor in continuing the provision of good public services to citizens (Granath, 2016). This is also perceived by the Dutch government, which expects digital infrastructure will have a supportive role in the upcoming Environment & Planning Act, in which participation will have a more prominent position in urban development (Ministerie van Infrastructuur en Milieu, 2017). Therefore, the aforementioned complexity in planning can benefit from the potential contribution that the digitalisation of society can bring, but this requires the development of better PSS. This research examines the usefulness of PSS for environment management, which concerns the integration of planning projects into its physical and social environment (Wermer, 2018). In this sense, this research will provide insight in how planning support systems can be useful, and are currently useful, as a support tool in the increasing complexity of planning issues and actors involved.

2. Literature review

2.1 The context of large-scale infrastructure projects in the Netherlands

The usefulness of PSS technology in planning practices depends on the context it is being applied to (Geertman, 2008; McEvoy, van de Ven, Santander & Slinger, 2019). Therefore, before elaborating on the relevant PSS concepts for this research, the context of this research topic and thus the context in which the usefulness of PSS is being researched will be reviewed in this section.

2.1.1 The institutional context of the Netherlands and its communicative turn

Throughout the past decades, the dominant style of spatial planning in the Netherlands has shifted from state-centred comprehensive planning to a participatory style based on social interaction. Until the 1980's, planning issues were perceived as well-structured, with scientific objectivity and political neutrality. This legitimised the government as the single-acting decision-maker that designed and implemented comprehensive plans (Geertman, 2006).

This state-centred approach in spatial planning changed after the 1980's as a result of scientific and societal developments. During this time, scholars such as Healey have increasingly acknowledged planning as an interactive and interpretative process between multiple dimensions in society (Innes & Booher, 2015). This 'communicative turn' did not only happen in planning theory, but also in planning practice. Boundaries between public and private sectors faded as both sectors increasingly cooperated in planning activities. This would improve the efficiency of the public service, which was increasingly being perceived as a complex practice with complex issues. These complex issues could only be addressed through interaction between the involved actors (Grijzen, 2010).

As planning became a practice that involved an increasing number of actors, the diverse experiences, perceptions and opinions of those actors were increasingly recognised as distinctive forms of knowledge. This meant a shift from knowledge in spatial planning being perceived as unitary to being the result of social interaction between these distinctive forms of knowledge (Geertman & Stillwell, 2020). Thus, throughout the past decades, boundaries have faded between public and private, as well as between science and non-science as spatial planning was becoming a multi-actor activity (Grijzen, 2010).

The aforementioned shift after the 1980's also happened in the Netherlands. Its once 'closed' spatial planning system opened up as other kinds of experts entered the planning field and initiatives started to come from outside the government. Stakeholders were increasingly involved in interactive planning settings between both public and private organisations (Grijzen, 2010). These developments of planning in the Netherlands happened while the post-war social system was being cut back and government functions were being slimmed and/or passed to other government institutions (Marshall, 2012). Thus, from the 1980's, the former roles and responsibilities of the Dutch government in spatial planning has both shifted and fragmented among multiple actors in both public and private sectors.

In reaction to the increased number and diversity of actors, the involvement of stakeholders in projects will be further institutionalised in the upcoming Dutch Environment & Planning Act. In this new Act, participation is an obligatory element throughout the project's existence. (Unie van Waterschappen, 2020).

The Netherlands is a democratic state in which decision-powers and responsibilities are distributed vertically (multiple scales of government) and horizontally (multiple sectors and elements of government). These distributions are also relevant to the field of spatial planning, which takes part in the overall planning of government and society and is therefore present throughout the different

scales (national, provincial and municipal) and sectors of government. The aforementioned trends and distribution of Dutch spatial planning have made it an increasingly interactive practice with an increasing number and diversity of actors involved (Marshall, 2012). These actors will have a more prominent position in projects, as their participation is institutionalised when the Environment & Planning Act will take effect.

2.1.2 Large-scale infrastructure projects and their stakeholder complexity

The aforementioned interactive character of present-day spatial planning is also relevant to large-scale infrastructure projects. For this research, large-scale infrastructure projects refer to projects that connect, protect and supply citizens in the Netherlands on a regional or above-regional scale (e.g. dikes and roads). In the Netherlands, the initiative of large-scale infrastructure projects mainly comes from government actors, after which these are commissioned to be executed by private actors. This would contribute to the efficiency and capacity of executing such projects in the increasingly complex planning context (Grijzen, 2010). However, as these projects serve the public interest, the Dutch government maintains some influence in order to guard this public interest (Marshall, 2012).

The various types of relationships that can exist between public and private actors can be considered as 'governance networks', which refers to a network of relationships between public and private actors in public policy-making and implementation. The diversity of actors in such governance networks lead to complexity in projects for multiple reasons: actors have different interests; different perceptions of problems and solutions; actors are interdependent; and decisions are made in multiple different settings at the same time. In regard to communicative planning, these reasons of the complexity correspond to the critique that is given to communicative planning as not being carried out properly and therefore resulting into complexity (Innes & Booher, 2015). In overall, regarding the reasons behind the complexity in projects it can be stated that: the higher the number and diversity of actors, the more of such network complexities occur in these governance networks (Verweij, Klijn, Edelenbos & Van Buuren, 2013).

The regional/above-regional scale on which large-scale infrastructure projects in the Netherlands are executed, and the public interests these projects serve leads to a relatively large number and diversity of stakeholders that are involved and/or affected by such projects. These stakeholders range from actors that are directly involved in the project to actors that are affected by the project (Chinyio & Olomolaiye, 2010). Furthermore, the interaction between the government as initiator and private actors as executers increases the interdependence between the public and private sector, which could come with conflicting interests and perceptions of the project at stake (Verweij et al., 2013). Regardless of how powerful and to what extent stakeholders are involved in a project, there are various ways how they can influence it: from starting legal procedures to expressing their resistance in the media (Chinyio & Olomolaiye, 2010).

Thus, managing large-scale infrastructure projects in the Netherlands are often complex because of the large number and diversity of stakeholders as a result of the regional/above-regional scale and the public interests these projects serve. The interdependence and potential conflicts between stakeholders on one hand, and their various options to influence the project on the other hand can make this network complexity a risk factor in Dutch large-scale infrastructure projects.

2.1.3 Project phases and environment management according to the IPM-model

As aforementioned, roles and responsibilities in large-scale infrastructure projects in the Netherlands have increasingly fragmented due to the growing number and variety of involved

actors. Together with the growing amount of input that must be considered as the process continues, large-scale infrastructure projects have become more and more complex. In reaction to this, Rijkswaterstaat - the executive agency of the Dutch Ministry of Infrastructure and Water Management (Rijkswaterstaat, n.d.) - developed the integrated project management model (IPM). By following a more uniform and transparent approach with more possibilities to involve external actors, the IPM-model would improve the collaboration between public and private actors, and would optimise the outcome of projects (Wermer, 2018).
In IPM-projects, five managers each represent the five disciplines that come together in an infrastructure project. These five managers are: project manager; manager for project control; environment manager; technical manager; and contract manager. Despite being different disciplines, collaboration and equality are central to the IPM-model (Wermer, 2018).

Phases in the IPM-model

Projects that are executed according to the IPM-model exist of the three phases: exploration, plan-development, and implementation. During the exploration phase, the problems are analysed after which potential solutions are formulated. The phase concludes with a specification of the preferred solution (alternative), based on the practical and legal possibilities and how it suits best with the different interests that are involved (Bernardini & Knoeff, 2017).

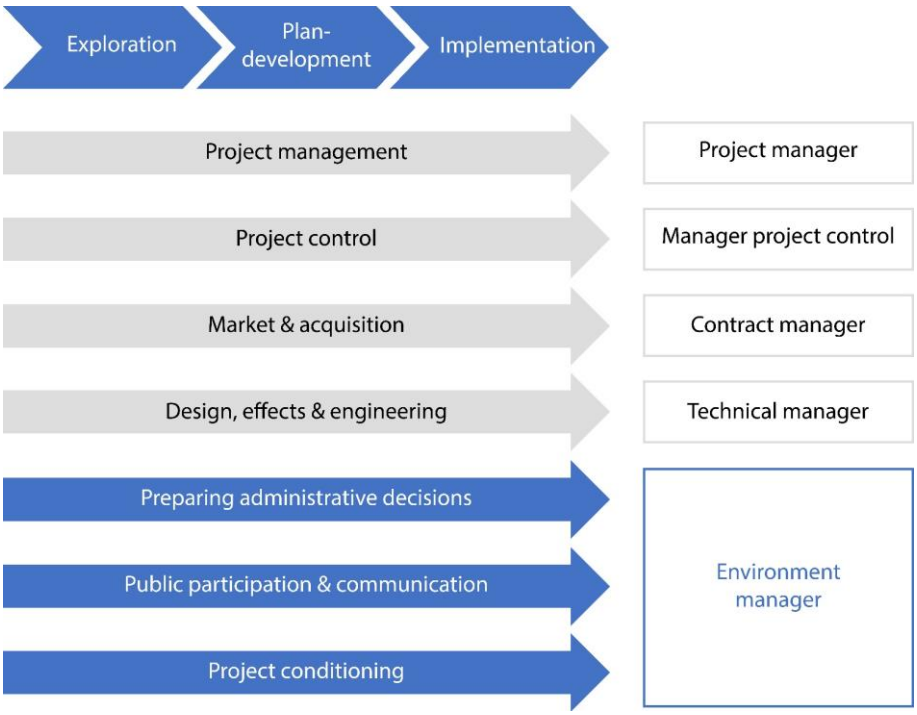

Figure 1: The phases, processes and manager roles in the IPM-model
(adapted from: Wermer, 2012)

After determining the direction of the plan, it is developed in further detail during the plan-development phase. Besides further development of the plan, the required actions and measures to implement the plan are being determined. This includes preparation of the contracts that are required for the implementation phase of the project (Bernardini & Knoeff, 2017; Ministerie van Infrastructuur en Milieu, 2016).
Being the final phase of the IPM-project, the implementation phase concerns the preparation and construction of the plan that is developed throughout the previous phases. After finalisation, the constructed project is operational and enters the maintenance phase (Bernardini & Knoeff, 2017).

Throughout these phases, seven processes simultaneously take place: project management; project control; market & acquisition; design, effects & engineering; preparing administrative decisions; public participation & communication; and project conditioning. These processes are carried out by one of the aforementioned IPM-managers (figure 1), in which the environment manager is responsible for:

- *Preparing administrative decisions*: follow the procedures according to law and policies.
- *Public participation & communication:* integrating the project in its social environment.
- *Project conditioning:* removing the physical and legal conflicts between the project and the environment it will be implemented in (Wermer, 2018).

Environment management in IPM-projects

In this research, the practice of environment management is based on the IPM-model that is applied to most large-scale infrastructure projects in the Netherlands. However, international literature about infrastructure and construction projects associates most of the processes that are being carried out by the IPM environment manager with the practices of stakeholder managers and project managers (Chinyio & Olomolaiye's, 2010). Therefore, this section explains the practices and tasks that are carried out by environment managers according to the IPM-model.

The three aforementioned processes of which the environment manager is responsible all concern the procedures that are required to integrate the project in its environment. This 'environment' refers to all parties that have an interest in the project, which include citizens, cable-infrastructure operators, local businesses, authorities, etc. The environment manager engages with these external stakeholders and agencies to integrate their claims and agreements into the project, which also requires interaction with the other members of the project. To enable the project to be implemented, the environment manager follows the required planning procedures, which include obtaining the required permits. composing agreements, and coordinating the required actions regarding cable-infrastructure, damage claims, expropriation, and research in the area (archaeology, explosives etc.). Thus, the environment manager is the link between the internal organisation of the project and the external integration in its environment (Expertgroep Projectmanagement, 2008).

For large-scale infrastructure projects in the Netherlands that follow the IPM-model, the following tasks of the environment manager can be formulated (Wermer, 2018):

- Gathering information about the environment to gain the knowledge that is required for the project to succeed.
- Regularly conducting stakeholder analyses to keep the stakeholder strategy up-to-date to achieve the goals of the project.
- Managing the communication and provision of information about the project for all stakeholders and relevant agencies.
- Managing the administrative procedures that are required to integrate the project into its environment (e.g. planning procedures, permit procedures and coordinating with cable-infrastructure operators).
- Maintaining contact with the external stakeholders and agencies that are relevant and/or important for the project's progress.
- Collecting claims and requests from external stakeholders and agencies and sharing these with the project organisation.

The majority of these tasks include interaction with external stakeholders, agencies and project members. In this research, external stakeholders are the actors that are not essential for the project's success, but are affected by the project and have the ability to influence it (e.g. the local community

and organisations). Agencies are actors or organisations that do not take part in the project but exercise influence over the project's success, which cannot be controlled by the project members (e.g. government authorities, traffic managers, cable-infrastructure operators). In other words, cooperation by these agencies is required for the project's success. The project members are the actors that are directly involved in the project and have interest in its success (e.g. project team, client, investors) (Chinyio & Olomolaiye, 2010).

2.2 Conceptual model

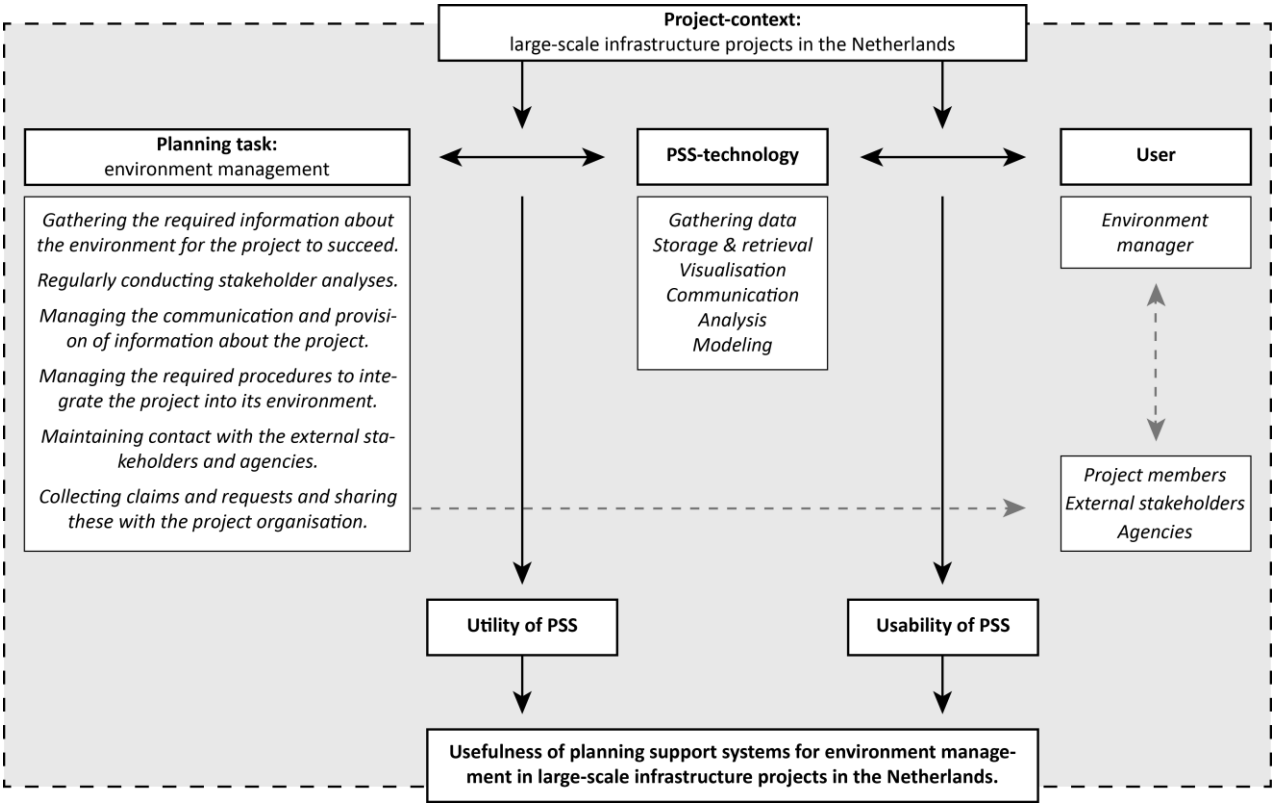

Figure 2: Conceptual model.

The conceptual model (figure 2) combines the concepts through which this research is carried out. It is partly based on the previously explained context of large-scale infrastructure projects in the Netherlands, in which the environment management tasks and the involved actors are explained. As visible in the conceptual model in figure 2, the project-context overarches the relation between the PSS-concepts, as this context influences the usefulness of PSS (Geertman, 2008; McEvoy, van de Ven, Santander & Slinger, 2019). As this research focuses on the usefulness of PSS for the tasks of environment managers in this project-context, the environment manager can be considered as the main user of PSS. However, as explained in the previous section, several environment management tasks include interaction with project members, external stakeholders and agencies. Therefore, in some situations, these actors could also be users of a PSS. As briefly explained in the introduction (chapter 1), the usefulness of PSS can be determined by its utility (the extent to which it is suitable to fulfil environment management tasks) and usability (the extent to which users are able to use the PSS functionalities). These PSS-concepts and their relations are further explained in the next section.

2.3 Usefulness of Planning Support Systems (PSS)

Throughout the past decades, a variety of scholars have written about Planning Support Systems (PSS), which has led to a variety of definitions. As stated by Geertman & Stillwell (2009), these definitions refer to PSS as 'being capable of improving the handling of knowledge and information in planning processes, a function that provides huge assistance to those involved in handling the ever-increasing complexity of planning tasks' (p. 3).
PSS can support both the planning process and its outcome and can be categorised into three main typologies (Vonk, 2006):

1. *Informing PSS*: making planning-related knowledge and information accessible and interpretable.
2. *Communicating PSS:* facilitating communication between those involved in planning.
3. *Analysing PSS:* facilitating the processing of data to find patterns, make projections, simulations and evaluations.

Moreover, PSS can exist in multiple forms, such as: physical devices; web-based PSS that enables sharing data across organisations; GIS-based PSS that enables sharing geographical information; and digital PSS that supports managing and processing data (Geertman & Stillwell, 2009). This research is aimed at the usefulness of digital planning support systems that are (partly) accessible on the internet.

2.3.1 Task-technology-user fit

The aforementioned support functions of planning support systems imply that it can be an added value to planning tasks in multiple ways. However, despite the increase of PSS literature and tools, their use in planning practice has remained limited (Te Brömmelstroet, 2013). This limited application is due to a variety of bottlenecks that occur when attempting to use PSS in practice. Several of these bottlenecks relate to a poor fit to the planning task (utility) and to those who use it (usability) (Geertman & Stillwell, 2009). This relation between the planning task, PSS technology and the users is referred to as the task-technology-user fit (Vonk, 2006).

Planning task:

There is a large variety of tasks that come with planning, which makes this profession impossible to generalise (Vonk, 2006). As the aim of this research is to gain insight in the usefulness of PSS-technology for the practice of environment management, 'planning task' for this research concerns the tasks that come with environment management. These tasks concern the environment management tasks according to the IPM-model, which have been formulated earlier in this chapter.

PSS-technology:

For the handling of information, Vonk (2006) has classified six technological functions of PSS in planning processes: information gathering; information storage and retrieval; visualisation; communication; analysis; and modelling (e.g. forecasting).

User:

As this research is aimed at the usefulness of PSS to carry out environment management tasks, the environment manager can be considered as the main user of PSS-technology in this context. However, many of the environment management tasks include interaction with external stakeholders, agencies and project members (Wermer, 2018). Therefore, besides the environment manager as user of PSS, these three actor-groups can also be considered as users of PSS when using it for environment management tasks.

2.3.2 Usefulness

Nielsen (1993) has defined 'usefulness' as 'whether the system can be used to achieve some desired goal.' (p. 24). He explained how this usefulness is one of the characteristics to determine whether a system is 'acceptable' to use in practice. Scholars explained the multiple ways how PSS can be useful for planning practices, such as by sharing information; gaining insight in the nature of the planning object; and by enabling carrying out more tasks with lower investment (Pelzer, 2015). However, scholars have also addressed multiple issues regarding the use of PSS in practice, which mainly relate to a mismatch (implementation gap) between the PSS' functionalities (supply) and the tasks and/or users it supports (demand) (Zhang, Geertman, Hooimeijer & Lin, 2019).

The usefulness of a system, such as PSS, can be broken down into its 'utility' and 'usability', which both can be placed in the aforementioned task-technology-user fit model, as visible in figure 3. In relation with this model, it becomes clear that determining the usefulness of PSS in a specific planning context requires evaluating the extent to which the PSS 'matches' with both the planning tasks and the users (Pelzer, 2015).

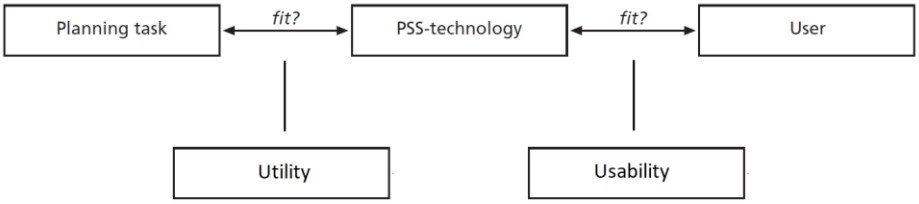

Figure 3: Utility and usability of PSS, in relation with the task-technology-user fit concept. (adapted from: Vonk, 2006)

Utility:

According to Pelzer (2015, p. 131), utility is achieved 'if the characteristics of the [PSS] technology (…) are suitable for the planning task that has to be fulfilled'. In this sense, utility fits between 'task' and 'technology' in the task-technology-user fit concept. Based on this position, utility can be assessed by evaluating to what extent the functionalities of a PSS are suitable to carry out the environment management tasks that have been explained in the previous section. Thus, for this qualitative research, the utility of PSS for environment management tasks is assessed as follows:

To what extend does the PSS-technology support:
Gathering information about the environment to gain the knowledge that is required for the project to succeed.
Regularly conducting stakeholder analyses to keep the stakeholder strategy up-to-date to achieve the goals of the project.
Managing the communication and provision of information about the project for all stakeholders and relevant agencies.
Managing the administrative procedures that are required to integrate the project into its environment (e.g. planning procedures, permit procedures and coordinating with cable-infrastructure operators).
Maintaining contact with the external stakeholders and agencies that are relevant and/or important for the project's progress.
Collecting claims and requests from external stakeholders and agencies and sharing these with the project organisation.

Table 1: Assessment (criteria) of the utility of PSS-technology for environment management tasks.

Usability:

The second determining factor of usefulness is usability of the PSS technology, which concerns the extent to which users are able to use PSS functionalities (Pelzer, 2015). This means that usability can be placed between 'technology' and 'user' in the task-technology-user fit concept. Nielsen (1993) has defined five attributes to determine a system's usability, according to which this research assessed the usability of PSS:

Usability attributes:	***Description***
Learnability	The extent to which the tool is easy to learn, so tasks can be carried out rapidly.
Efficiency	The extent to which the system is efficient to use after learning using it, to achieve productivity.
Memorability	The extent to which the system is easy to remember, so that it can be used again after some period of not using it.
Errors	The extent to which the system has errors and users make errors. And if so, the extent to which it is easy to recover from errors.
Satisfaction	The extent to which the system is pleasant for users to use.

Table 2: Attributes (criteria) of system usability (from: Nielsen, 1993).

3. Methodology

3.1 Research strategy

This research is about gaining deeper understanding about a phenomenon in a specific context: the usefulness of planning support systems for environment management in large-scale infrastructure projects in the Netherlands. As explained in the literature review in the previous chapter, this usefulness can be determined by a collection of variables, which mainly derive from how users of the planning support systems have experienced using PSS-tools in this research context, with the environment managers and their tasks as a focus. In this sense, this research is aimed at studying how the social actors in this context interact with PSS-tools which 'constructs' the usefulness of these tools. This understanding of the research topic is related to the constructionist ontology, which can be researched best with a qualitative research strategy (Bryman, 2012).

3.2 Case study research

As addressed in multiple articles, the usefulness of planning support systems is dependent on the context it is being applied to (Geertman, 2008; McEvoy, van de Ven, Santander & Slinger, 2019). When a phenomenon cannot be separated from its context, the most suitable method to research such phenomenon is by conducting case study research (Yin, 2018). Furthermore, it is the objective of this research to generate knowledge about a specific context: environment management in large-scale infrastructure projects in the Netherlands. Therefore, to come to findings about the usefulness of planning support systems in this context, the inclusion of this context is required (Merriam & Tisdell, 2015).
Within this research context, there remains some diversity in the type of projects and PSS-tools that are applied in these projects. Therefore, conducting an in-depth case study on one project in this context might result in a rich set of data, but these findings would come with limited generalizability for other projects and PSS-tools within this context. In other words, a case study without variation of projects and PSS-tools would lead to findings that rely on specific project conditions and a specific tool. Therefore, a comparative case study has been conducted with a variation of projects and PSS-tools, which are all relevant to the context of the research topic. The comparison of these cases enables generalization of similarities, while contrasting results provide insight in variations that depend on specific project conditions or the type of tool being used (Merriam & Tisdell, 2015).

3.2.1 Case criteria & selection

As aforementioned, this research is conducted by doing a comparative case study with some variation between the cases. In order to guarantee the feasibility of the research and the relevance of each case to the research context (Yin, 2018), the cases that were studied have been selected according to the following criteria:

1. ***To fit in the research context:*** the project is a large-scale infrastructure project in the Netherlands. Based on the explanation of this research context in the literature review, these concern projects that connect, protect or supply citizens in the Netherlands on a regional or above-regional scale. To ensure this regional or above-regional scale, a Provincial and/or at least two municipalities should have been involved in the project.

2. ***To research the right planning support systems:*** in each case, the PSS-tool being studied should have been used for environment management tasks. Moreover, as this research is focused on digital and online planning support systems, the tools should be digital software which were (partly) accessible online.

3. ***To ensure availability of data:*** at least one person who carried out the environment management tasks in the project is available to be interviewed. Besides the possibility to interview, content about the project and the tool (e.g. data from the tools and project-documents) is available for the researcher.
4. ***To ensure variation:*** each case should consist of a different PSS-tool, in a different type of project with a different person as the environment manager. As aforementioned, this variation prevents the findings of this research to rely on a specific tool and/or project, and provides insight in the variations of usefulness between these project conditions.

With these case criteria, the following cases have been selected to be studied:

Project	***Planning support system that was used***
Cycle fastlane between Utrecht and IJsselstein	IMBY
Lock renovation in Den Helder	Relatics
N203 liveability research Krommenie-Assendelft	Maptionnaire

Table 3: The studied projects and the used planning support systems.

3.2.2 Operationalisation: research propositions

The aim of this qualitative research is to gain deeper knowledge about the usefulness of PSS in a specific context of which existing knowledge is limited. Therefore, this research was an inductive process, in which the relevant themes and categories of the findings mainly derived from the research instead of from existing theory and the confirmation or rejection thereof. Regarding this inductive approach, one of the critiques on case study research is the lack of a systematic procedure according to which cases are being studied (Yin, 2018). To ensure that each of the studied cases in this research would be studied in the same systematic way, research propositions were formulated based on the theoretical concepts that are explained in the literature review. Moreover, formulating research propositions based on existing theory contributes to the validity of the research, as this helps with gathering the right information in order to answer the research question properly (Bryman, 2012). In combination with the conceptual model from the literature review, these research propositions have served as a lens through which the data could be collected and analysed (Merriam & Tisdell, 2015). The list of research propositions can be found in appendix 1 and have been formulated within the following concepts:

Project-context

As aforementioned, case studies were done for this research because the usefulness of planning support systems cannot be separated from the context in which these are applied. Therefore, the project-contexts of the cases have been studied according to the main contextual elements that are explained in the literature review, which mainly concern information about the project and the actors that are involved.

Task-technology-user

As explained in the literature, the usefulness of a planning support system can be determined by its utility and usability, which can be placed in the task-technology-user model (Pelzer, 2015). Therefore, to gain understanding of the utility and usability of the tools in each case, the supported tasks, technological functions and the users have been studied for each tool in each case.

Utility and usability

This qualitative research about the usefulness of planning support systems is for a large part based on the experiences of the environment managers. Therefore, too much research propositions for utility and usability could limit the amount of new perspective this research could gain (Yin, 2018). However, in order to connect this research to existing knowledge and to ensure the collection of the right data, some propositions have been formulated to evaluate the utility and usability of the tools in each case, which can be found in appendix 1.

3.3 Data collection and analysis

The aforementioned research propositions have guided the data collection and analysis process of this research. The required data to come to findings according to these propositions concern both objective data about the project and the PSS tool, and data about the experiences of users regarding the use of PSS in the project. Therefore, the two most suitable methods to collect these types of data are interviews and content analysis. Furthermore, the collection of data by using multiple sources (triangulation) optimises the validity of the findings, as this will limit the reliance of the findings on one data source and thus limits the influence of bias from these data sources (Bryman, 2012). Access to the data (content and interviews) was provided by engineering consultancy Sweco, in which the researcher carried out the research in combination with an internship.

3.3.1 Semi-structured expert-interviews

Because this research is aimed at gaining further insight the usefulness of PSS for the environment managers' tasks and their experiences regarding this, one of the data collection methods in this research was conducting expert-interviews with environment managers (Baarda et al., 2013). Originally, the aim was to also interview external users of the studied PSS-tools (i.e. external stakeholders and agencies). However, this was not feasible because of the privacy regulations the engineering consultancy Sweco is working with, which do not allow using the contact details that the users left when they used the tools. As this research is aimed at environment managers' tasks and their experiences with using the tools, this limitation did not affect the aim of this research. Information about how other users used and experienced the tool was asked in the expert-interviews and examined in the content analysis.

As aforementioned, this research has taken an inductive approach, in which the findings derive from the data collected in this research. Therefore, the expert-interviews were semi-structured, which allows the environment managers to come up with their own themes that are related to the topic and to be flexible for follow-up questions (Baarda et al., 2013). To ensure the interviews covered all the relevant topics, the questions were based on the research propositions that are explained in the previous section. The list of interview questions can be found in appendices 2 (Dutch) and 3 (English).

For each case, one environment manager has been interviewed, of which each on average took one hour and fifteen minutes. The language in which the interviews took place was Dutch, as that is the native language of the environment managers and the researcher. This enabled the environment managers to express themselves without a language barrier, and the researcher to transcribe and interpret the information in the native language (Bryman, 2012). Table 4 provides an overview of the interview dates of each case and the location of each the transcript in the appendices. Both the Dutch and the English versions of the interview questions can be found in appendices 2 and 3. Due to the covid-19 pandemic the interviews were held online via Microsoft Teams and have been recorded and transcribed anonymously with consent of the respondents, of which the transcripts can be found in appendices 5, 6 and 7.

Case:	*Date of the interview*	*Appendix of transcript*
Case 1: Cycle fastlane project: IMBY	22 May, 2021	Appendix 5
Case 2: Lock renovation project: Relatics	3 June, 2021	Appendix 6
Case 3: N203 liveability research: Maptionnaire	11 June, 2021	Appendix 7

Table 4: Overview of interview dates and their location in the appendices.

Types of questions

As aforementioned, the full list of interview questions can be found in appendices 2 and 3. To give a brief explanation of the types of questions that were asked in the interviews, this section describes the different parts of the interview with some of the questions as example.

In the first part of the interview, broad questions were asked about the project, the environment management tasks, the involved actors, and how these tasks and users relate to the tool (e.g. users, used for which tasks). Moreover, the interview started with broad questions about the tool and the motivation behind using that tool. Some of these questions and follow-up questions were:

- What actors were (indirectly/directly) involved in the project, and what were their interests?
    - Which of the actors in the project made use of the tool and how?
- Can you tell me more about the tool that was used in this project, and why specifically this tool was chosen?
    - Can you describe the functionalities the tool has?

The second part of the interview concern questions regarding the utility criteria that were formulated (chapter 2) based on the environment management tasks defined by IPM-literature, such as:

- To what extent does this tool support gathering information about the environment to gain the knowledge that is required for the project to succeed?

Similar to utility, in the third part questions were asked regarding the usability criteria (chapter 2) according to Nielsen's (1993) usability attributes, such as:

- How easy was the tool to understand in order to carry out the actions you wanted to do?

Additionally, questions were asked about how other user groups made use of the tool, and to which extent the tool was usable for the other users:

- Can you describe for each user of the tool: for which purpose did they make use of the tool, and through which functionalities?
- Can you generally reflect on to what extent the users of the tool were able to make use of it?

Can you also, more specifically, reflect on:

- How pleasant and easy was it for the other users to use the tool?
- How well could each user get familiar and efficiently navigate through the tool?

3.3.2 Content analysis

To gather additional data about the usefulness of planning support systems and about the project-context itself, the relevant documents and files of each project are analysed by conducting a 'content analysis'. Besides written documents, this content also includes export-files of the PSS-tools, which mainly concern exported excel-files with input from (external) stakeholders, and information how this input is further processed. Moreover, the results from the content data and interviews are, where relevant, supported by figures (e.g screenshots of the tool). This enables the reader to better understand the tool and the results of this research.

Documents and other existing content cannot be influenced anymore by the researcher and/or other external factors, which adds more credibility to the data and findings in this research. In relation to the data from the interviews, this data triangulation limits the potential influence of the bias from the interview respondents. However, this variety of content also required selection and interpretation by the researcher (Bowen, 2009). To ensure a systematic process and the selection of the right data, the data in this content is selected in the same way as the interviews: according to the research propositions that can be found in appendix 1.
To gain insight in the project and its process (including the use of the tool) in each case, the content analysis included documents in which the results of the project were reported. This concerned a reaction note (a response to the input that was gathered through a tool), and research reports (in which the results and the process is reported, including the tools). These documents were owned by the government actors that were involved in the project, which made these publicly available on the internet. These publicly available documents are listed in the bibliography of this thesis. The content that is not publicly available (e.g. export-files of the tool and internal content) is possessed internally by the project initiator and by Sweco. For each case, both the public and non-public content is described in the table below:

Case 1: Cycle fastlane project: IMBY	***Content description***	***Reference in the text***
Non-public content:	Exported excel-file with all the comments that were placed in IMBY, with each of them provided with response.	(Exported comments, 28 April 2021)
Public content: (full references stated in bibliography)	The 'Reaction Note', which is the Province's response to the comments that were left in the IMBY tool.	(de Bruijn, 2021)
	Letter for the residents and businesses nearby the route.	(Van Engelenburg, 2021)
Case 2: Lock renovation project: Relatics		
Non-public content:	Tender request by the Province of North-Holland to engineering consultancies.	(Tender document of Province, 27 September 2018)
	First part of Sweco's Plan of Approach, used in the tender process	(Sweco plan of approach step 1, 2018)
	Second part of Sweco's Plan of Approach, used in the tender process.	(Sweco plan of approach step 2, 2018)
Public content: (full reference stated in bibliography)	Report about the feasibility of a temporary alternative route during the renovation of the lock.	(Van der Meer et al.2020)
Case 3: N203 liveability research: Maptionnaire		
Non-public content:	Sweco's plan of approach to carry out the project for the Province of North Holland.	(Sweco plan of approach, 2020)
Public content: (full reference stated in bibliography)	End report with the results from this liveability research project, in which the process is also described.	(Van Velzen, Verbon & Visser, 2020)

Table 5: List of the non-public and public content that was used in each of the studied cases.

3.3.3 Data analysis

To systematically organise the different types of data that is collected in this research, NVivo is used to code all this data. Coding concerns labelling data according to themes and categories (Bryman, 2012). The data in this research is coded according to the research propositions, of which the coding scheme can be found in appendix 4. In this way, data from different sources could be combined and organised into the same structure, which enabled the formulation of the results in the same structure for each case. Besides describing the utility and usability of the tools in each case, these criteria were given a green (criterium is met), yellow (criterium is partly met) or red (criterium is not met) colour in each of the cases. The formulation of the results according to the same structure, and by summarizing this according to colours, optimises the comparability of case results (Yin, 2018), which is the main data analysis strategy of this research. From this case comparison, similarities and differences between cases came forward, which resulted into general and context-specific findings regarding the usefulness of planning support systems for environment management in large-scale infrastructure projects in the Netherlands.

3.4 Quality of the research

The quality of research is mostly expressed in its reliability, validity and generalizability (Bryman, 2012). Firstly, reliability refers to whether the results of the research are consistent, which means that the same results would come out of the research when repeated. In a qualitative research this is hard to achieve because of the influence of the social setting in which the research takes place (Bryman, 2012). Therefore, in qualitative research, transparency should be provided by reporting and motivating the chosen methods and procedures, which is also the aim of this methodology chapter (Boeije, ‘t Hart & Hox, 2009). The reliability of this research is optimised by formulating research propositions (appendix 1), which are based on the existing theory that is relevant to the research topic as explained in the literature review. Together with the case criteria, these research propositions are part of the case study protocol (Yin, 2018), and were the base for the formulation of the interview questions, and for coding the interview transcripts and the collected content. Therefore, together with the conceptual model, these research propositions guided the collection of data in the same way for each case, which also optimised the comparability between these cases. Additionally, further transparency of this research is provided by including the interview transcripts (appendices 5, 6 and 7), a list of the content that is used (table 5), and by including the coding scheme that was used in NVivo (appendix 4).

Secondly, validity refers to whether the right methods were used in order to come to the right findings about the concepts that are being studied. Using multiple sources of data increases the validity, as this strengthens the match between the findings and social reality (Yin, 2018). Therefore, multiple types of data have been collected from multiple sources, which concern interviews, internal and external documents, and exported files of the tools that were studied. In this sense, information from the interviews could be confirmed and/or complemented by the documents and files, and vice versa.

Finally, generalizability refers to the extent the findings of the research are applicable to other contexts and cases (Bryman, 2012). This research concerns a specific planning profession in a specific context: environment management in large-scale infrastructure projects in the Netherlands. Therefore, the findings in this research are hardly generalizable beyond this research context. However, this research is carried out by studying and comparing three cases within this research context. Despite the number of cases being limited to three, similarities between these cases are likely to be applicable to other cases within this context as well, especially because each case concerned different tools and projects (Yin, 2018). Therefore, by studying and comparing multiple cases, the findings of this research are generalizable within the research context.

4. Cycle fastlane Utrecht – Ijsselstein: IMBY

4.1 Case description

The project being studied in this case is part of the plan of the Province of Utrecht to develop cycle fastlane routes in the Utrecht city region by optimising existing cycle routes (figure 4). By doing so, the Province aims to make cycling more attractive for longer distances. This case study concerns the development of the cycle fastlane route from the city of Utrecht, through Nieuwegein until Ijsselstein. More space will be created for cyclists and pedestrians to improve safety and comfort, making the route more attractive. Furthermore, the amount of stops on this cycle route will be limited as much as possible by providing cyclists more priority and green traffic lights. In this way, cycling this route will become faster, safer and more comfortable (Van Engelenburg, 2021).

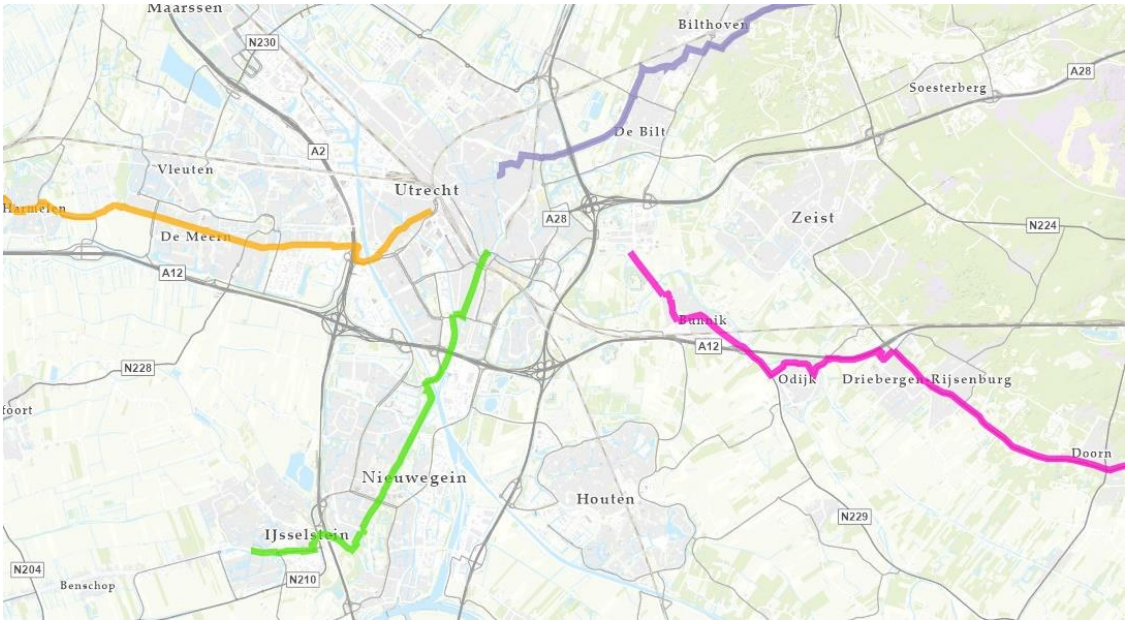

Figure 4: Cycle fastlane projects in the Utrecht city region, cycle fastlane project Utrecht – Ijsselstein in green (Province of Utrecht, n. d.).

The Province of Utrecht is the initiator and main funder of the project and collaborated with the Municipalities Utrecht, Nieuwegein and Ijsselstein, as the cycle route goes through these municipalities. Between the Province and the multiple municipalities there was some degree of interdependence as the route goes through the different municipalities, which required them to cooperate. Moreover, there were some differences between the interests of the Province and the Municipalities. The province was merely interested in implementing the cycle fastlane, while the municipalities wanted to integrate this with other developments of the route's environment. As the environment manager explained this relation: *There are, of course, many elements that were already final in this design, and in this case there were some adjustments, but this was on a small level. (...) But it was also taken into consideration: hey, there were a lot of comments about ideas besides the route, which was directed to the concerning municipality, who will make an extra budget available to integrate these ideas in a later stage of the project. (Interview, 22 May 2021).*

These differences of interests within the project organisation is also recognizable in the exported list of responses to the comments, such as the response to the following nearby resident of the route:

Comment in tool: Bicycle parking for visitors of 'Café Henkies'. To prevent visitors of the café from placing their bikes in front of houses of residents.

Response by Province: This request cannot be implemented within the scope of the cycle fastlane Utrecht-Nieuwegein-Ijsselstein. For this you can contact the municipality on their general phone number. (de Bruijn, 2021).

The municipality of Nieuwegein, in which the largest share of the route was located, initiated participation by external stakeholders in this project-stage. On behalf of the government actors, Engineering Consultancy Sweco carried out the development process of the project from the beginning until the contract stage. To answer to this participation demand, Sweco got involved in the environment management process as it introduced its own participation-tool 'IMBY' (abbreviation for 'In My Backyard') and carried out the tasks that came with the tool.
In this research, this project has been studied at the stage the tool was applied, which was during the development of an interim design for the route. The IMBY tool was used to gather comments from external stakeholders (e.g. surrounding residents, businesses, and users of the route) on this interim design. Most of the decisions were already final, which meant the external stakeholders could only provide input about more detailed elements of the design (Van Engelenburg, 2021). This mainly concerned practicalities during construction and for when the route is operational (e.g. traffic situations). Thus, the interim design of the route functioned as a concept-design on which external stakeholders could provide input for further improvement of the design on a more detailed level for the project to fit better in its environment.

4.2 The IMBY tool: task-technology-user

In the studied documents about the project and the interview with the environment manager, IMBY was described as a GIS-based platform in which users can leave comments on a map (de Bruijn, 2021). They can do so by placing a point, line or highlighting an area. They can either receive a response in the tool itself or, as was done in this project, in another way outside the tool. In the cycle fastlane project, the platform was open 24/7 for three weeks, after which the province responded to the comments in a 'Reaction Note'.

Task

IMBY was used in the project to show the interim design on a map and several renderings to gather information that concerned opinions, claims, requests and ideas from surrounding residents and businesses, and users of the route (Van Engelenburg, 2021). So, besides local opinions, the tool was also used to gather local knowledge about the project's environment, which concerns, for instance, traffic situations, damages and the use of public space. In this project, the tool was specifically meant for external stakeholders, which means communication and gathering input from other actors was done outside IMBY.
The project organisation was able to directly communicate back to the commenters through the tool, but in this project this was done by sending one overall 'Reaction Note' to all commenters. This reaction note included information about how the comments were used for improving the interim design, but also provided response to all comments separately. The reaction note is also made publicly available on the Province's website (de Bruijn, 2021).

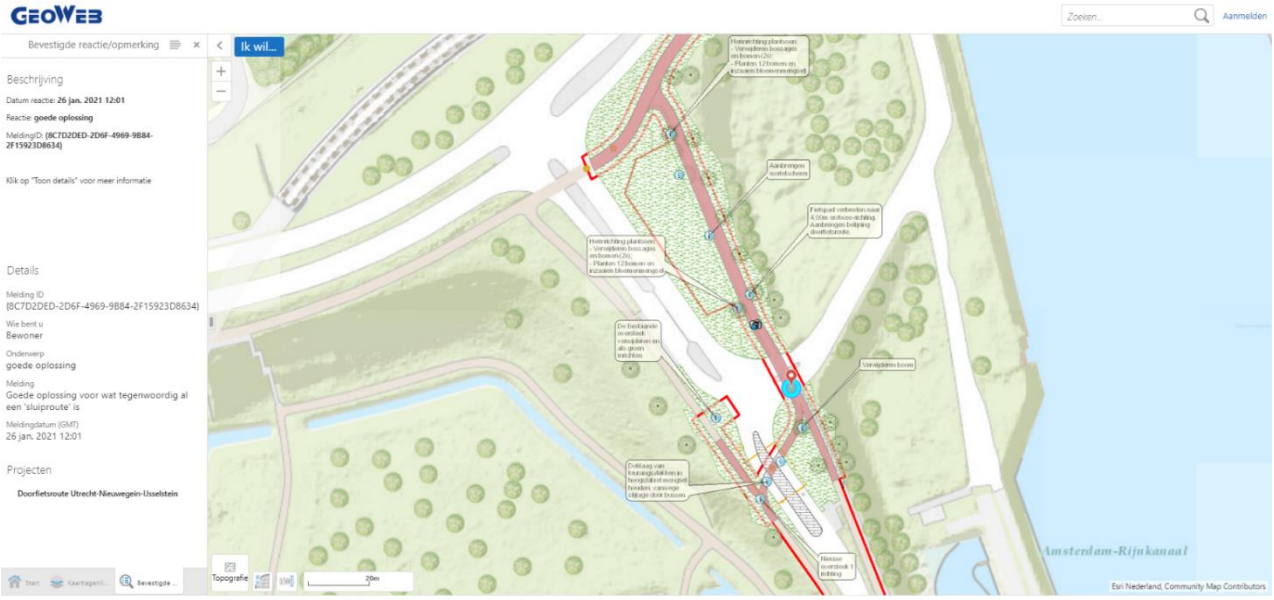

Figure 5: Screenshot of the main overview of the IMBY tool (source: interviewed environment manager, May 2021).

Technology

Being developed for this purpose, IMBY's main function is gathering data from, in this case, external stakeholders. This is done by showing the users a map and several renderings of the future situation, after which users can highlight an area on the map with a point, line or figure and leave a comment (figure 5 and 6). So, visualisation has a role in the tool's function of gathering data. The highlighted areas and comments are collectively visible and accessible for the project organisation to read, export and respond to. In other words, the comments are stored in IMBY, and communication is possible between stakeholders and the project organisation.

Figure 6: One of the renderings accessible in the IMBY tool (de Bruijn, 2021).

User

IMBY was introduced in the project when the project organisation wanted to inform the public (external stakeholders) about the interim design and to gather their comments. Therefore, all comments that were left in IMBY came from external stakeholders, this group can be considered as

the only user of the tool besides the environment manager. In this project being studied, 168 comments were left in IMBY by external stakeholders, which were distributed as follows:

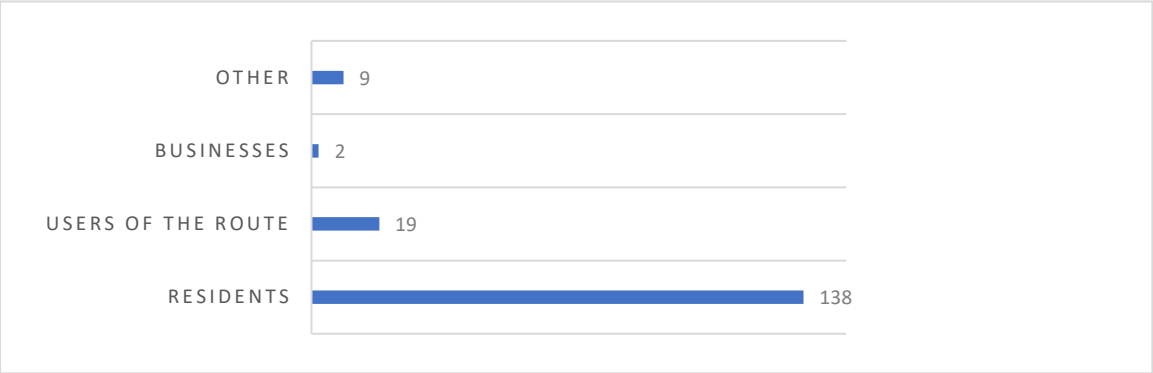

Figure 7: Distribution of IMBY-user types in the cycle fastlane project (adapted from: exported comments, 28 April 2021).

In this project, there were two environment managers: one overall environment manager and one environment manager specifically for managing the tool and the comments. The Environment Manager that worked with IMBY was the only user from the side of the project organisation (Interview environment manager, 22 May 2021).

Applying the IMBY tool to the task-technology-user model (with the environment management tasks, PSS-functions and user groups) has resulted in the following scheme:

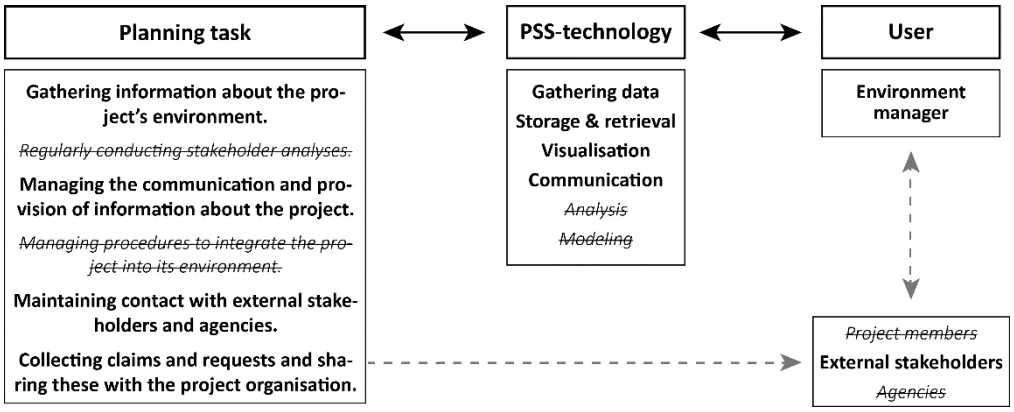

Figure 8: Task-technology-user model of IMBY (source: author).

4.3 The utility of IMBY for Environment Management

The first part of studying the usefulness of IMBY is examining to what extent the tool's functions are suitable for the environment management tasks, which are defined by IPM literature. In the interview was clarified that, theoretically, IMBY had the required functionalities to meet the participation demand by the project organisation: to present the interim design to the external stakeholders and gathering their comments. In practice, however, the tool gave stakeholders too little guidance and too much freedom for their comments while most of the decisions about the interim design were already final, resulting in too many expectations and limited usefulness of the input.

Finally, although the number of comments left on IMBY were above expectation, the environment manager found the tool an insufficient support for the environment management tasks to be carried

out in the project: *'But, if I look at environment management, I don't think it is a... I would not use it again or I would advise another tool...' (Interview, 22 May 2021).*

For each of the IPM environment management tasks is examined to what extent IMBY was a support, explained in the context of the cycle fastlane project. Besides describing the results based on documents and the interview, each environment management task is colored, in which green means fully supported by IMBY, yellow means partly supported and red means not supported by the tool.

Gathering information about the environment

IMBY's main function in the project was to collect local input by external stakeholders. Besides the local opinion, this input included local knowledge about the area. According to the environment manager, the tool enabled a relatively quick collection of local information, which provided insight in how the interim design was received by people and organisations that are currently present in the area. As explained during the interview: *'Well, the advantage was, of using the tool, ... was that we could quite quickly get an overview of what was happening in the environment regarding the design.' (Interview environment manager, 22 May 2021).*

Moreover, as this was done digitally, this information came from a more diverse group of external stakeholders and thus made the input more representative: *'And the advantage of such a tool is that it is a digital tool, so it is accessible for a lot of people in their own time, in contrast to an information evening that mostly attracts the same people.' (Interview environment manager, 22 May 2021).*

Besides input about the project, locals also commented other ideas and requests for the area, which were shared with the concerning municipality, which could integrate these ideas in future projects, such as the following comment in the tool by a nearby resident:

> *<u>Comment:</u> Parking along the water. Green strip between sidewalk and roadway on the side of the houses.*
>
> *<u>Response by Province:</u> The 'Herenstraat' will be narrowed down when this becomes a cycle street; which means there will be space to re-design. The Province of Utrecht and the municipality of Nieuwegein will reserve budget for re-designing this space. The municipality Nieuwegein will, together with surrounding residents, look at the possibilities regarding re-designing the 'Herenstraat', concerning: new pavement, green and/or a walking trail. Parking will also be taken into consideration. (de Bruijn, 2021).*

Regularly conducting stakeholder analyses

As IMBY is mainly used for gathering input from external stakeholders, it is not developed and thus used for analytical tasks. The tool enables the collection of information regarding the comment itself, an email address for further contact and whether the respondent is a resident or user of the area. Environment managers conduct stakeholder analyses through a different tool at the beginning stage of a project (Interview environment manager, 22 May 2021).

Managing the communication and provision of information for all stakeholders and agencies

As previously mentioned, IMBY's functionalities enabled two-way communication between external stakeholders and the project organisation. However, for this project was chosen to respond to the comments in an overall 'Reaction Note', as this enabled the provision of additional (publicly available) information besides separate responses to the comments. During the interview, the environment manager explained: *'You can use it to communicate, so you can directly respond to a comment, but you don't need to. In the cycle fastlane project Utrecht-Ijsselstein we didn't.' (Interview, 22 May 2021).*

However, the Reaction Note did not cover all communication back to the commenters. If a comment required direct communication or additional communication, stakeholders had to contact or were contacted in a different way, such as the following comment in the tool about traffic situations, addressed by a local business:

> *Comment: The cycle route along 'Winthontlaan' and 'Mauritiuslaan' Utrecht has several dangerous crossings, where cyclists come from multiple directions and also ride with a high speed from the 'Liesboschbrug'. This weekly leads to collisions and near-collisions. In the interim design there is not attention for this part of the cycle route.*
>
> *Response by Province: Your question has been forwarded to the municipality of Utrecht to be answered. (de Bruijn, 2021).*

Most of the information about the project was shared on the Province's website, with a link to the tool in which the interim design was shown for external stakeholders to leave a comment in. Moreover, agencies did not comment through IMBY, but communicated in different ways (Exported comments, 28 April 2021). Thus, despite being possible with IMBY's functionalities, communication and provision of information through the tool was, in this project, limited to the provision of the interim design in which a one-way direction of communication from external stakeholders was enabled.

Managing administrative procedures

IMBY was developed as a tool that gathers input from stakeholders and does not facilitate the management of procedures. However, the environment manager that was interviewed acknowledged how the results from the input can provide a better preparation for the procedures, as it clarifies how the local community reacts to the plans. When participation will become a legally obligatory element under the Dutch Environment and Planning Act, the interviewed environment manager expects the use of a participative tool like IMBY can contribute as a justification of participation: *I can imagine, under the new Environment and Planning Act, that you have to show how the environment has been involved in a project. In that sense, I can imagine you can show it in the way: we have used IMBY, and that's how we involved the environment. (Interview, 22 May 2021).*

Maintaining contact with external stakeholders and agencies

As aforementioned, maintaining contact with external stakeholders and agencies was possible with IMBY's functionalities. Moreover, commenters had to leave their email addresses when using the tool, which gave the project organisation access to their email addresses if further communication would be necessary. In this case, only the external stakeholders made use of IMBY, which were also the only ones to communicate through the tool: *'we call it a mailbox that is open 24/7' (Interview environment manager, 22 May 2021).*

Response to these comments and communication with agencies happened outside the tool. The main reason for this was, as aforementioned, that the phase of the project required the provision of additional information about the steps to be taken after the comments. All the information regarding the project was shared on the website of the Province. Thus, despite IMBY's functionalities enabled maintaining contact, the tool was not the platform in which all the communication took place.

F53 | 211

	A	B	C	D	E	F	G	H
1	Gegevens						Beantwoording	
2	Objectcode	categorie	Onderwerp	Locatie nr.	Deelgebied	MeldingID	melding	Antwoord
3	7ce1ada4-505d-405c-9715-9d94e0acb900	Bewoner	voetgangerszone langs fietspad Jutsfaserbrug	1	Oversteek Taludweg	6	Omdat er ook gelopen wordt over de Jutfasebrug is een voetgangerszone naast het fietspad wenselijk, zoals bijv. ook aanwezig is op de Nieuwe Heemstederbrug. Dus geen voetpad, maar een zone aan één zijde van het dubbele fietspad. En trek die zone dan door aan de kanaalzijde van de Utrechtsestraatweg, omdat de stoep ophoud bij de laatste woonboot.	Maatregelen aan de Jutfasebrug zijn niet onderdeel van de scope van dit project. De Utrechtsestraatweg voldoet aan de eisen van de doorfietsroute en zal dus niet volledig worden heringericht. Er is geen ruimte om een voetpad te realiseren aan de kanaalzijde van de Utrechtsestraatweg.
4	08acc644-98cd-4643-8111-8c087ac52933	Bewoner	oversteek bij Taludweg	1	Oversteek Taludweg	48	Deze "oude" oversteek voldoet prima als de fietser zich gewoon aan de regels houdt. Dit is veel veiliger dan de nieuwe kruising bij de rising step. Dit wordt erg onoverzichtelijk. Niet doen op deze manier!!	Er zullen geen wijzigingen aan de oversteek worden doorgevoerd, er zal alleen een oversteek extra worden ingepast ter hoogte van de bussluis. Bij deze nieuwe oversteek is er aandacht voor de veiligheid.
5	2ec9afa0-df55-467f-a31f-994895663dab	Bewoner	oversteek Utrechtsstraatweg	2	Kruispunt Remiseweg-Utrechtsestraatweg	1	De oude oversteek bij de stoplichten is verkeerstechnisch het veiligst. In de voorgestelde situatie is voor het auto- en busverkeer komend vanuit Utrecht naar Nieuwegein, het fietsverkeer van links onoverzichtelijk. Voorrangssituatie zal heel duidelijk aangegeven dienen te worden.	Er is na overleg besloten om hier de voorrangsregeling aan te passen. Uit verkeersveiligheidsoverwegingen zullen fietsers voorrang moeten verlenen aan het gemotoriseerde verkeer. Bij het ontwerpen van de oversteek is rekening gehouden met goed zicht voor fietsers. Hierdoor wordt voorkomen dat het gemotoriseerde verkeer conflicteert met de fietsers of de rising step.
	182ea6ce-b24a-4ee3-ba69-ef137daf1972	Bewoner	interactie met de step-up	2	Kruispunt Remiseweg-Utrechtsestraatweg	202	op de foto lijkt het alsof de fietsroute vlak langs de step-up gaat. Dit kan de volgende 2 problemen geven: indien het fietspad vlak achter de step-up ligt en de step-up is net naar beneden gegaan dan ben je geneigd om snel door te rijden omdat de step-up vanzelf weer omhoog gaat. wachten voor een aankomende fietser is dan lastig. Indien het fietspad vlak	Er is na overleg besloten om hier de voorrangsregeling aan te passen. Uit verkeersveiligheidsoverwegingen zullen fietsers voorrang moeten verlenen aan het gemotoriseerde verkeer. Bij het ontwerpen van de oversteek is rekening gehouden met goed zicht voor fietsers. Hierdoor wordt voorkomen dat het gemotoriseerde verkeer conflicteert met de fietsers of de rising step.

Reactienota def. blad

Figure 9: Excel sheet that was used to share the comments (grey part) with the project organisation to formulate responses for each comment (blue part) (Exported Comments, 28 April 2021).

Collecting claims and requests from external stakeholders and agencies, and sharing these with the project organisation

As the main purpose of IMBY is gathering input from external stakeholders, it sufficiently supports collecting claims and requests from that group of stakeholders. As a result of being open 24/7, a higher number and diversity of external stakeholders have left a comment in IMBY. However, to take the claims and requests further in the project, these have to meet 'SMART-formulation' criteria. During the interview, the environment manager mentioned multiple times how external stakeholders had too much freedom in what they commented about and how they formulated this (Interview environment manager, 22 May 2021). As a result, some comments were not clear or specific enough to become a point of attention. An example of this is the following comment placed in the tool by a nearby resident, of which was not clear what and where his comment was exactly about:

> *<u>Comment:</u> Please, create a safe crossing with more visibility in the direction of the 'Blauwe Brug'. Now from 'Utrechtsestraatweg' bad visibility when crossing without traffic lights (these are often turned off).*
>
> *<u>Response by Province</u>: On the map where you left your comment there is no crossing. If the comment refers to the crossing nearby the 'Blauwe Brug': this crossing will be redeveloped for a better overview for cyclists. (de Bruijn, 2021).*

A physical meeting between stakeholders and the environment manager would enable SMART-formulation of claims and requests, as the environment manager explained in the interview: *'If I have a conversation with a resident, I can steer into a 'SMART' answer, but in a tool I cannot. So, then you have to do it with what you have.' (Interview, 22 May 2021).*

Sharing the input that was gathered through IMBY was done outside the tool by sharing an excel file, as visible in figure 9. Moreover, the interviewed environment manager explained how another tool is often used to share claims and requests and to appoint these to the relevant project members. Thus, IMBY is suitable for what it is originally developed for: gathering input from external stakeholders. However, this is done with too much freedom, limiting the usefulness of their input for the project.

4.4 The usability of IMBY

The second part of studying the usefulness of IMBY in the cycle fastlane project is examining to what extent users were able to use the tool and its functionalities. In overall, the environment manager addressed in the interview that IMBY is relatively outdated compared to other tools on the market. IMBY was developed ten years ago (from the time of this research), and since then just minor changes were made. This was a point of critique by the members of the project organisation, who have had experience with better tools on the market, as addressed by the environment manager: *'So, in that sense, it is quite behind the other tools on the market. So also what the Province was used to get.' (Interview, 22 May 2021).*

Another overall point of attention about the usability of IMBY is the lack of flexibility to make changes in the tool in order to adjust it to the assignment of the project. This lack of flexibility limits the possibilities to further develop IMBY and to improve every aspect of the tool's usability, which each have been examined in this case study. Similar to the utility section, each aspect of usability is given a green, yellow or red color, which stands for the extent to which IMBY meets the concerning aspect of usability.

Learnability

In the interview, the environment manager repetitively mentioned that, in order to place a comment in the tool, users had to take 'unnatural', 'not-obvious' and 'very technical' steps: *'It is not very obvious. You have to know where to click. (…) I've helped quite some people with placing a comment.' (Interview, 22 May 2021).*

She addressed that the 'look and feel' of the tool was not instructive enough for users to know by themselves where to click. This resulted in her needing to explain users how to place a comment. These difficulties were also mentioned in the Reaction Note of the Province. In this document was explained that some comments were received and processed in different ways than the tool and where therefore not included in the Reaction Note (de Bruijn, 2021).

Efficiency

During the interview, the environment manager mentioned several difficulties regarding the tool's efficiency. The environment manager explained how users need to take multiple steps in order to place a comment, including confirming the comment via email: *'What you had to do: you first had to answer a number of questions. After that you click 'confirm'. Then you have to go to your email to confirm it there again. (..) So, I can imagine that for locals it was not very easy. (Interview, 22 May 2021).*

Furthermore, users are not completely free to decide on which device they want to access IMBY, as the tool is not accessible on a smartphone. This means, the user needs to find a moment when to place a comment on a pc, laptop or tablet. For the project organisation, IMBY is not flexible enough to make quick adjustments to make it fit better to the project, but instead depend on an ICT team: *Disadvantage of such a tool is, it's not like I can decide myself: I am going to use the tool and will set it up by myself. I depend on a team that sets up the tool. It takes two weeks before the tool is in the air and you can actually use it. (Interview environment manager, 22 May 2021).*

Lastly, multiple steps are required to process the input to, in this project, organise and respond to the comments by means of an overall Reaction Note.

Memorability

Related to the learnability of IMBY, the environment manager acknowledged that, once someone has learned how to use the tool, it is relatively easy to use the next time. However, the 'unnatural' way of placing a comment remains an obstacle: *'Once you know how it works… but it is not a very natural way of doing.' (Interview environment manager, 22 May 2021).*

Errors

The only error that occurred was that IMBY went offline during the first weekend when the tool was meant to be accessible. The interviewed environment manager believed that the weekend made the impact of the error bigger than when it would happen during a workday, when the ICT team would be in office to fix it: *'Well, I've sent an email and it was fixed on the Monday morning. But by then it had already been offline for the whole weekend.' (Interview, 22 May 2021).*

The inaccessibility was noticed by multiple stakeholders, who contacted the environment manager and placed a comment at a later stage. Most of these comments were sent in over the phone and responded to in a different way than the comments in IMBY, as stated in the Reaction Note: *'Besides that, late January 2021, several reactions came in over the phone about technical issues regarding the IMBY website; these have already been answered and are therefore not included in this Reaction Note.' (de Bruijn, 2021).*

Furthermore, the environment manager explained it is not clear whether there were stakeholders that never returned to leave their comment when IMBY was online again (Interview environment manager, 22 May 2021).

Satisfaction

During the interview, the environment manager expressed multiple times that she prefers not to use IMBY again because of the limitations the tool has. One of the reasons for this is the lack of flexibility to adjust the tool to the demands of the client (in this project: the Province). Another reason is that IMBY is ten years behind other tools on the market, which is noticeable when using the tool. In the interview, issues were mentioned such as the visibility of the comments when zooming in and out (as visible in figure 10), finding the required buttons to click and the overall 'look and feel' of the tool. According to the environment manager, these issues have also been addressed by external stakeholders. *'There is quite some room for improvement in terms of user-friendliness and 'look and feel'.' (Interview, 22 May 2021).*

Figure 10: A group of comments in one part of the map (de Bruijn, 2021).

4.5 Case summary: the usefulness of IMBY

IMBY was developed as a participative tool for local stakeholders and supports environment management in regard to informing by visualisation, gathering input from external stakeholders and communicating back. When considering all environment management tasks that are defined by IPM literature, IMBY does not support conducting stakeholder analyses and managing procedures (e.g. managing permit procedures etc.), making it an externally oriented tool. In the cycle fastlane project,

IMBY was introduced for a specific task: gathering input from external stakeholders. So, in theory, the tool met the demand of the project organisation. Despite that IMBY supports responding back to comments, the Province preferred to do so by publishing a Reaction Note. In combination with alternative communication because of an error in IMBY, this resulted in multiple different ways of communication between external stakeholders and the project organisation. Moreover, IMBY was used relatively late in the project, in which the tool offered too much freedom for external stakeholders to comment about what they wanted and to formulate their comment in the way they wanted. Despite that the amount comments and diversity of commenters were above expectations, this limited the amount of useful input.

Throughout its ten years of existence, IMBY has not had any significant improvements. This gives the tool a dated look and feel, which affects the learnability of the tool and guidance to know where to click and place a relevant comment. Besides the overall look and feel of the tool, the process of placing a comment has multiple, inefficient, steps both within and outside the tool. In the cycle fastlane project, some of the IMBY users needed help to place a comment. Moreover, the tool is accessible on a computer or tablet but not on a smartphone, which limits the extent to which users can access the tool wherever and whenever they prefer. Moreover, making adjustments in IMBY cannot be done by environment managers, but requires the involvement of an ICT team, which takes extra time and limits the tool's adaptability to a project. In fact, one reason for the aforementioned excessive freedom in commenting was the lack of adjustability of the tool to, for example, ask specific questions. IMBY did not steer the user to look at the design in a specific way and to comment about specific elements or topics.

Thus, the environment manager's description of IMBY as a 'mailbox that is open 24/7' is accurate when considering the tool's usefulness for the IPM environment management tasks and in the cycle fastlane project. IMBY's functionalities particularly support the environment management tasks that are oriented externally to the project and do not support the internal processes. Considering this external orientation of IMBY, usefulness of the tool largely relies on its usability for the multiple types of project-actors, which can have different backgrounds regarding their ability to use digital tools. Regarding usability, the tool is relatively hard to learn, and lacks guidance and efficiency for external stakeholders to place useful comments. For the project organisation, the tool lacks (efficient) adjustability to customize the tool to the project and lacks efficiency in processing and responding to comments. For both the external stakeholders and the project organisation these issues limit the extent to which the tool, as a '24/7 mailbox', can replace the bureaucracy of a traditional government mailbox. Thus, considering IMBY's functionalities, the tool would theoretically be useful for the externally oriented environment management tasks by gathering input from a large number and variety of external stakeholders. However, the multiple aforementioned usability limitations are the obstacles for the tool to be fully useful in practice.

5. Lock renovation project in Den Helder: Relatics

5.1 Case description

The project concerns the renovation of a lock, initiated by the Province of North Holland. This lock separates the harbor of Den Helder, which is connected to the open sea, from the 'Noordhollandsch' channel, which is situated behind flood protection. Therefore, this lock is part of the Dutch primary flood defence system as it protects the Dutch landscape against seawater (Tender document of Province, 27 September 2018). The renovation needed to happen because, according to the Province: *'A dive inspection in February 2015 of the walls of the lock have shown that the steel walls have reached their technical lifespan.' (Tender document of Province, 27 September 2018, p. 4).*

The project consisted of the renovation of the lock and making it longer to meet the (future) measurements of more types of commercial ships. Furthermore, the project also included the reconstruction of the alternative route through which ships needed to go during the renovation project, as visible in figure 11 (Tender document of Province, 27 September 2018).

Figure 11: KVSS is the lock to be renovated, the other two serve as alternative route (Tender document of Province, 27 September 2018).

As aforementioned, the project is initiated by the Province of North Holland. This government actor funded the project and directed the administrative and political processes that are required to carry out the project successfully. But because the Province did not have the required capacity and expertise to carry out the work (Tender document of Province, 27 September 2018), these have been outsourced to Sweco.

Besides its flood defence function, the lock serves as a connection between the open sea and the inland waterways for (commercial) ships. These shipment companies and recreational users are the most prominent external stakeholders in this project because, at an early stage, these have influenced the plans of the project in the following ways:

> *A long-term shutdown of the KVSS [abbreviated name of the lock] without a suitable alternative route is out of question for a number of big stakeholders (like the NAM, Gulf Oil, Peterson, Port of Den Helder) and will lead to significant economic loss. (Tender document of Province, 27 September 2018, p. 4).*

> *A diversity of stakeholders preferred to have both a renovated and a longer KVSS, which would make the lock future proof. The Province of North Holland has included this in the project. (Van der Meer et al.,2020, p. 5).*

This early prominence of the external stakeholders made it important for this project to keep track of all information related to these stakeholders, including their characteristics, interests and influence. This type of information was the responsibility of the environment manager and was stored in Relatics (Interview environment manager, 03 June 2021). This tool was used from the start of the project, a 'pre-contract phase' in which environment management carried out a feasibility

study, until the actual contract-phase, which is the phase were a contract will be created and signed with the constructor. The interviewed environment manager explained how the function of Relatics in the lock renovation project developed along with the development of the project-phases: *Well, in the feasibility-phase, that pre-contract phase, we have mainly filled it up with information. But when we reached the contract-phase, we haven't collected any new claims and requests. And at some stage, we 'froze' the environment management part in Relatics. Then we said: this is it. And then contract [contract management team] took it further, also in a Relatics environment. They have continued with the package we delivered. (Interview, 03 June 2021).*

Thus, Relatics was used to store, analyse and share all the information that was gathered in the feasibility study, which included information relevant to environment management (e.g. stakeholder information). After finishing the feasibility study, the Relatics database with the information was passed on to the contract-team to develop the information into a contract.

5.2 The Relatics tool: task-technology-user

Relatics is a tool that has been developed according to the System's Engineering approach in projects, in which registration and traceability of information, such as decisions and actions, are important elements (Interview environment manager, 03 June 2021). As Relatics is a commonly used tool in projects, and because of the variety of stakeholders in the lock renovation project, the Province of North Holland demanded the use of Relatics in the project organisations, which Sweco answered did as follows: *Per product we registrate the quality demands and give every product its own traceable identity. In this way, changes in the document and the decisions during the process can be easily tracked and taken further in the plan-development and execution phase. (Sweco plan of approach step 2, 2018, p. 3).*

The aforementioned 'products' concern information, decisions and actions related to project-risks, stakeholders, client demands, process requirements etc. and thus concern a relatively broad spectrum of information that is relevant to the project (Tender document of Province, 27 September 2018). Despite the differences between the disciplines of the project members, their work is interconnected and relevant to each other (Interview environment manager, 03 June 2021). With Relatics, project information is centrally stored and accessible for the whole project organisation.

Task

As aforementioned, Relatics is based on the System's Engineering approach, in which traceability and registration of information is central. This makes the tool focused on the internal processes of storing information and to make this information accessible and traceable for the project organisation (Sweco plan of approach step 1, 2018). Therefore, Relatics mainly supports the IPM-environment management tasks of regularly conducting and updating stakeholder analyses, managing administrative procedures and storing and sharing the claims and requests by external stakeholders and agencies. Of which the results regarding the tool's utility for these tasks are explained further in this section.

Technology

Because of the aforementioned purpose of Relatics, the tool's functions are mainly focused on the storage of information, structuring this and making it accessible for the rest of the project organisation (Sweco plan of approach step 2, 2018). This information could be registered and updated in Relatics. Moreover, the tool gave a clear overview of all stakeholders, their characteristics, interests and influence in the project (as visible in figure 12 on the next page). Relatics also provided an overview of points of attention, priorities and required actions, which

helped the environment manager to contact stakeholders whenever necessary and to keep track about past contact moments (Interview environment manager, 03 June 2021).

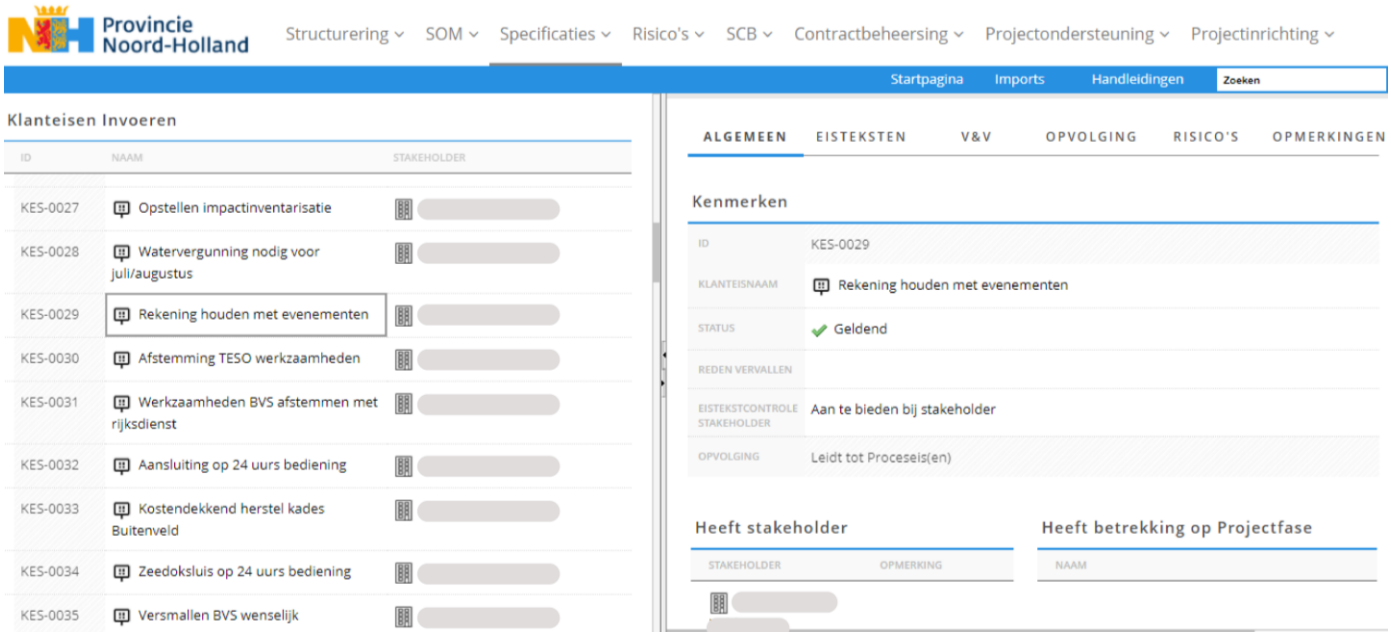

Figure 12: Screenshot of the Relatics overview of stakeholders (left column, hidden because confidential), their interests and information about the processes following the interests (right column) (source: interviewed environment manager, June 2021).

User

As Relatics supports internal processes within the project organisation, its users concern members of the project. In the lock renovation project, these project members were from the Province of North Holland and from engineering consultancy Sweco. The interviewed environment manager works for Sweco. Thus, in relation to the task-technology-user model, the users of Relatics were the environment manager and the other project members.

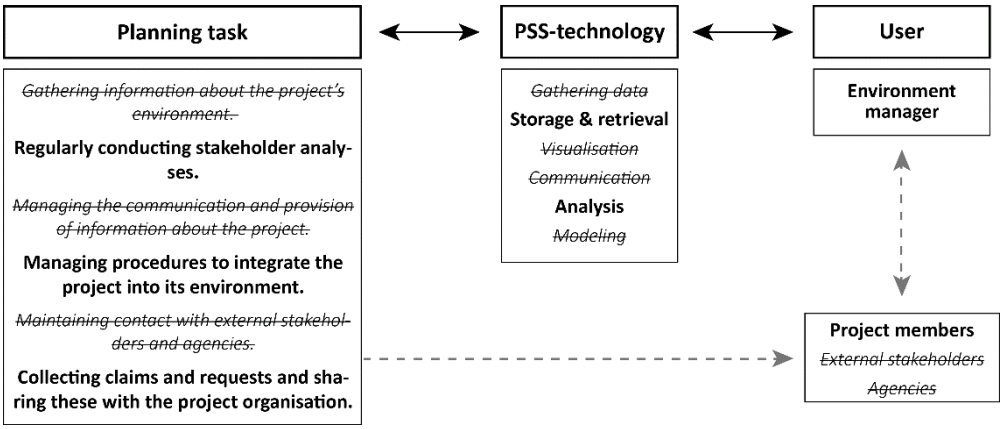

Figure 13: Task-technology-user model of Relatics (source: author).

5.3 The utility of Relatics for Environment Management

Relatics' main purpose throughout the project and for its organisation was to keep track of the information, decisions and actions throughout the process. As mentioned in the interview, the environment management experienced the added value of Relatics throughout the project:

The project took 2,5 years and in these years the project team has changed, especially at the Province. And there were some agreements with stakeholders or choices made of which the current environment manager of the Province did not know of. (…) And Relatics helps a lot with searching back and to prove: 'well, we've already discussed this with your colleague, and 'this' was the result back then. (Interview, 03 June 2021).

In the interview, the environment manager not only referred to traceability helping in internal discussions, but also with external stakeholders and agencies. Moreover, when the feasibility study phase ended, all the information in Relatics was 'frozen'. This means that no new information was added after that moment, which enabled the project organisation to integrate the agreements and decisions with stakeholders in the implementation-contract. As the environment manager explained in the interview: *We've had a 'freeze moment' to prevent further accumulation of other small issues. We could say clearly: well, this is the package, it is 'frozen' now and it will go to contract. And this makes the scope for the team after environment management much clearer. (Interview, 03 June 2021).*
Thus, keeping track of the information, decisions, agreements and actions in Relatics enables accessing this at a later stage in the project as prove in discussions or when integrating this into a contract. This overall function of Relatics in projects supports the IPM-defined environment management tasks as follows. Similar to the previous case, each task is given a colour, based on the extent to which the tool supports the concerning task (green = supportive, yellow = partly supportive and red = not supportive).

Gathering information about the environment

Considering this task mainly concerns collecting information, this task is not supported by Relatics. However, Relatics is a tool in which different types of information can be stored and made accessible for the rest of the project organisation. The environment manager explained how in this way Relatics enabled Sweco to gather information that came from the Province: *When we started the project, the Province had already placed their information about the project and its stakeholders in Relatics. So, in that way it helped us [Sweco] to gather the information with did not have yet, and to build further on this. (Interview, 03 June 2021).*
However, this function rather relates to sharing information with the project organisation instead of gathering 'new' information from the field.

Regularly conducting stakeholder analyses

One of the main objectives Sweco used Relatics for was to keep an up-to-date overview of the project risks: *'With the risk file as a standard element in our agenda, we secure that our work is focused on limiting and reducing the risks. Whenever necessary, we directly adapt these in Relatics.' (Sweco plan of approach step 2, 2018, p. 1).*
Related to these risks were the stakeholders and their claims and requests, which were all registered, prioritised and analysed in Relatics. As the environment manager described in the interview: *'In Relatics all the stakeholders, their interests, their impact and other characteristics are registered. And this database was complemented after every contact moment, which keeps the stakeholder-analysis up-to-date.' (Interview, 03 June 2021).*

Managing the communication and provision of information for all stakeholders and agencies

Relatics is a tool that is used internally by the project organisation. Therefore, communication and provision of information to external stakeholders and agencies is not supported by Relatics. In the interview, the environment manager explained that Relatics could be supportive by providing access to details about stakeholders, such as the last moment of contact: *'You can see when the last time of communication was with a specific stakeholder. And that is valuable when you want to communicate. But other than that there is no support from Relatics.' (Interview, 03 June 2021).*

Thus, preparation and registration of communication with stakeholders is supported by Relatics, as the tool stores information. But the communication itself is not supported.

Managing administrative procedures

Relatics' traceable and central storage of project information makes the tool supportive when starting administrative procedures such as permit requests. The fact that all information is accessible in one place helps the environment manager and, for example, a permit expert to quickly find the right information required to manage such administrative procedures.
Moreover, in the interview, the environment manager shared her enthusiasm about how Relatics can become an added value when the Dutch Environment & Planning Act will take into effect: *In the new Environment & Planning Act it will be obliged to motivate the steps that were taken to include the input from the environment in the project. That does not always happen, especially in government organisations. (...) And I think Relatics will be quite an added value in motivating and proving: look, we've taken these steps and it is all traceable and registered. (Interview, 03 June 2021).*

Maintaining contact with external stakeholders and agencies

Similar to managing the communication and provision of information about the project, maintaining contact with external stakeholders and agencies is not supported by Relatics. As aforementioned, Relatics can assist in preparing and registering the contact moments (as visible in figure 14), but Relatics does not facilitate communication itself (Interview environment manager, 03 June 2021).

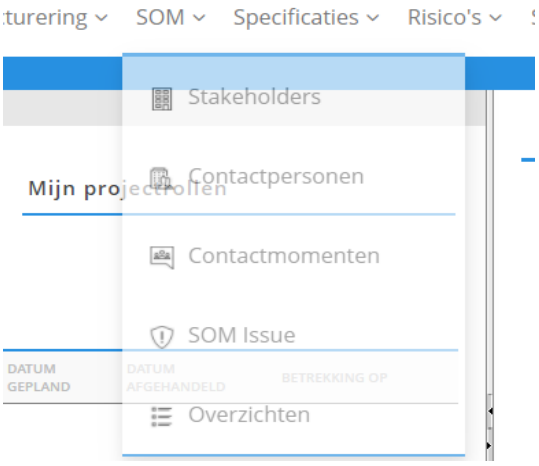

Figure 14: Screenshot of the options within Relatics regarding stakeholder contact registration (source: interviewed environment manager, June 2021).

Collecting claims and requests from external stakeholders and agencies, and sharing these with the project organisation

As aforementioned, information about a project, including all information about its stakeholders, is stored in Relatics, which is accessible to all members of the project organisation. However, collecting this information is done in other ways, as the functions of Relatics do not include communication and data collection. Despite that, the environment manager found Relatics helpful in registering stakeholder information and sharing this with the project organisation: *Collecting the information you must do yourself. But I think Relatics is very helpful in, for example, reporting an issue: you can register this in Relatics and you can show to the project organisation what you've done with the issue. This can be accompanied by a logbook, like: I've spoken to 'this' person and we solved it like 'that'. (Interview, 03 June 2021).*

5.4 The usability of Relatics

For the interviewed environment manager, Relatics was a relatively easy tool to use and navigate through. It provides a clear overview of the projects available to the user, which the user can navigate and search through. When the tool is being used in a project, it first needs to be set up by an ICT-colleague. Because the tool is commonly used in projects, its dependence on an ICT-team results in the tool being slightly different in each project. The interviewed environment manager has used Relatics in more projects, which made her aware of the abilities of the tool. However, not all these functions were included in each project, as the environment manager described: *'So, there were certain functions of which you knew they exist or are possible, but these were not yet present. Then it was difficult to get that included, because someone from ICT manages the tool's environment and your access.' (Interview, 03 June 2021).*

These differences between projects' Relatics environments not only relate to functions that were switched on or off, but also concerns the layout of Relatics. Buttons, menu's, pages and the overall look and feel differ between projects.

Thus, as Relatics needs to be set up by an ICT-team each time it is used in a project, its overall layout and set of functions can differ per project. This makes the tool adjustable to a particular project, but also affects its usability in multiple ways. This is explained according to the usability attributes and are also given colours, based on the extent to which Relatics meets the concerning usability criterium:

Learnability

As aforementioned, the interviewed environment manager could learn to use Relatics relatively easy. However, this partly depends on the user's personal background regarding their ability to work with computers, as the environment manager shared in the interview: '*I noticed that other people in the project organisation, which may be a bit older, could less easily navigate through the Relatics environment.' (Interview, 03 June 2021)*

The result of these people having difficulties with Relatics was that these would less frequently or never make use of the tool. According to the interviewed environment manager: *I think that the people that did not work with it [Relatics] in a project had too little relation, or did not feel comfortable. And I wonder, (…) also, whether they had the time and space in their head to start doing so. (Interview, 03 June 2021).*

In this quote, the environment manager also explained how it depends on the amount of time and effort a project member is willing to invest in learning to use Relatics. In the interview, the environment manager added that learning to use Relatics mainly comes with trial and error and asking help from colleagues (Interview environment manager, 03 June 2021). If a project member is not able or does not want to invest time in this trial and error, it can be harder to learn using the tool.

Efficiency

Navigating through Relatics is relatively efficient after the user has learned how to use the tool. However, as aforementioned, not all users of Relatics found it easy to use the tool. These users did not only avoid using the tool by barely or never using it, but also exported information to excel sheets to work in excel instead of in Relatics. In the interview, the environment manager shared from her experience how this affected efficient use of the tool: *You can export excels from Relatics. That is very handy. But what happens when there are people in the project organisation that do not find Relatics very pleasant, is that they are going to struggle around in the excel. Then you get an excel back, and want to import it back [in Relatics], but things have changed, which is why things do not match anymore, resulting into information that is wrong or not interconnected in the right way. (Interview, 03 June 2021).*

Therefore, this means that, despite a project member has learned well enough how to use Relatics, efficient working in Relatics can be affected by other users' lack of skills. Moreover, because the Relatics environment is set up and managed by members of an ICT-team, the project organisation of a project depends on this team if any adjustments need to be made or when an error occurs. As aforementioned, the environment manager had experienced situations in which functions that exist in Relatics had been switched off. Therefore, in order to make use of those functions, the ICT-team needed to be contacted to include it in the tool for that project.
Thus, the lack of skills by some users and the dependence on an ICT-team are both obstacles for efficient work in Relatics.

Memorability

In general, once the user has learned how to use Relatics, it is relatively easy to remember. However, as aforementioned, Relatics is set up for each project separately. For this project, the Province of North Holland demanded the consultancy that would carry out the project to be able to set up and work with Relatics (Tender document of Province, 27 September 2018). This means that, for each project, the structure and layout of the tool can be different, depending on the preferences of the project organisation and ICT-team. As explained by the interviewed environment manager, this requires getting to know the tool to some extent each time a new project has started: *Koopvaardersschutsluis [name of lock renovation project] clearly had it [a page] for environment management. Well, then I know where I need to be. But I've also had some projects where there is no page for environment management and then I have to look: where do I place the claims and how did they structure it [the tool]? (Interview, 03 June 2021).*
Thus, within a project, the tool is relatively easy to remember after learning how to use it. But when using the tool in a new project, users must learn to some extent how to use Relatics for that particular project.

Errors

During the lock renovation project, a particular type of error occurred several times. These errors were related to information and files not matching the requirements of the system in order to be integrated. The system would give an error whenever a piece of text or a file is not entered in the right way. Whenever this happened, the ICT-team needed to be contacted, after which it took several days before the error was fixed.
To fix the problem that caused the error, the environment manager and the rest of the project organisation needed to change the text or file to meet the requirements of the system, as the interviewed environment manager described: *'It had cost quite some effort to get those flaws out. But after you've put in that effort, the system was recovered again. And luckily a lot of data was still valid. After that we luckily could continue with Relatics.' (Interview, 03 June 2021).*
Additionally, the environment manager added in the interview that the error was limited to the team of environment management and contract management, and that the error happened approximately five times throughout the project (Interview environment manager, 03 June 2021).

Satisfaction

Besides the aforementioned errors and dependence on an ICT-team, the interviewed environment manager was relatively satisfied with Relatics. This, in combination with the client's requirement to use Relatics in this project, proves Relatics has a relatively positive reputation in infrastructure projects (Tender document of Province, 27 September 2018). However, as explained before, there were some other project members that did not like to use Relatics, because of their inability to use it and/or the time and effort they needed to invest to learn how to use it. Some project members avoided using it or used alternative tools or methods to carry out their work. This has

led to the aforementioned difficulties for the interviewed environment manager (i.e. errors and efficiency obstacles).
Thus, the discomfort for other project members to use Relatics has led to some difficulties for the rest of the users and thus affected their satisfaction of using Relatics.

5.5 Case summary: the usefulness of Relatics

Relatics is developed according to the System's Engineering approach, in which accessibility and traceability of project information is an important element. The tool supports projects by providing a digital environment in which a broad spectrum of project information can be registered, shared and analysed for future use and to be used by other project members. Regarding the environment management tasks as defined by IPM-literature, Relatics is a digital environment to store, share and analyse information related to stakeholders, in which it remains traceable throughout the project. In this project, Relatics was first used to build a database with stakeholder information, which after completion was used for contract development. In this sense, Relatics' function in the project developed along with the progress of the project. Thus, Relatics mainly supports internal processes within the project organisation: conducting stakeholder analyses and managing administrative procedures. However, Relatics also supports the environment manager in preparing and registering contact moments with stakeholders and analysing the information that comes out of that.

Relatics is commonly used in infrastructure projects and has a positive reputation. However, as the tool is used by a large share of members of a project, it has occurred that some of these members have insufficient skills to efficiently and satisfactory make use of Relatics. In the lock renovation project, it became clear that unskilled project members also affect the tool's usability for the users that are skilled enough. The project members that did not have sufficient experience with Relatics often avoided the tool by working in alternative ways or not using the tool at all. This has led to several difficulties related to efficiency and errors while using the tool. Moreover, when Relatics is used in a project, it needs to be set up by an ICT-team. This team can customize the tool's layout, structure and functions to the project. However, this makes the tool different each time a user starts using it in a new project. For later adjustments or solving errors, the project organisation depends on the same ICT-team, which would take several days in the lock renovation project. So, the extensive adjustability of Relatics affects the memorability of the tool and the dependence on the ICT-team to add functions or solve problems limits efficient use of the tool in the project.

The large number and influence of external stakeholders in the lock renovation project made Relatics a useful tool to keep track of all information relating to these stakeholders. The tool's main purpose of storing project information and making it traceable and accessible for the rest of the project organisation has helped in registering and analysing information, and preparing actions regarding these stakeholders. However, because Relatics supports the majority of the project organisation with this specific purpose, it does not support the multiple different tasks of the environment manager. Moreover, the variety of users throughout the project organisation and project phases mostly includes inexperienced project members, of which their behaviour in Relatics can affect the usability of the tool for the rest of the project organisation. Thus, the broad use of Relatics in the project organisation and throughout different project phases limits its support for the different environment management tasks and makes the project organisation more vulnerable to difficulties in the tool that are caused by inexperienced users.

6. Liveability research N203: Maptionnaire

6.1 Case description

The N203 is a provincial road between highways A8 and A9, and goes through several villages, mainly through Krommenie and Assendelft. In both villages, several houses are located along the N203, which were built in a time when there was less traffic. *'Especially on the Krommenie-side there are houses along the provincial road that were once built with the idea that it wouldn't be that busy. And now the road is the main connection between the A8 and A9, two highways.' (Interview environment manager, 11 June 2021).*

However, throughout the past decades traffic has increased, which has affected the liveability along this road. The Province of North Holland is dedicated to developing a new (highway) connection between the A8 and A9, which would decrease the amount of traffic going through the N203 and along these houses in Krommenie and Assendelft. However, this new connection will take several years to be planned and implemented, while the liveability along the N203 remains an issue (Sweco plan of approach, 2020).

Figure 15: Some of the houses along the N203 provincial road. (Van Velzen, Verbon & Visser, 2020).

For this reason, the Province of North Holland decided to invest in research and implementation of short-term measures to improve the liveability for residents around the N203 within three years. The research was carried out by Sweco in two tracks: the participation track and the expert track (Sweco plan of approach, 2020). In this way, the experiences and opinions of the local community was combined with expert knowledge on several liveability topics. This would eventually lead to a list of possible measures that would be feasible to implement within three years (Van Velzen, Verbon & Visser, 2020).

In the participation track, the original plan was a combination between physical and digital forms of engagement with the local community. However, because of the corona pandemic, this had to be switched to a completely digital approach: through phone calls and Maptionnaire:

> *'Because of the corona pandemic, the research approach of physical meetings (resident evenings) and 'walk-along' interviews on location were changed into:*
> *(...)*
> - *A bigger role for an online questionnaire through the platform Maptionnaire.' (Van Velzen, Verbon & Visser, 2020, p. 19).*

Participation in Maptionnaire was done in two stages. The first stage was gathering experience and ideas for measures, which was a relatively open approach to find out what the issues were regarding liveability, and ideas to improve it. The second stage was gathering opinions on these measures, which was focused on the proposed measures and resulted in insight in which of the measures would have the most local support (Van Velzen, Verbon & Visser, 2020).

6.2 The Maptionnaire tool: task-technology-user

Maptionnaire is a digital questionnaire tool, with a combination between text and visualisation. Input and/or questions can be asked about an area with the support of images and maps. The answers to these questions can be in text and by drawing or pointing something out on a figure or map. In the liveability research project for the N203, Maptionnaire was applied as follows:

> *Through the platform Maptionnaire, residents and other stakeholders (for example road users) could fill in a questionnaire, which was connected to the map of the research area. This was possible on desktop, laptop, mobile phone and tablet.*
> *(...)*
> *After going through the introduction-text screens, respondents could highlight their preferred location to show their experience for each of these, in three categories (pleasant, not so pleasant, very displeasing...). (Van Velzen, Verbon & Visser, 2020, p. 19).*

Moreover, besides gathering input from external stakeholders, Maptionnaire can also be used to provide additional information about the topic of the questionnaire. As the environment manager described in the interview: *We have also made some 'before and after' photos. We kept that very general, placed it in Maptionnaire on a map and people could click on every measure and respond, after reading the description: this is a good idea or not a good idea. (Interview environment manager, 11 June 2021).*

Task

As aforementioned, Maptionnaire is a tool that is focused on gathering input from external stakeholders. Therefore, Maptionnaire is a tool that is externally oriented rather than on internal processes, as confirmed by the interviewed environment manager: *'It is an external tool, you don't use it for internal documents.' (Interview environment manager, 11 June 2021).*

Despite Maptionnaire's main function as a digital questionnaire (Van Velzen, Verbon & Visser, 2020), its functionalities enable informing the external stakeholders about the topic with the support of text and visualisation (Interview environment manager, 11 June 2021). Thus, Maptionnaire supports the IPM environment management tasks of gathering input (information, claims and requests) from external stakeholders and informing them about the project.

Figure 16: Screenshot of Maptionnaire, in which the user is asked to place green, orange or red point(s) on the map to show positive or negative aspects of liveability in the area, after which some questions followed. (Van Velzen, Verbon & Visser, 2020).

Technology

The aforementioned tasks are mainly supported by Maptionnaire because of its main functionalities: gathering data and visualisation. The tool's strength is the combination of gathering data by extensive functionalities regarding the types of questions, adding texts and various types of visualisations, as visible in figure 16 (Interview environment manager, 11 June 2021).

The input that was gathered can eventually be viewed on a map or in graphs, which to some extent provide analytical insights. However, as the environment manager stated: *There will not just 'role out' a chart in 1-2-3, like: 'this amount of people think that'. Eventually you can relatively quickly make tables out of it, but you are going to edit it and make it more appealing or interpret it differently. You just have quite raw data, which you have to do something with. (Interview, 11 June 2021).*

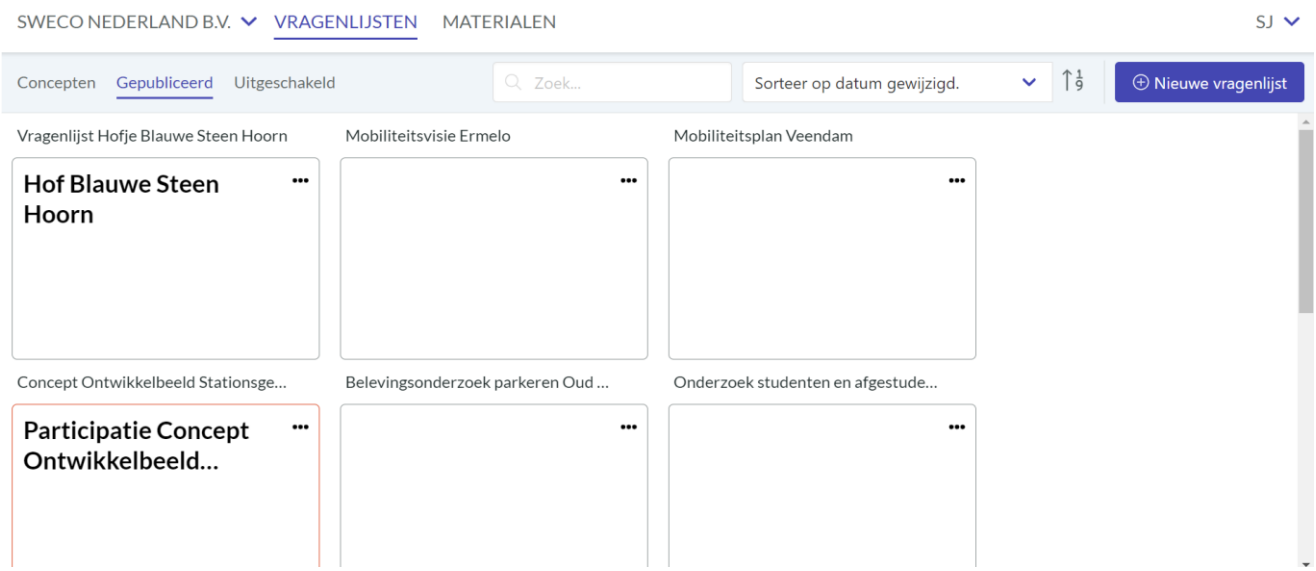

Figure 17: Screenshot of Sweco's project-overview on Maptionnaire. (source: author).

Finally, to be able to gather input, and to add text and visualisation, the tool also contains the function of storage and retrieval. Moreover, organisations can have an account on Maptionnaire, in which all their projects are organised and accessible for the organisation, which is visible on figure 17 on the previous page (Interview environment manager, 11 June 2021).

User

Considering Maptionnaire is mainly used for gathering input from local communities, the main user group is the external stakeholders. Moreover, internally, the tool is mainly related to tasks of the environment manager in project. As the environment manager addressed during the interview, other project members were only involved in the early process of setting up the tool: *Everyone took a look at it. There is a communication advisor at the province, who looked at every piece of text how it was formulated, but also the project leader, like: how are we going to publish this? Because this was a very important part of our approach... It had to be good, so to say. (Interview, 11 June 2021).* In the liveability research project for the N203, processing the gathered data into findings was done by the environment manager, after which these findings were shared with the project organisation. Moreover, organisations can have an account on Maptionnaire, in which all projects are accessible (Interview environment manager, 11 June 2021).

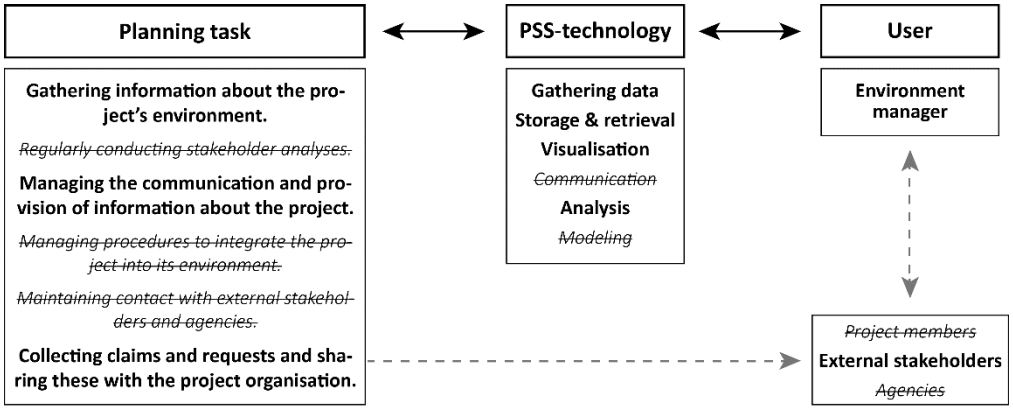

Figure 18: Task-technology-user model of Maptionnaire (source: author).

6.3 The utility of Maptionnaire for Environment Management

In the years before the liveability research project of the N203, Sweco remained sceptical about using digital tools instead of traditional physical approaches. However, increasing digitalisation came with an increasing demand by clients to also use digital methods. Sweco would use Maptionnaire for the first time, in combination with physical meetings. However, because of the corona outbreak, these physical participation approaches had to be changed into a completely online approach. This gave Maptionnaire a bigger role in the liveability research project than anticipated (Van Velzen, Verbon & Visser, 2020).

For the project organisation, the amount of response in Maptionnaire was significantly above expectations, as the environment manager mentioned in the interview: *'For us absolutely, because we couldn't have dreamed of gathering this many response. We actually expected about 100 or 200. And then it became around 1000.' (Interview, 11 June 2021).*

Thus, the sudden switch to online participation on Maptionnaire gave the tool a more prominent role in the project. The focus, and dependence, on a digital tool has turned out positively, as the amount of response was above expectations. For each IPM-defined environment management task is explained to what extent these are supported by Maptionnaire, and are given a colour: green (completely supported), yellow (partly supported) or red (not supported).

Gathering information about the environment

Regarding this task in the project, a large share of the required knowledge for the project was local knowledge about the liveability of the area, and ideas to improve this. Maptionnaire has gathered a high amount of information because of the large number of respondents, as was reflected by the end report: *Moreover, the large number of responses by other age categories has resulted in a very clear overview on the experiences and 'sore points' in the villages. (Van Velzen, Verbon & Visser, 2020, appendix 2 p. 3).* These 'sore points' were also visible on a map, as visible in figure 19.

Telephone interviews were carried out to gain deeper information from individual residents, but most information came from the input by external stakeholders on Maptionnaire.

This local input was combined with expert knowledge about the area, which consisted of information about the current status of the liveability in the area regarding noise, air and traffic norms. Experts reflected on the ideas from locals whether these were feasible as short-term measures: *'In the expert track, an overall view on the situation was created based on existing knowledge; eventually this expertise was used to translate the input from the local environment into measures for the 'measure market'.' (Van Velzen, Verbon & Visser, 2020, p. 4).*

Eventually, these measures were presented in a digital 'measure market' in Maptionnaire, inviting locals to provide their opinion on these measures. This has provided insight in the local support for these measures (Van Velzen, Verbon & Visser, 2020).

Besides a larger amount of input there was also a larger diversity of respondents in Maptionnaire compared to physical meetings, as mentioned by the interviewed environment manager: *'It is also a very democratic thing. Because, for example: you normally don't see people in their 30's and 40's. They also like to fill it in, and it's easy as well. You get a more balanced perspective.' (Interview, 11 June 2021).* Thus, Maptionnaire can gather input from a larger amount and diversity of external stakeholders compared to traditional participation methods. This gathered information concerned local experiences, ideas, and eventually the local opinion about short-term measures based on these ideas.

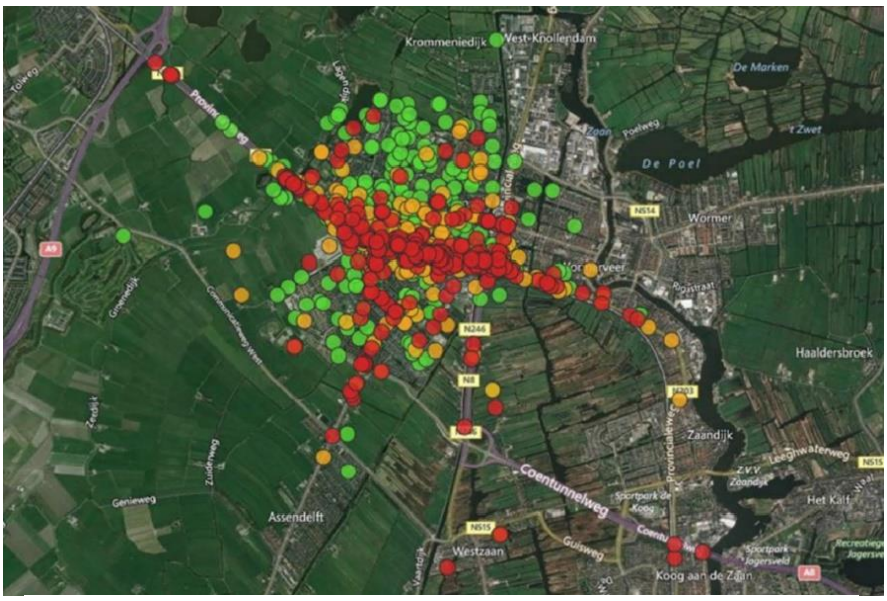

Figure 19: Map with the green, orange and red points that were placed by external stakeholders. (Van Velzen, Verbon & Visser, 2020).

Regularly conducting stakeholder analyses

Maptionnaire is developed for engagement with, mainly, external stakeholders by presenting plans and gathering input regarding this (Van Velzen, Verbon & Visser, 2020). This makes the tool externally oriented, which is why it does not support internal processes like a stakeholder analysis, as explained by the environment manager: *'You can only ask people when they are filling in their profile: in what age category do you belong, where do you live? It is not a stakeholder analysis in itself.' (Interview, 11 June 2021).*

In this explanation, the environment manager does acknowledge that Maptionnaire could provide extra information about stakeholders. But further processing and analysing this information is not supported by Maptionnaire (Interview environment manager, 11 June 2021).

Managing the communication and provision of information for all stakeholders and agencies

In Maptionnaire, both text and visualisation can be added to add context to the questions that are asked (Van Velzen, Verbon & Visser, 2020). Therefore, presenting information and/or a plan can also be done in Maptionnaire, as explained by the environment manager: *'You somewhat guide people through a story and the context. And there is enough space to write entire texts or let people just read, or to highlight things with figures.' (Interview, 11 June 2021).*

However, Maptionnaire is not a tool through which to communicate with external stakeholders. The tool is merely meant for guiding the respondents through a questionnaire with text and visualisations (Van Velzen, Verbon & Visser, 2020). Communicating with external actors needs to be done outside the tool. As the environment manager explained: *'You cannot only work [communicate] with the tool. (...) Communicating through newsletters, social media, websites and letters to residents, it [the tool] does not replace that.' (Interview, 11 June 2021).*

Managing administrative procedures

As aforementioned, Maptionnaire is oriented to gathering input from external stakeholders. It is a questionnaire-tool that mainly gathers subjective data from external stakeholders (e.g. opinions and experiences). Therefore, it is not developed for supporting internal processes such as the management of administrative procedures (Interview environment manager, 11 June 2021).

Maintaining contact with external stakeholders and agencies

As aforementioned, Maptionnaire does not support direct communication between the project organisation and stakeholders. However, the tool and its results provide insight in the content and context, which can be used by actors to communicate about, as the environment manager explained: *It is not the tool through which you communicate or respond, so to say. You do that differently. Of course, it is a tool about which you communicate, so the results that come out of it. (...) So, you communicate about the tool, not through the tool. (Interview, 11 June 2021).*

Thus, Maptionnaire provides data to communicate about, but the tool is not a platform to communicate on.

Collecting claims and requests from external stakeholders and agencies, and sharing these with the project organisation

The liveability research project for the N203 largely concerned the collection of ideas and experiences from locals regarding the liveability along the N203, after which these were combined with expert knowledge (Van Velzen, Verbon & Visser, 2020).

Therefore, collecting requests from locals is supported by Maptionnaire. However, according to the interviewed environment manager, claims mainly involve practical issues that emerge during, or close to, the implementation of measures: *'Look, gathering reactions, requests and preferences. That is all possible. It [Maptionnaire] supports this quite well. (...) But complaints, that is somewhat different, that is about something [measures] that is already going on.' (Interview, 11 June 2021).*

Moreover, the input that was collected in Maptionnaire was mainly processed by the team of the Environment manager: *'Not everyone has access. No, we keep that within environment management in Sweco who have access to it. (...) But we have actually made some sort of analysis of it [results], that came in the report.' (Interview, 11 June 2021).*
Their findings were eventually shared with the rest of the project organisation, such as the experts that would assess the feasibility (Van Velzen, Verbon & Visser, 2020). Therefore, the collected input in Maptionnaire was not directly shared with the project organisation.
Thus, Maptionnaire is a supportive tool to collect input from external stakeholders that consists of the opinion and ideas. Claims and complaints, however, mainly take place in a different project-stage and would require more direct communication. Finally, sharing the input with the rest of the project organisation was not done directly through Maptionnaire as the tool mainly contains large amounts of raw data.

6.4 The usability of Maptionnaire

In overall, Maptionnaire was pleasant to use, especially for the external stakeholders. Both the Province of North Holland and Sweco were pleasantly surprised by the rich data that was gathered, as reflected in the end report of the research:

> *The opportunity to participate has been used very well. In both phases, during both the experience research as the 'measure market', this has resulted into many reactions. In all aspects (quality of reactions, origin, age distribution, etc.) the participation was a success. (Van Velzen, Verbon & Visser, 2020, p. 51).*

In the project, Maptionnaire unexpectedly got a bigger role as result of the corona pandemic. Because of the pandemic, a larger share of information had to be collected with Maptionnaire than anticipated. This required investing more time and effort to get familiar and set-up the tool for the project, and to process the data in the best possible way in order to make it a sufficient alternative for physical meetings. *'And it [Maptionnaire] became our main approach, in which everything had to be good and end up in. (...) We have gained a lot of experience with it, but it was also a lot of work.' (Interview environment manager, 11 June 2021).*
Because the tool does not have extensive options for analyses, data had to be analysed differently to come to insights, which took extra steps and thus more time.
Thus, in overall, Maptionnaire's usability was satisfactory to all its users. On the other hand, a relatively high amount of time and effort was needed to make optimal use of the tool, as it was the main source of local input. The usability of Maptionnaire is further explained according to the extent to which the tool meets the usability criteria, in which these are given a green (criterium met), yellow (criterium partly met) or red (criterium not met) colour.

Learnability

When using the tool for the first time, it takes time to get familiar and to find out about all its functionalities: *'So, sometimes you have to look, like: I want this and this, is that possible? (...) But you have to explore that for a moment, like: is that all possible, how does that look?' (Interview environment manager, 11 June 2021).*
However, as the corona pandemic gave Maptionnaire a bigger role in the project, the environment manager was more willing to learn using the tool (Interview environment manager, 11 June 2021). Once familiar with the tool's layout and functionalities, using these functionalities for the project is also process of trial and error: *'You had to set up a lot of things yourself or search again and struggle. (...) You just have to know.' (Interview environment manager, 11 June 2021).*

On the other hand, for the external stakeholders to provide their input, the tool provides sufficient guidance with its types of questions, texts and visualisations (Interview environment manager, 11 June 2021).

Efficiency

As aforementioned, when using Maptionnaire for the first time, it takes time to get to know the tool, its functionalities, and to know how to apply these. Regardless of whether or not it is the first time of using the tool, setting it up for a project requires a relatively large amount of steps, which in this project has led to multiple mistakes and errors: *'If you wanted to copy or paste it went wrong again or what you've changed wasn't saved. That makes you not very happy, so to say. (...) So yes, it was very time consuming.' (Interview environment manager, 11 June 2021).*

However, this was an issue for the users that set up the tool (e.g. environment manager), not the users that provide input on the tool (i.e. external stakeholders) (Interview environment manager, 11 June 2021). In the project, Maptionnaire was first tested before being published for the external stakeholders, which was an extra assurance for its external usability (Van Velzen, Verbon & Visser, 2020). Moreover, as the amount and diversity of respondents was much more than expected, the project organisation assumed the tool was sufficiently usable for the external stakeholders (Interview environment manager, 11 June 2021).

Memorability

After investing time and effort to learn using Maptionnaire, it is relatively easy to use it again. The interviewed environment manager has used the tool at several moments in this project, and multiple times for other projects. As Sweco, and the environment manager, used Maptionnaire for the first time in this N203 project, it took time to learn using it. When using it later in the project and in other projects, it was relatively easy for him to use it again: *'If you have a little bit of experience, then it will work, then you'll know where to find everything.' (Interview environment manager, 11 June 2021).*

Moreover, the environment manager mentioned that organisations can have an account on Maptionnaire, in which all their Maptionnaire projects are organised and accessible for the entire organisation. This enables learning from how the tool was used in other projects: *'Everyone who has access to Maptionnaire can also see everything. And that makes it, of course, some sort of a learning platform. Like: oh, how did it go there? Oh I see an example. And that is nice, that exchange.' (Interview environment manager, 11 June 2021).*

Errors

As aforementioned, the environment manager had experienced some errors when setting up the tool. As the tool did not provide sufficient insight in the result when setting up a functionality in the tool, the environment manager found out only afterwards when the functionality was not set up well. Therefore, the amount of steps and the lack of clarity when setting up the tool increased the chance to make mistakes, as explained by the environment manager: *You have to click a lot of things before it will work. And then you still have to test whether it all went well. With the publication [in the project] it went wrong sometimes. Then it still wasn't saved like you've planned. (Interview, 11 June 2021).*

Moreover, the system of Maptionnaire itself had issues with saving the changes that were made: *'Or you were making adjustments and then it wasn't saved. Yes, those things were kind of frustrating in the system.' (Interview environment manager, 11 June 2021).*

On the other hand, the environment manager and the project organisation have had no reports of external stakeholders facing errors when using Maptionnaire. As aforementioned, the amount and variety of response proves that all types of users could use the tool (Van Velzen, Verbon & Visser, 2020). In the interview, the environment manager explained that they could also see that the response came from different types

of devices (computer, tablet and smartphone) (Interview environment manager, 11 June 2021). Moreover, as aforementioned, in the project the tool was tested before it was published for input, as mentioned in the research report: *'Before being used, the questionnaire was tested by members of the 'Omgevingstafel' [local interest organisation], to determine whether there were any issues or problems with the user-friendliness.' (Van Velzen, Verbon & Visser, 2020, appendix 2 p. 1).*

Satisfaction

Despite the aforementioned usability issues, which were mostly related to setting up the tool, the environment manager was generally satisfied with the tool because of all the possibilities it provided: *Everything that was possible [with Maptionnaire], I was very impressed with that. Also because before this project we thought: why should we? But now, for this research it just ended up really nice. Like: yes, this is what we wanted, and yes it is possible, digitally like that. (Interview, 11 June 2021).*
This opinion was also shared by the client: the Province of North Holland (Interview environment manager, 11 June 2021).
It is not known to what extent external stakeholders were satisfied in using Maptionnaire (Interview environment manager, 11 June 2021). However, the amount of respondents and input that was gathered, gave the project organisation the impression that external stakeholders found Maptionnaire easy to access and to use. The variety of respondents and the richness of data shows that a variety of external stakeholders were willing to put in the effort to provide input (Van Velzen, Verbon & Visser, 2020).

6.5 Case summary: the usefulness of Maptionnaire

Considering the functionalities of Maptionnaire and the environment management tasks it supports, the tool is mainly developed as a digital questionnaire with a variety of options. The tool is mainly used for gathering input from external stakeholders, of which the amount of response for this project was above expectations. Because of Maptionnaire's external orientation, it does not support procedures that are carried out internally, such as stakeholder analyses and administrative procedures. Moreover, the tool does not support communication between users, which means it is not a platform for interaction between the actors of the project. Besides gathering input, Maptionnaire can also be informative about the project to the external stakeholders by including texts and visualisation. This has made Maptionnaire a big support in this liveability research project for the N203, which all of a sudden had to switch to a completely digital participation approach because of the corona pandemic. In the project, Maptionnaire was first used to collect local ideas and experiences. Secondly, the tool was used again to present short-term measures to the local community, which led to insight in the local support for these measures.

The usability of Maptionnaire can be considered sufficient, as the tool was generally found satisfactory by the project organisation, including the environment manager. Moreover, the amount of response, the variety of respondents and the richness of the input gave the impression to the project organisation that the tool was usable for the external stakeholders. The project organisation assured the usability of the tool for the external stakeholder by testing it before publishing it for input. While the tool was open for external stakeholders, the environment manager barely heard of any difficulties for external stakeholder to use the tool. Despite the overall satisfaction with Maptionnaire, the environment manager had to invest a relatively high amount of time and effort to get familiar with the tool and its functionalities. Initially, Maptionnaire would have been used as one of several participation 'tracks', but became the main approach because of the corona pandemic. Therefore, the environment manager was more willing to invest time and effort to learn using the

tool. Moreover, setting up the tool required multiple steps of trial and error, as it lacked clarity about the final set-up of the tool for the project. In combination with a system error in which the tool did not always save changes, the multiple steps of trial and error when setting up the tool required more steps than necessary.

Maptionnaire is meant to support planners with gathering input from local communities, and by doing so guide the respondents through the topic by using text and visualisations. The sudden bigger role of Maptionnaire in this project because of the corona pandemic forced the environment manager to use Maptionnaire to its full potential. By doing so, some obstacles came forward regarding the tool's usability, mainly for the user that sets up the tool, which in this project was the environment manager. However, in this project, the tool did not disappoint in the extent to which it supported gathering input. Instead, the amount, diversity and richness of data that was gathered through Maptionnaire were above expectations. Finally, the tool was also informative for the external stakeholders, as explanatory texts and visualisations could be inserted to guide respondents through the questions. These functionalities make Maptionnaire more than just a questionnaire-tool, as users can also learn more about the project. Thus, in the liveability research project for the N203, Maptionnaire has proven how it can facilitate a completely digital participation approach with responses above expectation. However, the sudden switch to a bigger role for Maptionnaire in the project have also shown several usability obstacles while setting up the tool to make it a satisfactory alternative to physical participation.

7. Analysis: case comparison

After studying each case separately, an analysis was done in which the case results were compared. This is done according to the conceptual model and the research propositions (appendix 1) that were formulated for this research. This resulted into findings regarding: the project-contexts of the cases; task-technology-user models of the tools; the utility of the tools; and the usability of the tools. These findings have led to the answers to the two sub-questions and eventually to the main question of this research, which are stated in the next chapter.

7.1. Case context

First, the project-contexts of the three cases were compared (table 6), of which the findings provide insight in the context in which the tools were applied.

Project content	***Case 1: Cycle fastlane - IMBY***	***Case 2: Lock renovation - Relatics***	***Case 3: Liveability research N203 - Maptionnaire***
The purpose of the project.	Improving the cycle route between Utrecht, Nieuwegein and Ijsselstein, by making it faster, safer and more comfortable to cycle.	Renovation of a lock that connects the inland waterways with the open sea. This makes the lock part of the Dutch primary water defence. The lock would also be made longer and an alternative route for ships during the renovation would be provided.	Research on short-term measures to improve the liveability for residents along the N203 road. Feasible measures will be implemented, awaiting the development of an alternative road connection that decreases the amount of traffic on the N203.
The involved actors in the project.	The project organisation consisted of Sweco and the Province of Utrecht. The municipalities of the route collaborated, as they were interested in integrating the project in other developments. External stakeholders were involved for their reaction on the interim-design.	The project organisation existed of Sweco and the Province of North Holland. Externally to the project organisation, a relatively large amount of businesses and organisations had an interest in the lock and its renovation.	The project organisation existed of Sweco and the Province of North Holland. The external stakeholders of the project mainly existed of the residents along the N203 in Krommenie and Assendelft, but also of local businesses and users of the road.
Planning phase			
Phase of the project when the tool was used.	The concept of the interim-design was made, on which external stakeholders (surrounding residents, businesses and users of the route) were invited to leave a comment through the IMBY tool.	Relatics was used throughout the project. First it was used as the database in which to store variety of information about the project, including stakeholder information. Eventually, the environment manager stopped adding information to Relatics, after which it was used to develop an implementation contract.	Maptionnaire was used for the participation track of the research project. First, experiences and ideas about the area's liveability were gathered from external stakeholders. Second, reactions were gathered on potential measures that were created based on this input and research by liveability experts.

Table 6: Comparison of the summarized project-information of each case (source: author).

Different projects, different use of tools:
The three cases concern three relatively different large-scale infrastructure projects. Moreover, the tools in these cases are used differently. In case 1, IMBY is used for one moment in the project: to gather reactions on the concept interim-design. In case 2, Relatics was used internally throughout the project, for two purposes: storing project-information and using it for an implementation contract. In case 3, Maptionnaire was used as a participation track in research: to gather ideas and reactions. Thus, the tools were either used at a specific stage, at multiple stages or used in different ways throughout the project.

Using the tool for the most prominent external stakeholders:
The projects in case 1 and 3 mainly had residents, businesses and users of the area as external stakeholders, while in the project of case 2 these mainly concerned businesses and organisations. It is likely that the participative tools in case 1 and 3 were applied because of the prominent role of the local community in these projects. On the other hand, the businesses and organisations interested in the project of case 2 had a relatively strong influence because of their economic contribution to the area. This made keeping track of their interests an important task for the environment manager, which is supported by Relatics. Thus, in the three case studies, the tools were used to handle processes that were related to the most prominent external stakeholders in the project.

7.2 The tools: task-technology-user

In the previous chapters, each case study included a task-technology-user model of the tool that was used for environment management. Comparing these models (figure 20) provided insight in similarities and differences between the tools' functionalities, users and the environment management tasks the tools were used for.

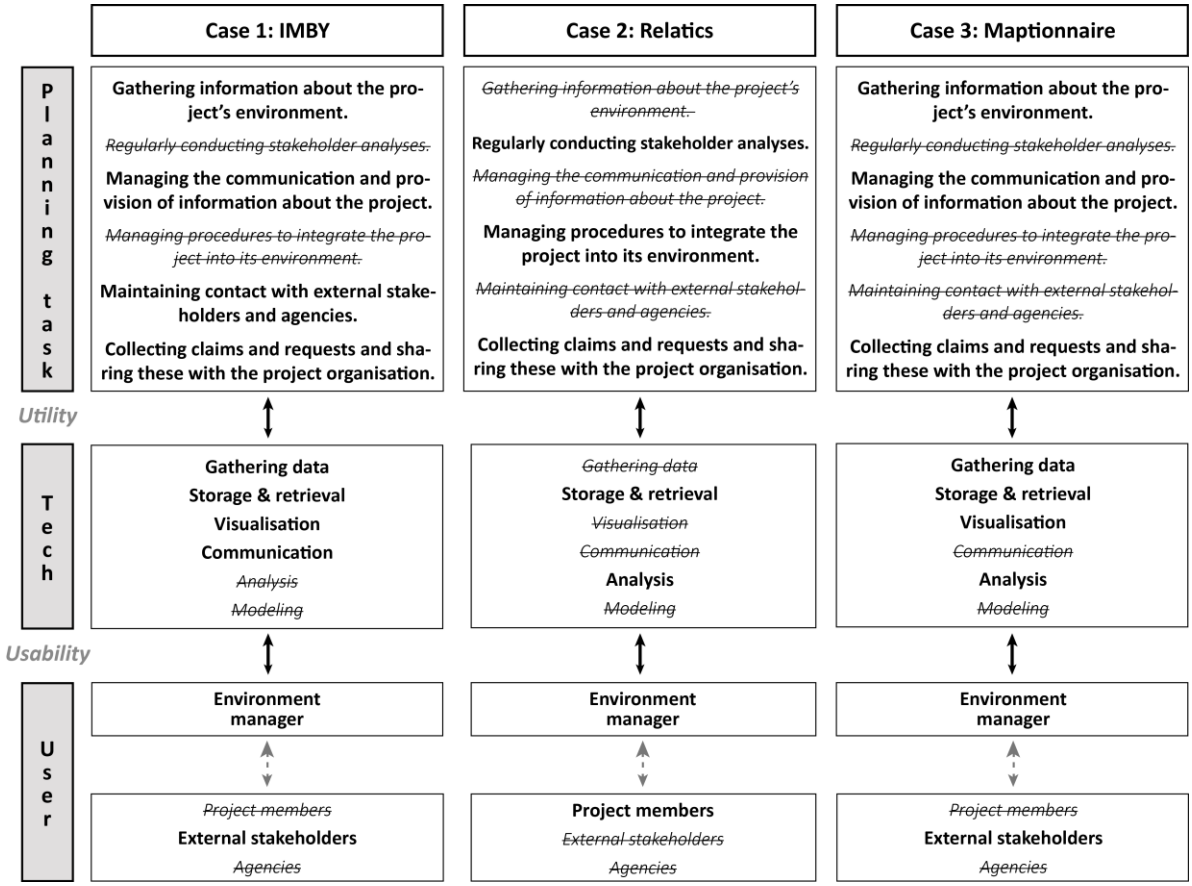

Figure 20: Comparison of the task-technology-user models of the cases (source: author).

Internal or external orientation:
By comparing the supported tasks, technological functions, and the users of the tools, a distinction can be made between tools that are oriented to the external or internal processes of environment management. The external tools (case 1 and 3) involve, besides the environment manager, the external stakeholders as user group, which are involved in the tool for gathering their input and to be informed about the project. The functionalities of the tools are, therefore: gathering data, visualisation, storage and retrieval and, to less extent, communication. The internal tool (case 2) is used by the environment manager and the other members of the project organisation. The internal tool mainly consisted of functionalities regarding the storage and retrieval of data, which could also be analysed. This tool was oriented to the internal processes of sharing data, managing procedures and analysing stakeholder information.

No support for agencies and no modelling and communication functions:
None of the three tools that were studied supported all the environment management tasks. However, all the environment management tasks were, to some extent, supported by the three tools combined. The extent to which these tasks are supported by each tool is explained in the results, and the findings in the following sections. On the other hand, there are elements in the task-technology-user models that are (nearly) absent, consisting of the functionalities: modelling and, to some extent, communication. Moreover, none of the studied tools were used by agencies (cable operators, explosive removal, archaeologists etc.) Thus, in this sense, tools did not support the environment managers in their work with agencies, and with modelling and communicating information, which explains why some tasks are supported partly.

7.3 Utility

In the case study results in the previous chapters, for each environment management task is explained to what extent these were supported by the tool that was used in the concerning project. Colours were appointed to the environment management tasks, in which green means the task is completely supported by the tool; yellow means the task is partly supported; and red means the task is not supported. While the full utility results provide a description that explains the extent to which the tool supports each environment management tasks, the colours provide a quick overview on the utility of the tool for each task, and enables comparison between cases in one overview:

Utility			
To what extent does the tool support:	***Case 1***	***Case 2***	***Case 3***
Gathering information about the environment.			
Regularly conducting stakeholder analyses.			
Managing the communication and provision of information for all stakeholders and agencies.			
Managing administrative procedures.			
Maintaining contact with external stakeholders and agencies.			
Collecting claims and requests from external stakeholders and agencies, and sharing these with the project organisation.			

Table 7: Colour comparison of the utility criteria between the tools of the three cases (source: author).

Either support for internal or external tasks:
The aforementioned external or internal orientation of the tools also becomes apparent when comparing the extent to which the tools support the environment management tasks. Case 1 and 3, the tools that are used mainly for gathering input, prove their utility in mainly the externally oriented tasks, while Relatics in case 2 mainly supports the internal processes.

Not communicative, but informative for communication:
The communication that was involved in several tasks was not done within the tool. Two of the three tools lacked communication functions, and for the other (IMBY) it was chosen by the project organisation to communicate in other ways. However, all three tools consisted of information that could be useful for the communication that was done outside the tool (e.g. contact information, stakeholder data, input by stakeholders etc.). Especially the Relatics tool in case 2 provides a large amount of information about the project's stakeholders by storing and analysing stakeholder information, which include insight in priorities and past moments of contact.

More input from more external stakeholder groups:
The (external) tools in case 1 and 3 both gathered an amount of input that was above the expectations of the project organisation. Moreover, there was more variety of respondents compared to the traditional meetings, which are often visited by a specific type of group. Thus, a digital tool attracts a larger number and diversity of stakeholders that provide input.

Explanation of context is essential for useful input:
Despite tools can gather a larger amount of input from a more diverse external stakeholder group, the usefulness of their input depends on the amount of context explanation that is provided by the tool. In comparison, in the IMBY tool in case 1, users were shown a map on which they could place a comment, without questions or explanatory texts. This resulted in comments that were not always relevant and/or useful for the project. On the other hand, Maptionnaire in case 3 guided the users with questions and explanatory texts and visualisations, which resulted in more specific and relevant input that could be used for the development of feasible short-term measures. Thus, the extent to which external stakeholders are guided through the tool by questions and explanatory texts and visualisation influences the usefulness of their input.

External tools as a channel of information, not as a collaborative platform:
The input from external stakeholders that was gathered through IMBY and Maptionnaire was processed and shared in the project organisation outside the tool itself. Data was exported out of the tools, after which it was analysed, shared and/or presented to the relevant project members, instead of doing this all within the tool. The two main reasons for this is that the tools did not have extensive analysis and communication functionalities, and that project members were already used or comfortable with doing this in other ways. In both of these projects, the environment manager was the project member that mainly used the tool. Therefore, these processes of exporting, sharing and communicating about the data became the (extra) tasks for mainly the environment manager.

Traceability of data, users and processes:
In all three cases, the tools to some extent supported the project organisation by keeping track of the data, users and/or the processes for which the tools were used. Relatics in case 2 was specifically meant as the database with traceable and up-to-date project-information. Moreover, the two other tools also provided insight in the type of users, their contact information and which comment belonged to which stakeholder. Therefore, using a digital tool for environment management not

only supports carrying out a task, it also supports the project organisation by making this data traceable.

7.4 Usability

In each case, the usability of the tools are studied according to Nielsen's (1993) usability attributes, which function as the criteria of the usability of PSS. Similar to utility, the results regarding the usability attributes were given a colour: green (usability criterium is completely met), yellow (criterium is partly met) or red (criterium is not met):

Usability			
To what extent does the tool meet the usability criteria:	***Case 1***	***Case 2***	***Case 3***
Learnability			
Efficiency			
Memorability			
Errors			
Satisfaction			

Table 8: Colour comparison of the usability criteria between the tools of the three cases (source: author).

The influence of learnability on willingness:
For all three of the tools, users needed to invest some time and effort to learn using the tool and to discover all the functionalities. After users learned using it for the first time, it was relatively easy for them to use it again. However, the amount of time and effort needed to learn using the tool differed among user groups, based on the time and skills these users have. Moreover, the amount of time and effort needed to learn using a tool affects the willingness of some users to use of the tool. For example, users within a project organisation could have a limited amount of time they are willing to invest in learning to use the tool, which occurred in case 2. Thus, the extent to which a tool is learnable influences the extent to which users are willing to invest time and effort to start using the tool.

The importance of guidance for external stakeholders:
In relation with the aforementioned learnability, the extent to which external stakeholders are able to use the tool is influenced by the extent to which a tool provides guidance for this user group. This guidance concerns the use of questions, texts and visualisations which explain the project, the purpose of the tool and how users can navigate through the tool. IMBY in case 1 lacked sufficient guidance for external stakeholders, which resulted into some users contacting the environment manager for help, while the guiding set-up of Maptionnaire in case 3 limited the extent to which users could make mistakes. Regarding the utility of the tool, as aforementioned, this could result into more useful input. Regarding the usability of the tool, this guidance improves the learnability, efficiency and satisfaction for users like external stakeholders, who are likely to use a tool one single time for a specific project.

Usability of externally oriented tools is mainly focused on the external users:
Despite aforementioned usability obstacles in some of the studied cases, both of the externally oriented tools (case 1 and 3) were relatively usable for external stakeholders. However, for the environment manager and the rest of the project organisation, setting up the tool, making adjustments and processing data from the tool is not efficient and is sensitive to errors and mistakes. Thus, the external tools might be suitable to gather input and be usable for external stakeholders, the inefficiency of setting up the tool and processing the gathered data is an obstacle for the usefulness of the tool for environment managers, as this results into more work needed to handle the often-large amount of gathered data.

Efficiency and flexibility depends on project members and other teams:
Besides the aforementioned efficiency issues within the tools, usability is also influenced by the users themselves and the dependence on an ICT-team. As not all users are comfortable and/or willing to use the tools, some decide to work outside the tool. In case 1, the IMBY tool, it was chosen not to respond directly to the comments within the tool, but to write a 'Reaction Note'. Therefore, the comments were exported into an excel-sheet, which needed to look professional to be published as appendix to this note. In the project in case 2, not all project members wanted to work in Relatics but preferred working in an excel file, which they would re-upload in the tool after being finished. Mistakes that were made in excel resulted into errors in Relatics, which required the project organisation, including the environment manager, to correct the mistakes manually in excel to fix the error. Moreover, the tools in case 1 and case 2 both required an ICT-team to be set up, adjusted or whenever an error would occur. Thus, fellow project members and other teams in an organisation influence the flexibility and efficiency of applying tools in projects.

8. Discussion

In the previous chapter, the results from the three cases have been compared, which resulted into findings regarding the utility and usability of planning support systems for environment management in large-scale infrastructure projects in the Netherlands. With these findings, the two sub-questions can be answered. Therefore, before discussing the findings of this research that answer the main question, the two sub-questions of this research are briefly answered.

Sub-question 1: What is the utility of planning support systems for environment management in large-scale infrastructure projects in the Netherlands?

In regard to the definition of utility: 'if the characteristics of the [PSS] technology (…) are suitable for the planning task that has to be fulfilled' (Pelzer, 2015, p. 131), this research suggests that planning support systems are particularly useful for environment management in reaching a larger and more diverse group of external stakeholders, and to keep track of the information concerning these stakeholders (e.g. characteristics, interests, contact moments). However, these external and internal processes are not supported by one tool, as each of the tools that have been studied in this research had specific functionalities. This gave the tools a specific orientation of tasks these supported. In fact, the studied tools could be distinguished as either being oriented to internal or external environment management processes. Thus, the utility of planning support systems for environment management is rather limited to specific tasks supported by each PSS, requiring the environment manager to use other methods and/or tools to carry out the other tasks.

Sub-question 2: What is the usability of planning support systems for environment management in large-scale infrastructure projects in the Netherlands?

In regard to Pelzer's (2015) definition of the usability of PSS: 'the extent to which users are able to use PSS functionalities', this research suggests that the externally oriented tools were sufficiently usable for external users, but the tools were inefficient to set up and to use by the environment manager and the rest of the project organisation. Moreover, these cases made clear that guidance by the tool through texts, visualisations and questions are important functionalities to optimise usability and to gather useful input. The internal tool that was studied in this research made clear how usability issues can affect the willingness of actors in a project organisation to make use of a tool, and how this can affect the usability (i.e. errors and efficiency) for the other users. Thus, the usability of planning support systems for environment is sufficient for external users, but need improvement for members of the project organisation (including environment managers) for the tools to become fully useful for the tasks these are meant to support.

As aforementioned, utility and usability together formulate the usefulness of PSS. Therefore, the utility and usability findings have resulted into usefulness findings, through which the main research question is answered and discussed as follows:

How useful are planning support systems for environment management in large-scale infrastructure projects in the Netherlands?

Considering the environment management tasks and the digital tools that were studied in this research, PSS in environment management is mainly used for, firstly, external processes such as: gathering input and providing information. Secondly, PSS is used internally for: saving, sharing and analysing data to draw findings from data and use it to carry out procedures. Therefore, this research suggests a distinction between internal and external orientation of PSS, as opposed to Vonk's (2006) distinction between the three functional orientations: information provision;

communication; analysis. In fact, the tools that were studied in this research could not be categorised into one of these three functions, but rather consisted of a mixture of such information-, communication- and analysis-functions, as these planning support systems were developed for a specific purpose. This corresponds to the recent developments, explained by Geertman and Stillwell (2020), in which an increasing number of PSS are specialised for a particular demand. In this sense, it can be seen as a reaction to the mismatch in the development and application of PSS being mainly technology (supply) driven instead of being driven by the task(s) and users it is meant to support (demand) (Geertman & Stillwell, 2020).
As stated by te Brömmelstroet (2013, p. 299): 'planning support systems are a family of computer-based instruments specifically designed to support actors in their complex tasks in the field of planning'. It is exactly this complexity in which environment managers work, as they coordinate the processes that are required to integrate a project into its social and physical environment (Wermer, 2018). In this context, planning support systems are used to gather, share, analyse, present and communicate different types of data, between different types of user groups. Therefore, this research suggests that the usefulness of a planning support system for environment management in Dutch large-scale infrastructure projects depends on the extent to which the tool possesses technological functions that support these different ways of handling data between and within the different user groups that are involved in the environment management tasks in such projects.

The externally oriented tools that are currently used for environment management in Dutch large-scale infrastructure projects are particularly useful for informing and gathering input from a large and diverse group of external stakeholders. This relates to the types of usefulness explained by Punt et al. (2020): learning about objects and opinions of other participants; collaboration; and better-informed plans. However, this usefulness depends on the extent to which users are guided through the tool. This research suggests that tools that provide guidance through questions, explanatory texts and visualisations are better usable and informative, which is also acknowledged by Geertman (2017): such guidance can enhance the richness and usefulness of the data that is gathered from this group of users, which contributes to a better-informed plan.
Internally, the studied tools were useful as a database that consist of project-information, which is accessible and useful for the project organisation and for other purposes throughout the project's process. Finally, the tools handle a variety of data in a systematic and traceable way, which makes a tool useful for keeping track of the, in this case, environment management processes in a project. This internal usefulness is one of the strengths of planning support systems that were defined by Vonk, Geertman & Schot (2007) and relates to PSS' kinds of usefulness: 'collaboration' and 'communication' (Pelzer, 2015).
On the other hand, besides the aforementioned external or internal orientation, the studied tools and their functionalities were developed for a specific purpose, task(s) and user group(s). This limits the versatility of these planning support systems and the extent these can fit specific planning practices, which are two of the ten most important bottlenecks for the usage of PSS, stated by Vonk, Geertman & Schot (2005). In combination with other utility and usability issues that are explained in the previous chapter, the usefulness of planning support systems for environment management in large-scale infrastructure projects is currently, more specifically, affected by:

- Limited functionalities in tools, which limits the extent to which these tools support handling (e.g sharing, communicating, analysing) the different types of data that are involved in the environment management tasks. This relates to one of the weaknesses of planning support systems as defined by Vonk, Geertman & Schot (2007), which concerns how planning support systems currently support uncomplex tasks, while planning practice involves complexity. In

other words, current PSS do not support planners in the complex tasks, while this is the support planners are searching for in PSS.

- The lack of flexibility to adjust a tool and its functionalities to a specific project and group of users. This may result in a tool not entirely suiting a, for example, particular project-phase. This lack of flexibility to adapt to different planning contexts is in line with one of the ways how the implementation gap of PSS manifests, stated by Punt et al. (2020).
- Insufficient usability for the internal users within a project organisation to set up and adjust a tool, and for further use of the same data. This also relates to the aforementioned problem of insufficient flexibility of PSS to adapt to different planning contexts. However, this issue is more related to the bottleneck of insufficient user-friendliness of PSS for experts and the lack of cooperation between geo-information specialists and planners, as defined by Vonk & Geertman (2008). In the studied cases in this research, however, there was not a lack of cooperation between geo-information specialists and planners, but an issue of too much dependence of environment managers on these specialists to set up the tool, make adjustments and fix errors.
- The current underuse of functionalities that can provide guidance through the tool (e.g. questions and explanatory texts and visualisations), affecting the usability of the tool and the usefulness of the users' contribution to the project. This issue relates to Zhang, Geertman, Hooimeijer & Lin's (2019) user-design fit model, in which usability is determined by user characteristics (e.g. competences and motivation) and design characteristics (e.g. ease of use and efficiency) of the tool. Regarding this model, this research suggests that a lack of guidance by the design of a planning support system increases the tool's dependence on the users' competences and motivation in order to be usable.
- The lack of experience and trust in tools by some project members, which affects the use and development of functionalities, and increases the preference and need to work outside the tool. This affects the efficiency of some processes of handling data, which is in line with the weaknesses of planning support systems that are explained by Vonk, Geertman & Schot (2007), in which the development of PSS is limited by a lack of intention by planners to use PSS and vice versa. In other words, when planners lack trust and experience in using planning support systems, the use of PSS remains limited, which eventually limits the extent to which PSS can develop according to user-experiences.

9. Conclusion

The increased complexity of planning issues and the involved actors throughout the past decades has made spatial planning an increasingly complex practice. In large-scale infrastructure projects in the Netherlands, environment managers coordinate this complexity in order to integrate the project into its social and physical environment. They do so by managing administrative processes (e.g. permits) and by involving, informing and communicating with different types of stakeholders. While working in this complexity, environment managers could potentially benefit from planning support systems in various ways described by existing literature. However, the same literature also addressed issues that affect the usefulness of planning support systems and how their usefulness is determined by several contextual factors in planning practices.

This research was aimed at gaining insight in how planning support systems can be useful for the environment management tasks in Dutch large-scale infrastructure projects, and what the current state of this usefulness is in this context. Environment management in large-scale infrastructure projects in the Netherlands is about the coordination of multiple types of processes and project-actors, which concerns handling different types of information in different ways. The PSS-tools in the studied cases in this research were used to gather, share, analyse, present and communicate different types of data, between different types of user groups. Therefore, this research suggests that the usefulness of planning support systems for environment management in large-scale infrastructure projects in the Netherlands is determined by the extent to which these consist of the required functionalities to support the different ways of handling data between and within different actor groups that are relevant to the tasks of the environment manager.

Besides determining what makes planning support systems useful for environment management in large-scale infrastructure projects in the Netherlands, this research has gained insight in the current state of usefulness of the PSS-tools that are currently used in such projects. Currently, planning support systems for environment management in this research context are either oriented to external (e.g. informing external stakeholders and gathering their input) or internal (e.g. saving and processing stakeholder data) processes. Regarding this orientation, these tools were specifically useful in reaching a large and diverse group of external stakeholders, and in organising data in an accessible and traceable way throughout the project's existence. Besides this external and internal orientation, the tools that were studied in this research were developed for a rather specific purpose in a project, which determined the tool's functionalities, user-orientation and the task(s) these tools supported.
Finally, as explained more extensively in the discussion chapter, this research has determined five more specific main issues that currently affect the usefulness of planning support systems in large-scale infrastructure projects in the Netherlands: limited functionalities in the tools; a lack of flexibility to adjust a tool; insufficient usability for the users within a project organisation; the underuse of functionalities that can provide guidance through the tool; and a lack of experience and trust in tools by project members.

Limitations of this research

There were some factors in this research that could have influenced the findings that were made. The first overall reflection is the fact that this is a qualitative research, which for a large part relies on the interpretation of the researcher and is sensitive to the social setting it takes place in (Bryman, 2012). To limit the influence of bias, research propositions and variables were used to collect and analyse data, which were based on literature and theoretical concepts.

Moreover, the context in which this research is conducted was during an internship at the engineering consultancy Sweco. This has given the researcher access to a rich collection of data and environment managers to interview for the cases that were studied. However, the findings of this research could therefore differ from environment management in other organisations, despite these environment management tasks are defined by literature. Moreover, as the organisation exists of Dutch employees, the documents and interviews were all Dutch. This had to be translated to English, in which not all Dutch words could be translated in their full meaning. For example, 'environment management' is translated from 'omgevingsmanagement'. For several of the environment management tasks, international literature refers to 'stakeholder management' and 'project management'. However, 'environment management' was chosen to prevent confusion with international definitions, because in the Netherlands 'omgevingsmanagement' involves more than stakeholder management.

Despite the internship provided access to documents and environment managers to interview, the external users of the tools (e.g. citizens, other organisations) could not be reached because of privacy regulations. This has limited the richness of insight in the perspective of the external users. However, as this research concerned the usefulness for environment management, the interviews with the environment managers in combination with the content analysis provided enough information for this research subject, while in the meantime these multiple sources of information provided enough triangulation to limit bias.

Finally, the findings from this research is based on three case studies in which each case consisted of a different tool, which optimised the diversity of tools that were researched. However, three tools are still just a selection of the tools that currently exist in the work field. Moreover, software, such as planning support systems, develop over time. Therefore, the findings of this research can become less relevant to the research context in the future as these tools remain in development, just like the knowledge about planning support systems.

Recommendations for further research

This research has focused on how planning support systems can be useful for environment management in large-scale infrastructure projects, based on existing tools and the environment management tasks as defined by IPM literature such as Wermer (2018). Further research could enrich the findings of this research by examining what functionalities are required in tools to support the different processes of handling data as explained in this research. Such research would therefore relate to more research on the supply-side of PSS in relation to the findings of this research.

Environment management tasks are carried out in more project-contexts than large-scale infrastructure projects, further research could provide insight in to what extent the practice of environment management, and the usefulness of PSS, is different in other project-contexts, such as more local projects. This would add to knowledge about the influence of context on the use of planning support systems, which has been addressed by Geertman (2008).

This research suggests that a planning support system for environment management in Dutch large-scale infrastructure projects is useful in the extent to which it supports handling the different types of data within and between different types of user groups. To confirm this, further (quantitative) research can be done on the relation between the variety of functionalities in a PSS-tool and the extent to which these have been found useful for environment management tasks.

This research was aimed at how PSS can be useful for environment management in the context of large-scale infrastructure projects in the Netherlands, and what the current state is of this usefulness. This was done by a qualitative approach, of which the findings included suggested relations between factors that influence this usefulness (e.g. variety of functions, influence of usability on useful input etc.). Therefore, quantitative research could confirm these suggested relations.

To research each tool's usability, this research has used Nielsen's (1993) usability attributes. However, as explained by Zhang, Geertman, Hooimeijer & Lin's (2019) user-design fit model, usability also depends on user-characteristics. This also became clear in the findings of this research, as tools with more 'guidance' by text, questions and visualisations were more usable for external users. Therefore, further research on the relation between the user-characteristics and the tool's design-characteristics, and the impact this has on the usability of a tool could confirm this suggested relation. Moreover, such research can provide insight in what design-characteristics a PSS-tool would need in order to be usable per type of user-group.

Recommendations for practice

Currently, most of the tools are developed for a specific activity in a project, with specific project-actors as users. This requires the environment manager to switch between tools and/or other methods to carry out all the other tasks, while data in the tool could also be used for those purposes. By integrating more functionalities in one tool to support the diverse ways of handling data, one tool can be used for more purposes in environment management, which would decrease the need to switch to other methods outside the tool and would stimulate the use of data for multiple purposes. The specific purpose that the tools in this research were developed for limited their versatility. As previously recommended, creating more diversity of functionalities in one tool increases the support function it could have for environment management. However, a large number of functionalities might make a tool complex to use, while not all functions might be needed in a specific project. This complexity can be prevented by making a tool flexible enough to 'turn on and off' functionalities when setting up the tool, enabling the tool to be customized to each project.

Setting up and/or adjusting a tool, or as previously recommended: 'turning on and off' functionalities, should be simple enough for the environment managers to carry out themselves. The environment managers have the experience to know for which tasks they prefer to use a tool, and a tool might need to change along with the progress of the project. Thus, improving the usability and autonomy for the environment manager enables them to set up and adjust a tool based on the tasks it is aimed to support in a project, and to prevent a tool from being an additional cause of complexity in a project.

In relation to the recommended diversity of functionalities, tools should also be able to provide explanatory texts, visualisations and questions to the user groups that need it. This can be done by guiding the user through multiple screens, adding explanatory text boxes and by visual explanation besides texts. This research suggests that optimising a tool's usability decreases the required skills and can increase the willingness of users to use the tool.

Besides the instrumental characteristics of a tool, the organisation that applies the tool in a project can affect its usefulness. Some cases that were studied in this research have shown that not all project members were equally motivated and skilled to use the tool. This resulted into the need to work outside the tools for those project members, which came with difficulties (inefficiency and errors) for the project members that used the tool. Therefore, when a tool is being applied into a project, the project organisation should collectively agree and commit to making use of it for the activities it is being applied to. Moreover, the project members that do not have sufficient skills should be able to follow tutorials and/or courses during worktime.

Bibliography

Baarda, B., Bakker, E., Fisher, T., Julsing, M., De Goede, M., Peters, V., & Van der Velden, T. (2013). *Basisboek kwalitatief onderzoek.* Groningen: Noordhoff Uitgevers.

Bernardini, P. & Knoeff, H. (2017). *Hoogwaterbeschermingsprogramma (HWBP): Handreiking verkenning (version 2).* Utrecht: HWBP.

Bisschops, S., & Hollemans, D. (2018). Participatie: discrepantie tussen wet en praktijk. *Rooilijn. Tijdschrift voor wetenschap en beleid in de ruimtelijke ordening, 51*(5), 380-386.

Boeije, H., 't Hart, H., & Hox, J. (2009). *Onderzoeksmethoden*. Den Haag: Boom Lemma uitgevers.

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal, 9*(2), 27–40. https://doi.org/10.3316/qrj0902027

Bryman, A. (2012). *Social research methods (4th ed.)*. London: Oxford University Press.

Chinyio, E. & Olomolaiye, P. (Eds.) (2010). *Construction Stakeholder Management.* Chichester: Wiley-Blackwell.

de Bruijn, E. (2021). *Reacties Nieuwegein digitaal platform IMBY: Doorfietsroute Utrecht-Nieuwegein-IJsselstein*. Retrieved from the provincial government website: https://geotest.provincie-utrecht.nl/publiek/AGO/snelfietsroutes/Utrecht_Nieuwegein_IJsselstein/20210503_Reactienota_doorfietsroute_Utrecht-IJsselstein_D1.1.pdf

De', R., Pandey, N., & Pal, A. (2020). Impact of digital surge during Covid-19 pandemic: A viewpoint on research and practice. *International journal of information management, 55*, 102171. https://doi.org/10.1016/j.ijinfomgt.2020.102171

Expertgroep Projectmanagement (2008). *Rolprofielen IPM: Kader voor de rolprofielen van Projectmanager, Manager Projectbeheersing, Omgevingsmanager, Technisch Manager, Contractmanager.* Utrecht: Rijkswaterstaat.

Geertman, S. (2006). Potentials for Planning Support: A Planning-Conceptual Approach. *Environment and Planning B: Planning and Design, 33*(6), 863–880. https://doi.org/10.1068/b31129

Geertman, S. (2008). Planning Support Systems: A Planner's Perspective. In: R. K. Brail (Ed.), *Planning Support Systems for Cities and Regions* (213-230). Cambridge, Massachusetts: Lincoln Institute of Land Policy.

Geertman, S. (2017). PSS: Beyond the implementation gap. *Transportation Research Part A: Policy and Practice, 104*, 70–76. https://doi.org/10.1016/j.tra.2016.10.016

Geertman, S., & Stillwell, J. (2009). Planning Support Systems: Content, Issues and Trends. In S. Geertman, J. Stillwell (eds.*), Planning Support Systems Best Practice and New Methods* (1-26). Springer Science+Business Media B.V.

Geertman, S., & Stillwell, J. (2020). Planning support science: Developments and challenges. *Environment and Planning B: Urban Analytics and City Science, 47*(8), 1326–1342. https://doi.org/10.1177/2399808320936277

Granath, M. (2016). The Smart City–how smart can'IT'be?: Discourses on digitalisation in policy and planning of urban development. *Linköping Studies in Arts and Science (Vol. 693)*. Linköping University Electronic Press.

Grijzen, J. (2010). *Outsourcing Planning: What do consultants do in regional spatial planning in the Netherlands*. (PhD Thesis, Amsterdam University). Amsterdam: Amsterdam University Press.

Innes, J. E., & Booher, D. E. (2015). A turning point for planning theory? Overcoming dividing discourses. *Planning theory, 14*(2), 195-213.

Marshall, T. (2012). *Planning Major Infrastructure: A Critical Analysis*. London, England: Routledge.

McEvoy, S., van de Ven, F. H. M., Santander, A. G., & Slinger, J. H. (2019). The influence of context on the use and added value of Planning Support Systems in workshops: An exploratory case study of climate adaptation planning in Guayaquil, Ecuador. *Computers, Environment and Urban Systems, 77*, 101353. https://doi.org/10.1016/j.compenvurbsys.2019.101353

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation (4th ed.)*. London: Jossey-Bass.

Ministerie van Infrastructuur en Milieu (2016). *Spelregels van het Meerjarenprogramma Infrastructuur, Ruimte en Transport (MIRT).* The Hague: Ministerie van Infrastructuur en Milieu.

Ministerie van Infrastructuur en Milieu. (2017). *De opgaven voor de Nationale Omgevingsvisie*. The Hague: Ministerie van Infrastructuur en Milieu.

Nexusplexus. (n.d.). 'Digital technology background with social networking and interaction concept' [stock photo]. Retrieved from https://www.123rf.com/photo_50230302_digital-technology-background-with-social-networking-and-interaction-concept.html

Nielsen, J. (1993). *Usability Engineering*. Oxford: Morgan Kaufmann.

Pelzer, P. (2015). *Usefulness of Planning Support Systems: Conceptual perspectives and practitioners' experiences*. (Dissertation, Utrecht University). Groningen: InPlanning.

Province of Utrecht (n. d.) (consulted on 2021, 1 june). Overzicht Snelfietsroutes [ArcGIS environment]. Retrieved from: https://utrecht.maps.arcgis.com/apps/MapSeries/index.html?appid=c749c67bf4334e8b97fc6fc698a31f95

Punt, E. P., Geertman, S. C. M., Afrooz, A. E., Witte, P. A., & Pettit, C. J. (2020). Life is a scene and we are the actors: Assessing the usefulness of planning support theatres for smart city planning. *Computers, Environment and Urban Systems, 82*, 101485. https://doi.org/10.1016/j.compenvurbsys.2020.101485

Rijkswaterstaat (n.d.) (consulted on 2021, 12, April). About us [webpage]. Retrieved from https://www.rijkswaterstaat.nl/en/about-us

te Brömmelstroet, M. (2013). Performance of Planning Support Systems. What is it, and how do we report on it? *Computers, Environment and Urban Systems, 41*, 299–308. https://doi.org/10.1016/j.compenvurbsys.2012.07.004

Unie van Waterschappen (2020). *Handreiking Projectbesluit Omgevingswet: Een handreiking om te komen van projectplan Waterwet tot projectbesluit Omgevingswet.* The Hague: Unie van Waterschappen.

Van der Meer et al. (2020). *Resultaten haalbaarheidsonderzoek: Onderzoek naar de haalbaarheid van de omvaarroute via de Boerenverdrietsluit en Zeedoksluis*. Retrieved from the provincial government website: https://www.noord-holland.nl/Onderwerpen/Verkeer_vervoer/Projecten_Verkeer_en_Vervoer/Renovatie_Koopvaardersschutsluis/Documenten/Rapport_haalbaarheidsonderzoek_omvaarroute.org

Van Engelenburg, H. (2021). *Voorlopig ontwerp doorfietsroute Utrecht-Nieuwegein-IJsselstein, deel in gemeente Nieuwegein.* (Letter to residents). Retrieved from the provincial government website: https://www.provincie-utrecht.nl/sites/default/files/2021-01/Bewonersbrief%20voorlopig%20ontwerp%20snelfietsroute%20IJsselstein%20%E2%80%93%20Nieuwegein%20-%20Utrecht%2022-01-2021%20.pdf

Van Velzen, B., Verbon, S. & Visser, M. (2020). *Leefbaarheid N203 Krommenie: Onderzoek naar kortetermijnmaatregelen.* Retrieved from the provincial government website: https://www.noord-holland.nl/Onderwerpen/Verkeer_vervoer/Projecten_Verkeer_en_Vervoer/Verbinding_A8_A9/Over_het_project/Projectdocumenten/2_f_Maatregelen_Krommenie_Assendelft/Eindrapport_leefbaarheidsmaatregelen_Krommenie.org

Verweij, S., Klijn, E.H., Edelenbos, J. & Van Buuren, M.W. (2013). What Makes Governance Networks Work? A Fuzzy Set Qualitative Comparative Analysis of 14 Dutch Spatial Planning Projects. *Public Administration: An International Quarterly, 91* (4), 1035-1055.

Vonk, G. (2006). *Improving Planning Support; The Use of Planning Support Systems for Spatial Planning*. (Dissertation, Utrecht University). Utrecht: Utrecht University Repository.

Vonk, G., & Geertman, S. (2008). Improving the Adoption and Use of Planning Support Systems in Practice. *Applied Spatial Analysis and Policy*, *1*(3), 153–173. https://doi.org/10.1007/s12061-008-9011-7

Vonk, G., Geertman, S., & Schot, P. (2005). Bottlenecks Blocking Widespread Usage of Planning Support Systems. *Environment and Planning A: Economy and Space*, *37*(5), 909–924. https://doi.org/10.1068/a3712

Vonk, G., Geertman, S., & Schot, P. (2007). A SWOT Analysis of Planning Support Systems. *Environment and Planning A: Economy and Space*, *39*(7), 1699–1714. https://doi.org/10.1068/a38262

Wermer, F. (2012). *Integraal Projectmanagement bij Rijkswaterstaat: Beknopte leaflet voor externen*. Utrecht: Rijkswaterstaat.

Wermer, F. (2018). *De kracht van een driehoek: Praktijkervaringen met Integraal Projectmanagement (IPM).* The Hague: Neerlands diep.

Westerink, J., Kempenaar, A., van Lierop, M., Groot, S., van der Valk, A., & van den Brink, A. (2016). The participating government: Shifting boundaries in collaborative spatial planning of urban regions. *Environment and Planning C: Politics and Space*, *35*(1), 147–168. https://doi.org/10.1177/0263774x16646770

Yin, R. K. (2018). *Case study research and applications: Design and methods (6th ed.).* Thousand Oaks, California: SAGE Publications.

Zhang, L., Geertman, S., Hooimeijer, P., & Lin, Y. (2019). The usefulness of a Web-based Participatory Planning Support System in Wuhan, China. *Computers, Environment and Urban Systems*, *74*, 208–217. https://doi.org/10.1016/j.compenvurbsys.2018.11.006

Appendices

Appendix 1: Research propositions

Appendix 2: Dutch interview questions

Appendix 3: English interview questions

Appendix 4: Coding scheme NVivo

The interview transcripts are in a separate document because of the large number of pages:

Appendix 5: Transcript interview case 1

Appendix 6: Transcript interview case 2

Appendix 7: Transcript interview case 3

Appendix 1: Research propositions

Project-context research propositions

1. The purpose of the project.
2. The involved actors in the project.
3. Phase of the project was in when the tool was used.

Task-technology-user research propositions

4. The environment management tasks the tool supports.
    - The tasks will be reflected on the environment management tasks defined by IPM literature, as explained in the literature review.
5. The functionalities of the tool.
    - The functionalities of the tools will be reflected on the PSS-functionalities that are explained in the literature review.
6. Which project-actors were users of the tool?
    - The project-actors that used the tool will be categorised according to the user-groups that are explained in the literature review.

Utility and usability research propositions

7. Utility of planning support systems:
   Because the utility of a planning support system differs per task it is being applied to, a suitable way to measure the utility of PSS for environment management is by evaluating each of the environment management tasks according to the definition of utility, as explained in the literature review:

   To what extent does the PSS-technology support…
   - *…gathering information about the project's environment?*
   - *…regularly conducting stakeholder analyses?*
   - *…managing the communication and provision of information about the project?*
   - *…managing procedures to integrate the project into its environment?*
   - *…maintaining contact with external stakeholders and agencies?*
   - *…collecting claims and requests, and sharing these with the project organisation?*

8. Usability of planning support systems:
   As explained in the literature review, Nielsen (1993) has formulated five usability attributes, which were used in this research to collect data about usability:

   To what extent is the PSS…
   - *…easy to learn, so tasks can be carried out rapidly?*
   - *…efficient to use after learning using it, to achieve productivity?*
   - *…easy to remember, so that it can be used again after some period of not using it?*
   - *…sensitive to errors by the system and/or its users? And if so, how easy is it to recover from them?*
   - *…pleasant for the users to use?*

Appendix 2: Dutch interview questions

Introductie: Allereerst dank u wel voor uw tijd voor dit interview. Voordat we beginnen met het interview: gaat u ermee akkoord dat het wordt opgenomen?

Project-context:

1. Hoeveel ervaring heeft u met het gebruik van tools voor uw werkzaamheden als omgevingsmanager?
2. Over het project waarvoor ik u nu interview: wat voor project was het en wat was de opgave?
3. Wat voor omgevingsmanagement taken heeft u uitgevoerd in dit project?
4. Wat voor partijen waren (zowel direct als indirect) betrokken bij het project, en wat waren hun belangen?
    a. Welke van deze partijen in het project maakten gebruik van de tool, en op welke manier?
5. Kunt u mij meer vertellen over de tool die is gebruikt in dit project, en waarom specifiek deze tool is gekozen?
    a. Wat voor functionaliteiten heeft de tool?
    b. Is deze tool vaker gebruikt in andere projecten? En waren dit dan gelijksoortige projecten of ook hele andere projecten dan dit project?
6. En dan de laatste vraag voordat we wat verder de diepte in gaan: hoe denkt u dat deze tool heeft bijgedragen aan het project, in vergelijking met als er géén gebruik van zou zijn gemaakt.
    a. En hoeverre heeft de tool aan de verwachtingen voldaan? (bijv. Gewenste respons behaald etc.)

Over de functionaliteit/utility van de tool (task+tech):

7. Om te beginnen me een algemene reflectie: in hoeverre vond u de tool geschikt voor de omgevingsmanagement taken die zijn uitgevoerd in het project?
8. Voor welke omgevingsmanagement taken was de tool vooral bedoeld? (deze taken zijn beantwoord in vraag 3).
9. Zou u voor de functionaliteiten van de tool kunnen reflecteren of deze geschikt of ongeschikt waren voor de uitgevoerde omgevingsmanagement taken? En waarom wel/niet?

Nu ga ik wat vragen stellen over hoeverre de tool de Omgevingsmanagement taken ondersteund zoals deze taken zijn beschreven in literatuur over het IPM-model. Wellicht dat een aantal van deze taken niet heel prominent zijn geweest in dit project. Toch zou ik graag uw perspectief hierover horen, vanwege uw ervaringen als omgevingsmanager die deze tool heeft gebruikt.

10. In hoeverre ondersteunt deze tool het <u>verzamelen van informatie</u> over de omgeving om de benodigde kennis op te bouwen die nodig is voor het uitvoeren van het project?
11. In hoeverre ondersteunt deze tool <u>het regelmatig uitvoeren van stakeholder analyses</u> om de stakeholder strategie up-to-date te houden?
12. In hoeverre ondersteunt deze tool het <u>onderhouden van communicatie en informatievoorziening over het project</u> voor alle stakeholders en instanties?

13. In hoeverre ondersteunt deze tool <u>het afhandelen van de administratieve procedures die nodig zijn om het project te integreren in de omgeving</u>? (bijvoorbeeld: planologische procedures, vergunningen, coordineren met instanties)
14. In hoeverre ondersteunt deze tool <u>het onderhouden van contact met externe stakeholders en instanties</u> die relevant en/of belangrijk zijn voor de voortgang van het project?
15. In hoeverre ondersteunt deze tool <u>het verzamelen van klachten, verzoeken en eisen van externe stakeholders en instanties en het delen van deze met de rest van de projectorganisatie?</u>

Over de gebruiksvriendelijkheid/usability van de tool (tech+users):

De volgende vragen gaan over de gebruiksvriendelijkheid van de tool. Bij deze vragen zou ik graag uw reflectie willen horen over hoe u het gebruiken van deze tool hebt ervaren.

16. In hoeverre was het voor u fijn om de tool te gebruiken?
17. In hoeverre was de tool makkelijk te begrijpen, zodat u hiermee de werkzaamheden kon uitvoeren die u ermee wilde uitvoeren?
18. Nadat u gewend was aan de tool, hoe efficient kon u de tool gebruiken en erdoorheen navigeren?
19. Heeft u de tool vaker benaderd tijdens het project, en tussen projecten?
    a. Zoja: hoe makkelijk was het voor u om de tool weer te gebruiken nadat u het voor de eerste keer hebt gebruikt?
20. In hoeverre heeft u bepaalde fouten of problemen ondervonden toen u de tool gebruikte?
    a. Zoja: Kwam dit door een menselijke fout, of een fout van het systeem?
    b. Hoe makkelijk was het om na deze problemen weer gebruik te kunnen maken van de tool?

Naast uw eigen ervaringen met betrekking tot de gebruiksvriendelijkheid, zou ik ook graag van u willen horen hoe gebruiksvriendelijk de tool was voor de andere gebruikers. Dus in de volgende vragen zijn de vorige 5 vragen ook verwerkt, maar dit keer zou ik graag alles willen horen van wat u weet over hoe de andere gebruikers het gebruik van de tool hebben ervaren.

21. Kunt u voor elke gebruiker van de tool uitleggen: voor welke doeleinden maakte elk soort gebruiker gebruik van de tool, en welke delen van de tool gebruikten zij?
22. Over het algemeen: in hoeverre denkt u dat de andere gebruikers van de tool in staat waren de tool te gebruiken?

    Zou u, aan de hand van de volgende vragen, specifieker kunnen reflecteren op:
    a. Hoe fijn en makkelijk was het voor de andere gebruikers om de tool te gebruiken?
    b. Hoe goed konden de andere gebruikers wennen en zich uiteindelijk wegwijs kunnen maken in de tool?
    c. Waren er gebruikers die bepaalde problemen of fouten in de tool hebben ervaren? En kwam dat door een menselijke fout of een systeemfout?
23. Kunt u voor elk deel (functionaliteit) van de tool reflecteren of deze wel of niet gebruiksvriendelijk waren voor elke gebruiker? En waarom dat wel of niet was?
24. Dit waren de onderwerpen die ik met u wilde bespreken. Wilt u nog iets delen over de tool of het project?

Appendix 3: English interview questions

Introduction: First of all thank you for your time to be interviewed. Before we start: are you okay with me recording this interview?

Project-context:

1. Can you tell me about how much experience you have with the use of tools for your work?
2. About the project I am interviewing you for: what was the project about, what was the main assignment?
3. Can you describe the tasks that you carried out as Environment Manager in this project?
4. What actors were (indirectly/directly) involved in the project, and what were their interests?
    a. Which of the actors in the project made use of the tool and how?
5. Can you tell me more about the tool that was used in this project, and why specifically this tool was chosen?
    a. Can you describe the functionalities the tool has?
    b. Was this tool used more often in other projects, were these projects similar or different to this project?
6. And the last question before going further in-depth: How do you think this tool contributed to the project compared to not using a tool? And to what extent did the tool meet the expectations?

About the utility of the tool (task+tech):

7. Starting off with a general reflection: to what extent did you find the tool suitable for the Environment Management tasks that were carried out in the project?
8. For which environment management tasks was the tool specifically meant?
9. Can you reflect on the tool's functionalities whether these were suitable or not suitable for each of the Environment Management tasks that were carried out in the project, and explain why?

Now I am going to ask some questions about to what extent the tool supports the Environment Management tasks as described by literature about the IPM-model. Perhaps some of these tasks might not have been carried out in this project. But still I would like to hear your point of view based on your profession and experience as an Environment Manager that has used this tool.

10. To what extent does this tool support gathering information about the environment to gain the knowledge that is required for the project to succeed?
11. To what extent does this tool support regularly conducting stakeholder analyses to keep the stakeholder strategy up-to-date to achieve the goals of the project?
12. To what extent does this tool support managing the communication and provision of information about the project for all stakeholders and relevant agencies?
13. To what extent does this tool support managing the administrative procedures that are required to integrate the project into its environment (e.g. planning procedures, permit procedures and coordinating with cable-infrastructure operators)?

14. To what extent does this tool support maintaining contact with the external stakeholders and agencies that are relevant and/or important for the project's progress?
15. To what extent does this tool support collecting claims and requests from external stakeholders and agencies and sharing these with the project organisation?

About the usability of the tool (tech+users):

The following questions concerns the usability of the tool. Throughout these questions I would like to hear your reflection on how you experienced making use of the tool.

16. How pleasant was it for you to use the tool?
17. How easy was the tool to understand in order to carry out the actions you wanted to do?
18. After getting familiar with the tool, how efficiently could you navigate and use the tool?
19. Have you used the tool multiple times? If so: how easily could you use the tool again after having used it the first time?
20. Did you experience any errors while using the tool? If so: was this because of your own mistake or was it an error in the tool itself?

Besides your own experiences regarding the usability, I would also be interested to hear your reflection on how usable the tool was for other users of the tool. So in the next questions the previous five questions are also integrated, but this time I would like to hear everything you know about the experiences from other users of the tool.

21. Can you describe for each user of the tool: for which purpose did they make use of the tool, and through which functionalities?
22. Can you generally reflect on to what extent the users of the tool were able to make use of it?

    Can you also, more specifically, reflect on:

    a. How pleasant and easy was it for the other users to use the tool?
    b. How well could each user get familiar and efficiently navigate through the tool?
    c. Were there any users that experienced any errors? And was that because of their own mistake or was it an error in the tool itself?
23. Can you reflect on each of the tool's functionalities if these were or were not usable for each user, and why?
24. After answering all these questions, do you have anything else to share about the tool's usefulness in this project?

Appendix 4: Coding scheme NVivo

Category	*Codes*	*Description*
Project-context	Purpose of the project.	All information that relates to the project, the actors that are involved and the phase in which the tool was used.
	Involved actors.	
	Project-phase when using tool.	
Task-technology-user model	Description of the tool.	Information about how the tool is described by documents and the environment manager in the interview. More specifically, all information related to the environment management tasks the tool (partly) supports, and the functions and users of the tool.
	IPM environment management tasks supported by the tool.	
	Technological functions of the tool.	
	Users of the tool.	
Utility of the tool	Gathering information about the project's environment.	Information is coded when it describes the extent to which an IPM-defined environment management task is supported by the tool.
	Regularly conducting stakeholder analyses.	
	Communicating and informing all relevant stakeholders and agencies.	
	Managing administrative procedures to integrate project into its environment.	
	Maintaining contact with external stakeholders and agencies.	
	Collecting claims and requests from external stakeholders and agencies, and sharing these in the project organisation.	
Usability of the tool	Learnability.	Information is coded when it describes the tool's usability for its users in relation to each of Nielsen's (1993) usability attributes.
	Efficiency.	
	Memorability.	
	Errors and recovery.	
	Satisfaction.	