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Geographical Information Management and Applications

TOWARDS AN ONLINE PUBLIC PARTICIPATION GIS ENVIRONMENT, USING VGI AND 3D GEO-INFORMATION

Researching the added value of an Internet-based PPGIS environment by the use of VGI and 3D Geo-Information in spatial planning

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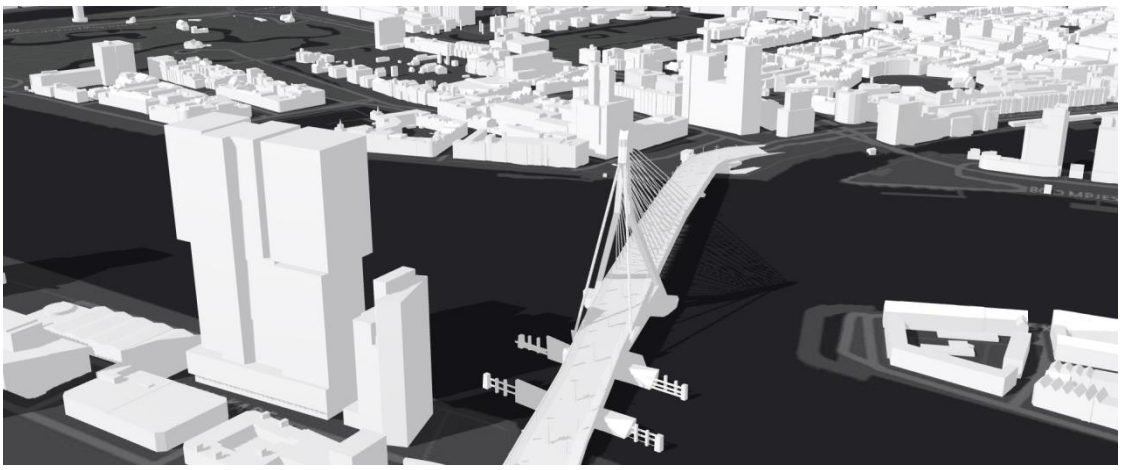
A case study for the City of Rotterdam



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ABSTRACT

Public participation is of importance in local government, particularly in the decision-making process of spatial planning projects. In recent decades, Planning Support Systems, such as Public Participation GIS (PPGIS) have been introduced to help increase public participation in de planning process. However, these participation tools have mostly been used by municipalities to inform citizens rather than to gain knowledge and ideas from each other. Moreover, public participation and its tools have not always been evaluated positively. To increase levels and quality of citizen participation, the added value of participation tools should be identified and lower thresholds should be realized to enable citizens to communicate and participate more directly and more meaningfully. Tools such as Volunteered Geographical Information (VGI) and 3D geo-information are therefore of interest to be used in an online Public Participation GIS environment. In this online environment, ways are provided to enable citizens to easily give ideas or opinions on plans. Furthermore, neighborhoods are visualized in 3D to create better understanding of the proposed plans, improving communication and participation. Tests are done for the City of Rotterdam in two case study areas; 'de Zenostraat' and 'het Noordelijk Niertje Oost' (NNO). The amount of respondents for these case studies is very small, respectively 11 and 14 citizens. Therefore it must be noted that due to this small N, conclusions must be taken with care. Furthermore, the NNO project showed a mismatch in desires for public participation, which resulted in less responses and lower attitude results. Via an online questionnaire based on Likert type and scale data, the potential added value of the online PPGIS environment is compared to that of public hearings. Indicators used to analyze this added value are based on recent work of Peter Pelzer (2015). Results show that respondents are overall slightly more positive about the public hearing as a method alone, though it was indicated that the real added value can be found in combining the two participation methods in a complementary fashion. Furthermore, the applied indicators for added value (utility, usability and usefulness) were found to have no complete coverage of the respondents' attitudes toward participation methods. Therefore, additional indicators are proposed for the future study of public participation methods in the decision-making process of spatial planning projects. These are focused on (1) tuning desires of municipality and citizens, in order to prevent such mismatches; i.e. the before-design study, and on (2) gaining trust of citizens towards the proposed online PPGIS method, by proving that citizens' opinions will be used in the decision-making process; i.e. the after-application study.

Tags: *Online PPGIS; VGI; 3D Geo-information; PSS; Public Participation; Added Value; Spatial Planning; Decision-Making; Web-Application; City of Rotterdam*

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1. INTRODUCTION

This section provides an introduction to the relevant concepts of public participation in the spatial planning process. Several Planning Support System (PSS) methods, tools and techniques are discussed and their respective contexts described. Subsequently, the overall problem is stated, which explains the choice for this research topic.

1.1 Introduction & Context

Within local government, the role of citizens' opinions is of increasing importance. A trend to involve citizens in data collection campaigns has emerged in all sorts of local government agencies (Brovelli et al., 2015b). Involving citizens and public opinions in decision-making processes is known as *public participation,* which comprises the involvement of both stakeholders and interested citizens (Al-Kodmany, 1999). Public participation is gaining popularity in the public domain (Brovelli et al., 2015b); especially in decision- and policy-making processes for *spatial planning* projects. Moreover, public participation is argued to be valuable in making *urban planning projects* successful (Hu et al., 2015; Seeger, 2008). Urban planning, as part of spatial planning, is aimed at improving the living environment of the city and its citizens, hence the importance to include the opinion of those that will be affected most. Studies show that the success of a spatial planning project is strongly dependent on the timing and intensiveness of public participation in the planning process. Participation of the public is valuable to produce efficient and inclusive decisions (Al-Kodmany, 1999). Ideally, public participation should be part of all stages of the planning decision-making process (Hu et al., 2015). However, including citizen participation in the decision-making process, let alone incorporating it in every part of the planning process, is costly (Irvin & Stansbury, 2004; Neshkova & Guo, 2012). These costs can be found largely in time and budget constraints. Consequently, Neshkova & Guo (2012) stress that the most active and involved citizens, due to private interests, could represent different opinions and desires than those of the broad public. Therefore, one can argue that there seems to be a gap between the use of public participation and its actual value in the decision-making process.

Public participation in planning processes comes in many forms; from analogue citizen hearings to digital participation forums. Computer science technologies have shown to be useful in enhancing digital public participation in spatial planning processes (Armstrong, 2000, in Wu et al., 2010). The development of the Web 2.0 and urban planning tools allow planning designers to make their plans publicly available through the Internet as electronic maps, and have caused society to rapidly move toward digital communication (Tang & Liu, 2015; Wu et al., 2010). It has been recognized that Web 2.0 tools are crucial for the facilitation of public participation (Brovelli

et al., 2015b: 2). Examples of digital GIS-supported participation technologies and geospatial tools are: *Public Participation GIS* (PPGIS) methods, such as Map-based touch Tables (Pelzer et al., 2014; Pelzer et al., 2013), and tools such as Geospatial Surveys and *Volunteered Geographic Information* (VGI) (Seeger, 2008). These technologies and tools are meant to include collaborative decision-making which are used nowadays as Planning Support System (PSS) (Geertman & Stillwell, 2004). PSS is defined as "…geoinformation technology-based instruments that incorporate a suite of components that collectively support some specific parts of a unique professional planning task" (Geertman, 2008: 47). *GeoWeb* 2.0 tools and technologies are seen as the foundation of most PPGIS practices. The growing number of mobile devices, such as smart phones and tablets, have led to an increase in the integration and interpretation of geospatial knowledge, captured by the people themselves (Brovelli et al., 2015b). Therefore, as a second observation, a wide variety of digital and online methods and tools are available to use in public participation, thereby possibly acquiring added value. It is for this reason, that some of these methods and tools of interest are explored in further detail.

The method of interest, Public Participation GIS (PPGIS), was first used in the mid-1990s. It can be described as all modes of using Geographic Information Systems (GIS) as a method to engage public participation in planning decision-making processes (Brovelli et al., 2015a; 2015b). Moreover, GIS are known as a combination of the five 'geowares' - hardware, software, data(ware), people(ware) and organizations(ware) – and institutional arrangements to collect, store, analyse and disseminate geographic information (Brovelli et al., 2015a). GIS can be effective in facilitating continuous public participation in spatial planning decisions (Aggett & McColl, 2006). In the early stages, PPGIS was often used in face-to-face meetings, as a traditional form of participation, to investigate the participatory processes. Nowadays, digital PPGIS is more common, of which the MapTable is a well-known and studied example in the Netherlands. Furthermore it is important to explore PGIS, which stands for Participatory GIS. The distinction between PGIS and PPGIS can largely be found in the situational context (see Table 1), in which PGIS is inter alia focused on community empowerment for rural planning in developing countries. PPGIS on the other hand is focused on enhancing public involvement, mostly for urban planning applications in developed countries (Brown et al., 2015; Brown & Kyttä, 2014). Furthermore, PGIS mostly focuses on making *non-digital GIS* available to less-favoured societal groups, whereas PPGIS is mostly focused on the outcome of a *digital GIS-based decision-making process* (Rambaldi et al., 2006, in Brovelli et al., 2015b: 2). An overview of the differences in characteristics between PPGIS and PGIS in relation to VGI can be viewed in Table 1.

	PPGIS	PGIS	VGI
Process emphasis	Enhance public involvement to inform land use planning and management	Community empowerment Foster social identity Build social capital	Expand spatial information using citizens as sensors
Sponsors	Government planning agencies	NGOs	NGOs, ad hoc groups, individuals
Global context	*Developed* countries	*Developing* countries	Variable
Place context	Urban and regional	Rural	Variable
Importance of mapped data quality	Primary	Secondary	Primary
Sampling approach	Active: probability	Active: purposive	Passive: voluntary
Data collection	Individual (e.g., household sampling)	Collective (e.g., community workshops)	Individual
Data ownership	Sponsors of the process	People and communities that created data	Shared (e.g., data commons license)
Dominant mapping technology	Digital	Non-digital	Digital

Table 1: An overview of the characteristics of PPGIS, PGIS and VGI (Brown & Kyttä, 2014).

Nowadays, the development of *online* PPGIS is on the rise, mainly to escape some of the spatiotemporal constraints to which the traditional, face-to-face participation methods are bounded. These constraints are mostly distance and scheduling factors, which may result in biased opinions of the public (Hu et al., 2015). According to Tang & Liu (2015), the Internet-based PPGIS environments are more flexible in time and distance factors than the traditional participation methods and traditional PPGISs. Therefore online PPGIS is more likely to be attractive for users to participate in planning processes, which could be of added value to public participation in the decision-making process.

The first public participation tool of interest, Volunteered Geographic Information (VGI), consists of the voluntarily creation, assembling and dissemination of geospatial data by many citizens or individuals, acting as volunteer sensors (Brown et al., 2015; Campagna et al., 2015; Goodchild, 2007; Seeger, 2008; Silva & Rocha, 2012) in both spatial and temporal dimensions (Brovelli et al., 2015b). VGI has been introduced by Goodchild (2007), and can provide insights into the wishes, perceptions, experiences, or desires of the public on any topic (Seeger, 2008). VGI participants are mostly characterised by the fact that they do not have any expertise in geography, cartography or any other related fields (Seeger, 2008; Silva & Rocha, 2012). Including VGI as a tool in PPGIS could enhance participation of a broader public, as it eases the ways to participate in the planning process. Therefore VGI could contribute to the added value of public participation in the decision-making process.

The second tool of interest is the use of 3D visualizations. 2D maps of spatial plans are often used in participatory planning. These 2D representations help to ease the understanding of plans and enhance participation in the decision-making process, in comparison to written plans in text, figures or tables (Geertman, 2002; Hu et al., 2015). When looking beyond 2D environments for public participation, possible further improvements and added value for public participation can be found. Hereby, 3D (including heights) or even 4D (including time) environments and visualizations can be of interest (Brovelli et al., 2015b). 3D generally involves an extra coordinate value – z -, next to the x and y coordinates which describe the 2D environment. The z value adds height or depth to the geographic information (Stoter, 2014). There are different varieties of 3D

data; it may involve height information on surface areas (AHN2) or the underground levels, BIM models (Building Information Models) or 3D models of physical objects, which all can be described on different Levels of Detail (LoD) (see Figure 1). The higher the LoD, the closer it approaches reality. Moreover, if an x,y coordinate has only one z value, it is called 2.5D or LoD1 since it is a generalization of the actual heights; that is in reality, one place can have multiple z values. Nonetheless, it is shown that 2.5D can already be of added value when compared to 2D versions of geographic data (Stoter, 2014). The 3D representation is even more similar to reality than 2D maps, which could make it easier to understand spatial plans and interact with the virtual reality. 3D visualizations as a public participation tool could thus contribute to the added value as well, in order to ease communication and further enhance participation in the decision-making process (Geertman, 2002; Hu et al., 2015).

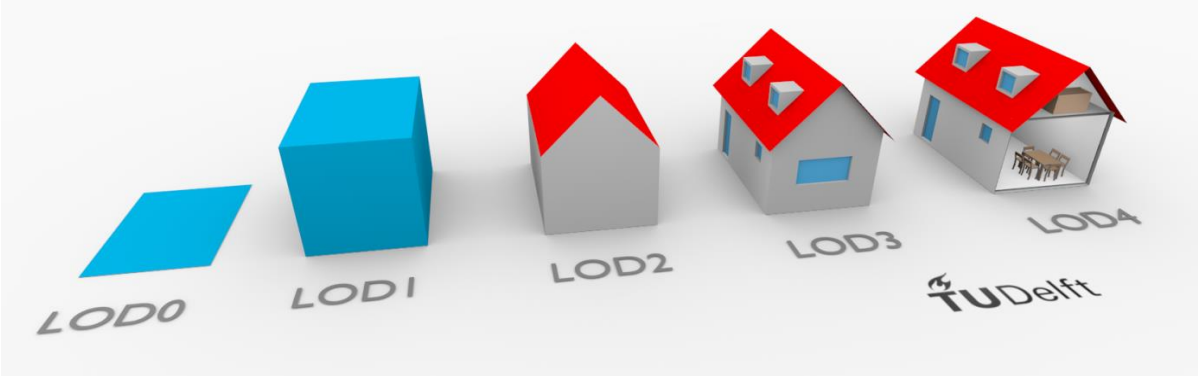


Figure 1: Different Levels of Detail (LoD) according to CityGML; from 2D to 3D (TUDelft, 2015).

1.2 Problem

To identify the main problem for this research, firstly the identified problem in scientific literature is touched upon. Then the identified problem by interviews with internal stakeholders of the municipality of Rotterdam are discussed. As a conclusion to the central problem which is identified out of both literature and interviews, the focus of this research is explained.

1.2.1 Identified problem in literature

Many studies have been done on public participation, of which most studies are found in PPGIS (c.f. Brovelli et al., 2015a, 2015b; Brown et al., 2014; Brown et al., 2015; Tang & Liu, 2015), collaborative GIS (c.f. Geertman, 2002; Balram & Dragicevic, 2009), PSS (c.f. Geertman, 2002; Pelzer et al., 2013; Pelzer et al., 2014) and collaborative planning (Healey, 1998; Healey, 2003). In these, the focus lies upon spatial planning and decision-making. In this study, urban planning is of interest. However, most studies in the literature are related to public participation in environmental planning, in which the public is used to rate and identify most appreciated spots in nature or landscapes. Added value of PSS is studied in spatial planning (c.f. Pelzer et al., 2014, 2015; Pelzer, 2015) based on utility, usability and usefulness. Related studies on VGI (c.f. Goodchild, 2007; Campagna et al., 2015; Seeger, 2008; Tang & Liu, 2015) and 3D GIS (c.f. Stoter, 2014; Hu et al., 2015; Wu et al., 2010) have been found in spatial planning and decision-making as well, though not in combination of each other.

PPGIS is already an often used and applied method, which has proven to be valuable in enhancing public participation in the spatial planning decision-making process, and to gain insight in public desires, needs and expectations (Hu et al., 2015; Al-Kodmany, 1999). It is shown that online PPGIS tools also have potential to improve public participation in the decision making-process, however not many experiences, real implementations or evaluations of results have taken place in an urban planning setting (Bugs, 2012: 480). The use of online participation tools are becoming essential in urban planning to provide continuous access on planning proposals to the public, thereby achieving higher participation levels (Bugs, 2012: 481). Furthermore, online PPGIS offers the possibility to combine three key aspects; interaction (ICT), technology (GIS), and local knowledge (Ibid: 488). It is however shown that internet-based public participation is mainly used for information delivery, whereas in a few cases public services are made available. Overall, there is an underuse of internet-based PPGIS possibilities in urban planning decision-making (Ibid: 481). It is indicated by Brown & Kyttä (2014) that there is a highly prioritized need for research to understand how to increase public participation and how to make it more attractive.

According to Nielson (2006) in Brovelli et al. (2015b), public participation follows the 90:9:1 rule. The rule implies a proportion of the sort and amount of citizen participation. It shows that 90% of the users will only consume information, 9% of the users will contribute on occasional basis, and only 1% will assist constantly on active basis. It would be ideal to find solutions on how to increase the amount of citizen that will participate on a more occasional or even active basis. To do so, it is of importance to evaluate the proposed online public participation method in order to explore where *added value* for public participation in the decision-making process can be found.

Added value of PSS has been studied extensively in Pelzer et al. (2014: 16), in which *added value* has been defined as: "*a positive improvement of planning practice, in comparison to a situation in which no PSS is applied´.* In this study, added value can be described as the positive improvement of public participation in the decision-making process by the Internet based PPGIS environment, in comparison to traditional and present situations of public participation methods. Pelzer (2015) furthermore provides a framework for added value, which is explained as a derivative of *Utility, Usability* and *Usefulness.* These three terms are generally used as synonyms of each other, though in the added value framework of Pelzer, they have different meanings. With utility, the fit of planning tasks and technology in the participation process is meant (Pelzer et al., 2015). In this study, utility is explained by the information obtained from the interviewees and from the literature review; the role of public participation in the planning process and the role of recent technologies in enhancing public participation. Thereby, utility is the main focus of this research. Usability and Usefulness are assessed later in this study to be able to explore the added value of the proposed participation method.

1.2.2 Identified problem according to internal stakeholders and users

Meetings have been arranged with internal stakeholders of the municipality of Rotterdam, to gain insight in the present situation of public participation in spatial planning and its potential for the near future. These interviews are meant to identify the main problem in public participation within the municipality of Rotterdam, and are used as input for the research focus. In total, six interviewees gave their view on the current use, effectiveness and future potential of public participation in the spatial planning process. Their relation to public participation, in order to gain a broad perspective of the current status. A small introduction to the interviewees with a summary of each conversation can be found in Appendix I. In this section, the overall problem and focus, as has been identified from these interviews is given.

Public participation is a term that is widely used within municipalities, although it does not necessarily involves citizen participation within planning decisions. Present participation is mainly concerned with citizen initiatives, in which citizens generally give ideas on activities or

social interaction in their neighborhood. In this kind of participation, digital and online tools are used such as mobile applications; however these applications are not applicable yet for public participation in the spatial planning decision-making process. It is indicated that communication about planning projects is currently inefficient, therefore it should be improved. Citizens could be increasingly when communication is improved during the planning decision-making process. An important way that was proposed to improve communication in the planning process, was the use of 3D visualizations. This is already done by urban planners, however not in 3D GIS. This means there is currently no standardized approach to create 3D information, which leads to redundant work and an inefficient use of resources. One interviewee explained that a goal is to create a shared and standardized 3D geo-information environment, in which spatial plans could be easily implemented and used by both planners and citizens. In an ideal situation, citizens should be able to upload their ideas in this environment as well. An important remark to this was about concerns on how much extra work this would take for urban planners when citizens could give their opinion online, at any time in the planning decision-making process; it would lead to a lot more information and opinions to be processed than before. It was explained that at first the added value of such an environment should be analyzed, otherwise the introduction of the environment would not be used or appreciated by urban planners. Therefore, it was stated that the added value of stakeholders and users – which comprises mainly urban planners and citizens – should be studied. Furthermore, the added value of introducing public participation in several stages of the planning decision-making process should be explored as well.

1.2.3 Focus

The main focus of this research is an online PPGIS environment as a participation method, which makes use of VGI and 3D geo-information tools. In this environment, VGI can be used to ease ways for participation, as it enables the digitally collection of public opinions. VGI thus may enhance public participation (Tang & Liu, 2015; Brown & Kyttä, 2014; Brovelli et al., 2015b; Wu et al., 2010). The problem indicated by the interviewees, mainly concerned poor ways and poor methods to communicate with the public. 3D visualizations can be used to ease understanding of spatial plans as it can make communication to the public more effective (Hu et al., 2015). Studying added value would be helpful to state the importance to the main users; urban planners and citizens. The added value of an online PPGIS environment in the planning decision-making process, in comparison to a traditional and present participation method, will therefore be analyzed for the citizen users. As discussed before, the added value is explained by the framework of added value by Pelzer et al. (2014; 2015). Therefore, the main question of this research is as follows: *'To what extent is an Internet-based PPGIS environment of added value to the spatial planning process, by using VGI methods and 3D geo-information?'* To be able to answer this

question, case study areas in the municipality of Rotterdam are used. Tests on public participation for the case study areas are done with the online PPGIS environment, which is developed during this master thesis.

The following section explains the research objectives, including the central question and sub-questions. Subsequent chapters contain the theoretical framework, in which several sub-questions on present and potential use of methods and tools are answered. Furthermore, a conceptual framework is developed, which explains the focus and activities of this research. The actual research proposition is explained in the methodology chapter, in which the approach for data collection is also clarified. The case study areas are discussed in detail, to describe the situation of each. Subsequently, analyses are performed and the results are discussed in Chapter 6. The findings and overall progression of this research are discussed, to finally lead to a conclusion in which an answer is given to the main research question.

2. RESEARCH OBJECTIVES

In this chapter the four research objectives of this study are described. Also, the main research question and its additional sub-questions are provided.

2.1 Objectives

This research focuses on the development of an interactive Internet-based PPGIS environment, which could be used as a web application. The PPGIS environment uses VGI to enhance easy geo-referenced public opinions and 3D geo-information to visualize spatial plans for easy understanding and communication to the public. The initial assumption is that this participation method can be of added value to public participation in the spatial planning decision-making process. The research is focused on analysing and evaluating the possibility of this added value, by comparing the online participation method to a traditional public hearing. Four objectives are identified in this research:

(1) Defining the concepts PPGIS, VGI and 3D GIS, finding related work in scientific research on these concepts, and identifying their present and potential role in public participation.

(2) Defining added value, finding related work on analysing and evaluating added value for public participation and identifying potential added value of VGI and 3D geo-information for public participation.

(3) Designing an online PPGIS environment which combines 3D geo-information and VGI methods for doing case studies among citizens.

(4) Assessing the degree to which an online PPGIS environment is of added value for public participation as a continuous and interactive part in the planning decision-making process.

It should be noted that part of the citizens are left out by focusing on online participation. These excluded people may not feel comfortable using a digital environment, they may not have Internet access or they do not even possess a personal computer. However, it is beyond scope of this study to include these factors of representativeness, as it is mostly dependent on availability.

2.2 Questions

The research objectives can be translated into research questions, which will lead to an evaluation of the initial research assumption. The main research question is: *'To what extent is an online PPGIS environment of added value to the spatial planning process, by using VGI methods and 3D geo-information?'* The following sub-questions are included to be able to comprehensively answer this question:

1. What is the present and potential role of public participation GIS in the spatial planning process?
2. What is the present and potential role of VGI in PPGIS and in the spatial planning process?
3. What is the present and potential role of 3D geo-information in PPGIS and in the spatial planning process?
4. How and in what sense can VGI in an online PPGIS environment contribute to public participation in the spatial planning process?
5. How and in what sense can 3D GIS in an online PPGIS environment contribute to public participation in the spatial planning process?
6. What advantages and disadvantages can be observed for the online PPGIS environment in comparison to a traditional public hearing?

The sub-questions 1,2 and 3 correspond to the first research objective. Sub-questions 4 and 5 correspond to the second research objective. Sub-question 6 corresponds to the third and fourth research objective. An overview of the relations between research questions and objectives is given in the design scheme (see Figure 2).

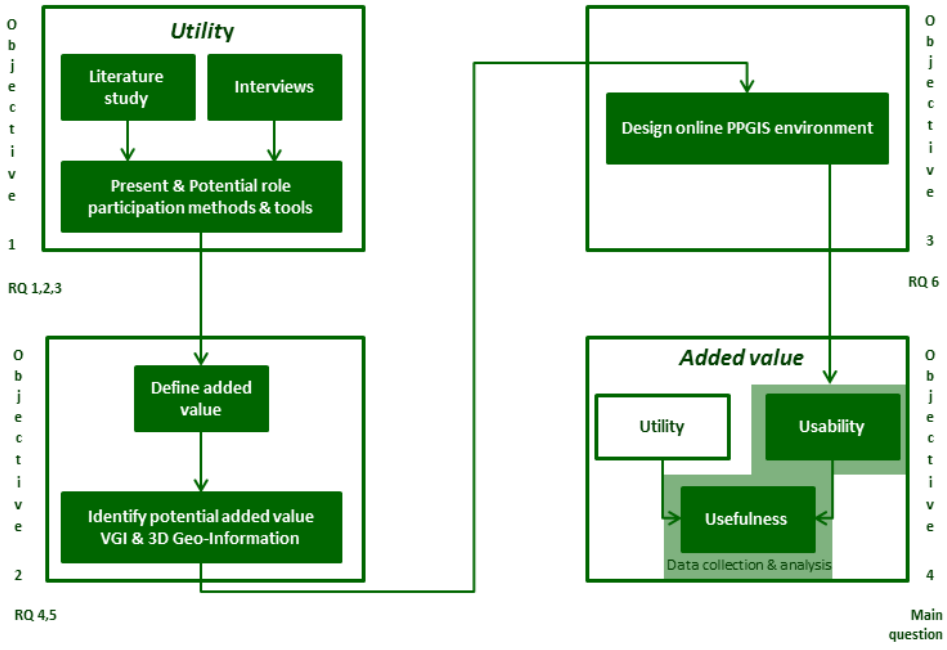


Figure 2: Research design scheme showing a sequence of actions.

3. THEORETICAL FRAMEWORK

This chapter includes further discussion of relevant literature to identify the present and potential role of the concepts PPGIS, VGI and 3D GIS in the spatial planning decision-making process. Furthermore, potential added value of 3D geo-information and VGI to public participation in the planning process is discussed. These concepts with their relations, indicators and variables are deduced from this literature review and placed in a theoretical framework, which visualizes the main focus of the research.

3.1 Spatial planning

The term spatial planning is the most preferred term in Europe to indicate "(…) *methods used by the public sector to influence the distribution of people and activities in spaces of various scales"* – (University of Innsbruck, 2012). A whole series of terms and disciplines that involve spatial planning are: regional planning, land use planning, environmental planning, urban design and urban planning, which are often used interchangeably. It is clear that spatial planning takes place on different levels. In the 1960s, three forms of spatial planning were identified: planning as a *government* activity, planning as a profession or occupational group, and planning as a social movement. In this context, government comprises the policy system and its practices (Healey, 1998). In 2003, Patsy Healey reflected on the debates surrounding the ideas of 'collaborative planning' and the 'communicative planning theory' in the spatial planning practice. Collaborative Planning is an approach which can be used to understand and evaluate *governance* processes. It was first inspired by the perception of planning as an interactive process. Secondly, by planning as a *governance* activity. Thirdly, by planning as a policy for maintaining the quality of place. And fourthly, by planning as social justice. Governance in this context is understood as the process by which societies or social groups manage collective affairs (Healey, 2003). As shown in the perceptions of Healey, a shift from *government* activities to *governance* activities in spatial planning has occurred. Driessen et al. (2012) confirm the shift for which a clear conceptual framework for different modes of governance and changes from one mode to another is provided. The modes of governance comprise: centralized governance, decentralized governance, public-private governance, interactive governance and self-governance. The modes of governance depend on several key features: actor features, institutional features and features concerning policy content. A shift is shown from centralized government to strong internal dynamic interactions with many stakeholders.

3.2 Planning decision-making process

It is important to understand the fit of public participation within decision-making processes, since the latter often involves necessary multistage analysis and collaborations. It depends on sorts and kinds of decision-making projects to define its exact stages. Overall five common stages can be identified (see Figure 3), including: the problem definition, problem analysis, alternative solution generation, alternative solution evaluation, and implementation (Hu et al., 2015: 213).

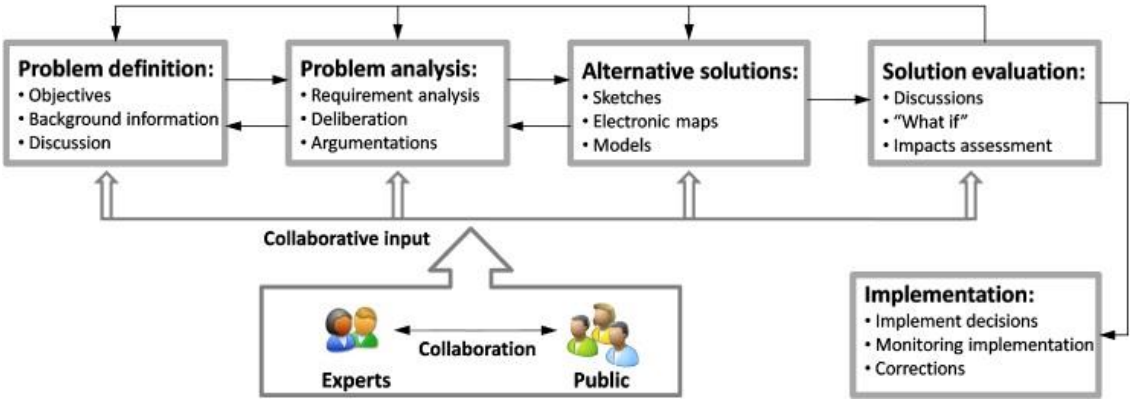


Figure 3: The five general stages in decision-making processes with an idealistic view on public participation (Hu et al., 2015: 213).

The stages of decision-making almost never occur linearly. In fact they most often occur iteratively, since interim evaluations are necessary. The five stages show an ideal situation of decision-making process, in which it is desired to have public participation in at least the first four stages. As discussed in Hu et al. (2015), two types of online GIS for participation can be appointed, which allow different kinds of participation. The first is asynchronous GIS, which allows ubiquitous participation. This basically means that participation can take place at any time on any location. The second is synchronous GIS, which allows intensive participation to bring back-and-forth dialogs and real-time collaboration. The use of Internet-based asynchronous communication GIS for public participation brings along '24/7' access and can be applied in every stage of the decision-making process. In real life, however, online participation is often solely facilitated in the solution evaluation phase.

Studies have proposed various frameworks to identify and approach public participation in the spatial planning process. Different stages of public participation have been identified by the framework of Sherry Arnstein, called the 'Ladder of Citizen Participation'. The ladder is used as a metaphor to describe different levels of public participation in decision-making, of which each rise of a level (rung) refers to an increase of public power and control (Arnstein, 1969). Three main

'steps' are identified within this framework, each of them containing several of the eight rungs of citizen participation, being:

- *Nonparticipation*: (1) Manipulation & (2) Therapy;
- *Tokenism*: (3) Informing, (4) Consulting & (5) Placation;
- *Citizen power*: (6) Partnership, (7) Delegation & (8) Citizen Control.

Nonparticipation is not about enabling the public to participate in planning programs, but it is about enabling "[…] powerholders to 'educate' or 'cure' the participants." (Arnstein, 1969: 217). The stages of *tokenism* make sure that citizens may hear and be heard, but this is not ensured that they are being heeded, due to a lack of power. This means that in this stage, the citizen participation reaches no further than giving some advice to the power holders. The stages in *citizen power* have increasing decision making influence, ranging from negotiation in partnership to full managerial power in citizen control (Arnstein, 1969: 217). Figure 4 shows the classical framework.

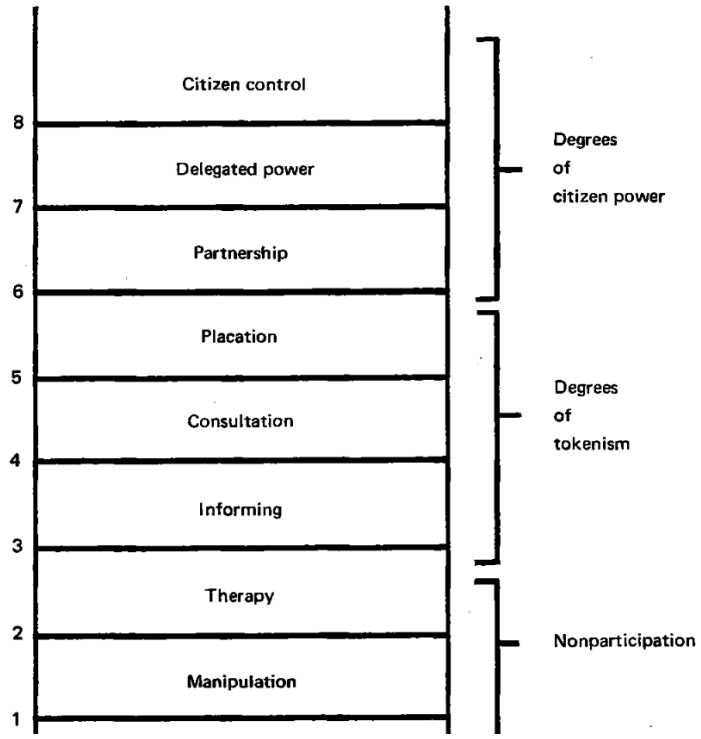


Figure 4: The classic framework for public participation: 'The Ladder of Citizen Participation' (Arnstein, 1969).

Ever since the ladder of participation was introduced by Arnstein (1969), a lot of modifications have been done on this framework (c.f. the ladders of Connor, 1988; Wiedemann & Femers, 1993; Guaraldo Choguill, 1996; Carver, 2001). However, to outline the role of

participation and its methods in spatial planning processes, the original ladder of Arnstein (1969) is used as a basis.

Public hearings are one of the traditional public participation methods (Hu et al., 2015), still being often applied within local government authorities on planning decision making processes. This kind of participation is not considered most effective, since spatiotemporal constraints are often indicated as disturbing factors that affect the value of public collaboration. Both distance and time constraints may prevent some interested citizens or groups from participating in public hearings. Another constraint that can be found is objectivity of public opinion. Bi-directional web participation (with synchronous GIS) can be used to solve these problems (Hu et al., 2015).

Other traditional types of public participation are paper-based maps and text specifications (Wu et al., 2015). The traditional public participation methods are located in the lower levels of the *tokenism* step, where people can give some advice, and where participants are heard. Later on, the use of databases, computer graphics and computer-aided design (CAD) tools were introduced in urban planning support processes. More recently, GIS technology was widely adopted in the planning practice, which is currently the most used tool in urban planning. Web-based GIS is used to publish planning designs and to collect suggestions on them (Drummond & French, 2008 in Wu et al., 2010). The more recent public participation methods are somewhere located in the upper levels of the *tokenism* step in the ladder of citizen participation, and are rising towards the *citizen power* step. However, full citizen control is still far from being reached.

The role of public participation in decision-making, especially via web-based mapping is stressed in Kingston (2007), who describes five types of public participation in the decision-making process (based on work by the OECD in 2011):

1. Information and transaction: government informs citizens, i.e. a one way process;
2. Consultation: government consults citizens, although responses are predetermined;
3. Deliberative involvement: government engages citizens in the consultation process, in which the citizens are encouraged to reflect on issues, before the final response;
4. Government-led active participation: government causes consultation and keeps its decision-making powers;
5. Citizen-led active participation: citizens are actively engaged in the decision-making process. Their decisions become binding and they share ownership and responsibility over the outcomes.

Similarities can be observed between these five public participation types and the eight rungs of public participation by Arnstein (1969).

Kingston (2007) focuses on how ICTs and online maps can be used to improve participation services to local communities. It is stated that before the development of map-enabled systems were introduced, a lot of time was spend to identify the exact location of the problem. Online participation systems could help improve e-government. A crucial element is to use a well presented, understandable interactive map (Kingston, 2007). Both advantages and disadvantages of public participation in the decision-making process can be identified. Irvin & Stansbury (2004) provide an overview of these, as well for the decision-making process as for the outcomes for both citizens and government (see Table 2 & Table 3).

Advantages of Citizen Participation in Government Decision Making	Advantages to citizen participants	Advantages to government
Decision process	Education (learn from and inform government representatives)	Education (learn from and inform citizens)
	Persuade and enlighten government	Persuade citizens; build trust and allay anxiety or hostility
	Gain skills for activist citizenship	Build strategic alliances
		Gain legitimacy of decisions
Outcomes	Break gridlock; achieve outcomes	Break gridlock; achieve outcomes
	Gain some control over policy process	Avoid litigation costs
	Better policy and implementation decisions	Better policy and implementation decisions

Table 2: An overview of the advantages for citizen participation in the decision-making process (Irvin & Stansbury, 2004).

Disadvantages of Citizen Participation in Government Decision Making	Disadvantages to citizen participants	Disadvantages to government
Decision process	Time consuming (even dull)	Time consuming
	Pointless if decision is ignored	Costly
		May backfire, creating more hostility toward government
Outcomes	Worse policy decision if heavily influenced by opposing interest groups	Loss of decision-making control
		Possibility of bad decision that is politically impossible to ignore
		Less budget for implementation of actual projects

Table 3: An overview of the disadvantages for citizen participation in the decision-making process (Irvin & Stansbury, 2004).

The process-oriented benefits for the evaluation of the effectiveness of citizen participation are considered to be public knowledge and better cooperation, whereas the outcome oriented benefits are considered to be better policy and implementation decisions (Irvin & Stansbury, 2004; Neshkova & Guo, 2012). Strategies that are often used by government authorities to collect citizen opinions are: telephone hotlines, citizen/client surveys, focus groups, open forum, public hearings, citizen advisory boards/commissions or budget simulation/contingent valuation (Neshkova & Guo, 2012). A detailed overview of the participation methods as used by the municipality of Rotterdam is included in Appendix II.

3.3 The role of PPGIS

In the previous section, several public participation methods are shown, although these are not necessarily map-based, or engaged with GIS, such as Public Participation GIS. PPGIS was often used in face-to-face meetings as a traditional form of participation. Map Tables are a popular digital method for PPGIS. Nowadays, through Web 2.0 technologies platforms flourish online, thereby enabling the production, collection and diffusion of user-generated contents. In this setup, the community becomes more important in the creation and production of data (Campagna et al., 2015). In recent years, a shift is shown from hierarchical PPGIS platforms to platforms of increased equal rights, in which communication is improved, transparency is increased and bi-directionality is the main focus (Silva & Rocha, 2012).

Much research and empirical studies has been done on the quality of crowd sourced geographic information via PPGIS and its quality for use in (planning) decision-making processes. Although academic interest in PPGIS is increasing, there is still little tangible evidence for the actual use of PPGIS in decision support by agencies. This is partly caused by the absence of trust in the quality of the spatial data derived from non-authoritative sources, as stated in Brown et al. (2015). Kingston (2007) states that trust is a key issue for the public when using PPGIS, since it is essential for online participation to be successful. Nevertheless it is shown that spatial data quality of PPGIS is good enough to complement authoritative data in planning decisions (Brown et al., 2015).

3.4 The role of VGI and its contribution to public participation

As argued in Seeger (2008), the definition of the term VGI implies that a pure form of VGI should only consist of individuals who are willing to participate on their own initiative, i.e. without invitation or prompting. A well-known example of a pure form of VGI is Open Street Map (OSM), in which anyone can contribute on a completely voluntarily basis. However, to include citizens in the planning process, a framework of some sort has to be arranged. In Seeger (2008), this is called 'facilitated-VGI' (f-VGI), by which the facilitation of digital mapping interfaces for VGI purposes is meant. This can provide more local and detailed information, specifically to be used for the creation of a more informed design solution. Seeger (2008) defines f-VGI as*:* "… the use of online mapping interfaces that allow the public to individually or collaboratively contribute information to be located on a map. This information might be contributed in response to a predefined set of criteria, such as an explicitly defined question, or limited to an established geographic extent." – (Seeger, 2008: 200). It is argued that f-VGI is not only limited to design processes, as it can be used in local governments as well, to improve decision quality or even reduce costs and avoid confrontations (Creighton, 2005 in Seeger, 2008:200). The use of VGI has been proven successful in spatial planning and participatory processes (Campagna et al., 2015) enhancing professional information in the decision-making process (Silva & Rocha, 2012). VGI can furthermore be used in PPGIS, since effective participation consists of bi-directional communication; planning information is send out to the public and ideas and opinions are received from the public (Tang & Liu, 2015).

Information obtained from crowd sourcing and collaboration, which is closely related to VGI, can be helpful to let marginalized or excluded groups contribute in the planning process, to give opinions, visions and ideas. Crowdsourced information can be used through geospatial tools to enhance authoritative information, which is used by professionals and decision makers (Seeger, 2008). Web standards like W3C and OGC, and GPS devices have introduced neogeography (Turner 2006 in Brovelli et al., 2015b). Neogeography is closely related to VGI and (geo-)crowdsourcing

and can simply be explained as 'geography or mapping for the masses' (Silva & Rocha, 2012). Seeger (2008) discusses the three main purposes for public participation, which were identified by Sanoff (2000). These main purposes are: the exchange of information, supplementation of design and planning, and resolving of conflicts. As becomes clear from these purposes, the focus lies upon planning and design. As Seeger (2008) subsequently argues, this focus can be generalized to establish a framework for collective use to apply f-VGI in for example spatial planning in order to enable public participation. The framework includes:

1. The share and composition of geographic information;
2. The individual or collaborative collection of opinions on (spatial) plans;
3. The identification of potential conflicts early in the process.

This framework can be used for the design of f-VGI in the online PPGIS environment. The use of VGI in spatial planning and participatory processes has been proven successful. Even the use of Social Media as a very specific type of VGI (SMGI) has been evaluated (Campagna et al., 2015).

3.4.1 SMGI

Campagna et al. (2015) discuss the role and integration of Social Media Geographic Information (SMGI) in spatial planning decisions. SMGI is argued as a specific type of VGI (implicit-VGI) of which integrated use with Authoritative Geographic Information (A-GI; i.e. official spatial data) in spatial planning is discussed. SMGI is known as geo-referenced multimedia, in which users become producers and consumers of personal geo-referenced information. SMGI could be useful to provide insights in user perceptions, needs and opinions on places and in local identities (Campagna et al., 2015). Social media is built on Web 2.0 and comprises Internet-based virtual communities, to create, share and exchange information. It promotes online communication and has become increasingly popular (Tang & Liu, 2015: 12). Rinner & Fast (2014) proposed a framework to classify VGI contributions, among others Social Media Geographic Information (see Figure 5). The VGI, or f-VGI as it will be used in the online PPGIS environment, can be located in the bottom right quadrant, since it is based on geographic features (markers placed on a map), which contain content (opinions about plans or ideas for designs).

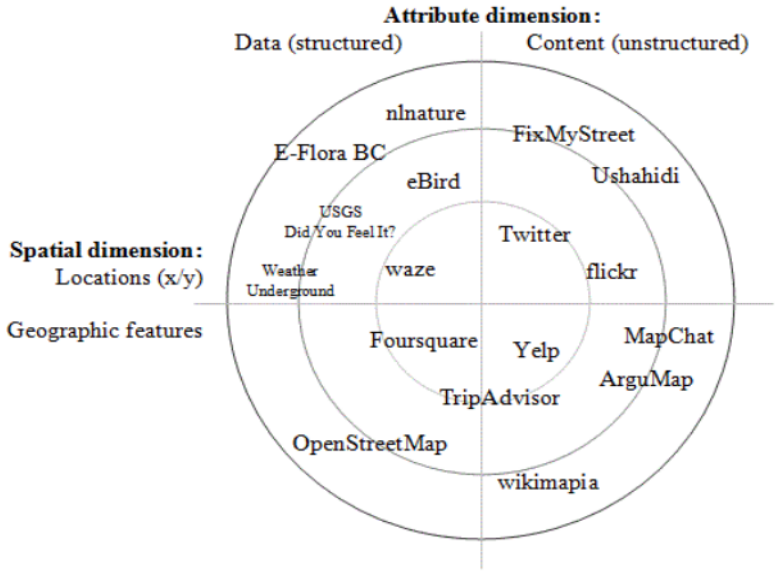


Figure 5: VGI framework; classification of user contributions (Rinner & Fast, 2014).

Due to its popularity and large amount of users, SMGI contains Big Data characteristics. The use of advanced analytics could help to tackle the Big Data management issues, making it possible to extract relevant knowledge for spatial planning and design decision-making (Campagna et al., 2015). It is shown that online participation projects often use social media to facilitate public participation. By some of these projects, Social Media is even treated as an inseparable part. It is, however, required to have careful management in SMGI, for instance to update recent developments and to communicate with participants once in a while, to make this public participation via SMGI effective and successful. Otherwise public participation SMGI will not attract and retain long-term active users (Tang & Liu, 2015). SMGI is an interesting type of VGI, which is popular in usage, and which can be useful to gain relevant knowledge in spatial planning. However, SMGI is associated with Big Data which beyond the scope of this research. Furthermore, the use of Social Media as information portal for authoritative data could lead to privacy issues, which is undesirable for (local) government authorities in some cases. Therefore, it is chosen not to focus on SMGI, and only to use f-VGI in the study of the online PPGIS environment.

3.5 Present and potential role of 3D geo-information

In 1999, a 3D urban simulation system was introduced, combining different technologies, such as Virtual Reality, GIS and (spatial) databases. The 3D environment was designed so that geographic information and plans could be interactively visualized, used and controlled on the Internet (Huang, 2003; Wu et al., 2010). It has been shown that 3D models are extremely useful for internal communication for spatial plans. They could also be used to easily involve citizens in

planning designs, to make communication more efficient, and to introduce public participation in the early stages of the planning decision-making process (Stoter, 2014). As stated in Wu et al. (2010), including 3D geo-information in public participation for spatial planning, simplifies communication to and by the community in the planning process. 3D geo-information could therefore be a useful tool in an online PPGIS environment, to make it easier for local governments to communicate spatial plans to the public. Furthermore, it can be easier for the public to understand the planning decisions and purposes of the local government.

Modelling an urban environment in 3D causes some difficulty in acquiring precision and in transmitting large data sets. Image pyramiding can be used to organize huge data sets on servers, while AJAX creates the possibility to work online smoothly, as if operating on a local computer (Garrett, 2005 in Wu et al., 2010). An effective way of modelling a 3D urban environment provided is the extrusion of a third dimension from 2D maps (Wu et al., 2010). This basically means that a 2D environment is visualized as 3D, based on extrusion heights, although the dataset itself has no 3D component. Research has been done to propose a solution for integrating globe-based visualization technology and Web Service technology to enhance the public participation in urban planning processes. For this research, a convenient method would be the use of the 3D scene of Rotterdam, provided by ESRI's ArcGIS online. An example of the 3D environment is shown in Figure 6 and is further explained in Chapter 4.

Figure 6: A 3D scene of Rotterdam provided by ESRI in ArcGIS Online.

Hu et al. (2015) propose a PPGIS framework, based on a 3D collaborative GIS and the multistage decision-making process, in which they even speak of geo-referenced communication, although VGI is not mentioned. Related work on added value is mainly found in PSS and PPGIS, while added value of an online PPGIS environment, in particular making use of the concepts of VGI and 3D geo-information, is understudied. As stated in Pelzer et al. (2014), to analyze the added value of PSS, the focus should be on the perspective of the actual user. To increase public participation, awareness of the added value needs to be addressed. By doing so, participation could be perceived as a more attractive option for citizens and urban planners, which could enable more active and effective participation in the decision-making process (Kingston, 2007).

3.6 Added value

Two participation methods – the traditional public hearing and the proposed online PPGIS environment - are being evaluated by the use of some predefined assessment criteria. These criteria or indicators will help determine the extent of added value of the online PPGIS method on public participation in the decision-making process. In Bugs (2012: 485) three criteria where used, based on a PPGIS analysis framework in Steinmann et al. (2005) to compare PPGIS methods. These comparison criteria are: Interactivity, Functionality, and Usability. In Steinmann et al. (2005), the studied criteria were interactivity and functionality. Usability was studied by them in previous research. Interactivity is connected to the participation ladder of Arnstein (1969) and the e-participation ladder of Carver (2001) which refers to the user interaction with the PPGIS method. The 'Interactivity' assessment criteria are made up of four stages of interactivity or levels of participation. The 'Functionality' assessment criteria are made up of standard GIS functionalities, although specified to online PPGIS applications. The 'usability' assessment criteria are based on whether the application works and whether the application meets the user needs in an effective, efficient and satisfactory ways (Bugs, 2012). These usability measures originate from ISO 9241-11 (1988), which is the standard on usability (Brooke, 1996). It defines usability in ergonomic standards as: *'... the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.'* (ISO, 1988).

Sidlar & Rinner (2009) use usability and utility assessment criteria; they describe usability as the user success, and utility as the application success. Important to note is that both assessment criteria are context dependent, which means that in every planning task, process phase and project plan, context is different and can thus affect the outcome of added value. Furthermore, it is stressed in Sidlar & Rinner (2009) that added value of geocollaboration tools can be evaluated when utility assessment criteria are used for the predominant examination of software usability.

Pelzer (2015) proposed a framework to assess added value, which is derived from utility, usability and usefulness. Usefulness is stressed as the 'fit' or applicability of the participation method in the planning and participation process, and is seen as an outcome of utility and usability. For both utility and usability, several indicators are used to determine and compare the outcome of usefulness. Utility can shortly be described as the task-technology fit (Goodhue & Thompson, 1995 in Pelzer et al., 2015: 107), and can be defined as: "the matching of the functional capability of available information technology with the activity demands of the task at hand (Dishaw & Strong, 1998: 154 in Pelzer et al., 2015: 108). The technology must fit the planning tasks, which means that the capabilities of the participation method must have a purpose that fits within the planning tasks and participation process (see Figure 7).

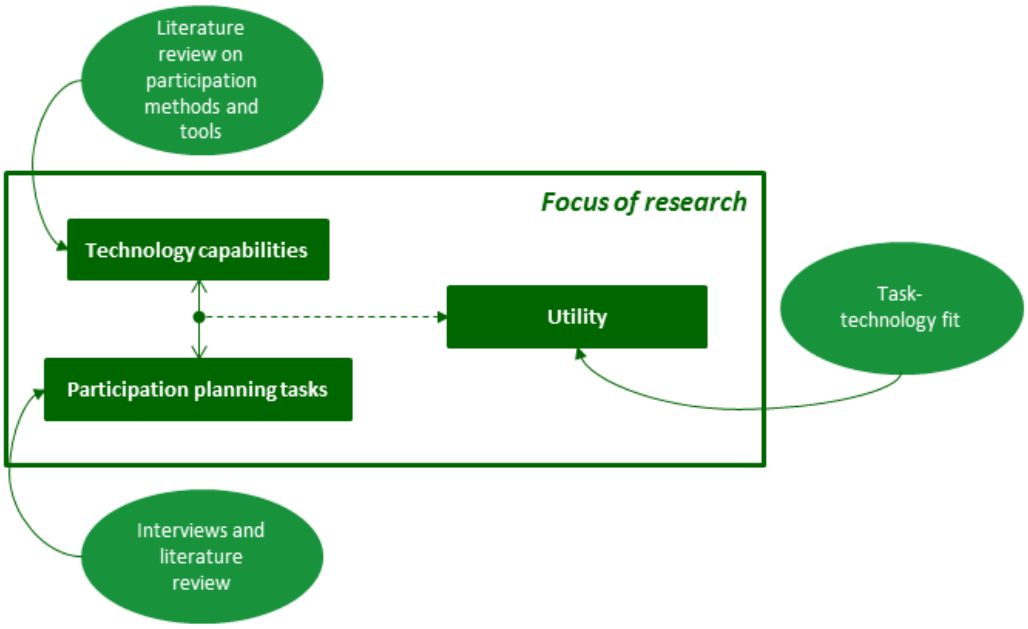


Figure 7: Adapted framework for utility (task-technology fit) which forms the focus in this research (Pelzer et al., 2015).

The framework which Pelzer (2015) proposes as a framework to explain added value for PSS is given in Figure 8 and is used as well in this research to be able to compare traditional versus proposed participation methods. The framework shows the relation of the first framework for utility - in this research part of the focus of the research - to the framework of added value. Whereas utility is used to define the focus of this research, usability and usefulness will be used to further assess the extent of the added value of the online PPGIS environment. Usability will be used to focus on the functionality of the participation method in comparison to the user's needs; the user-functionality success. Usefulness is focused on the fit of the participation method in the decision-making process; the process fit. A combination of the three concepts will therefore help

assess added value of the online PPGIS environment to public participation in the spatial decision-making process.

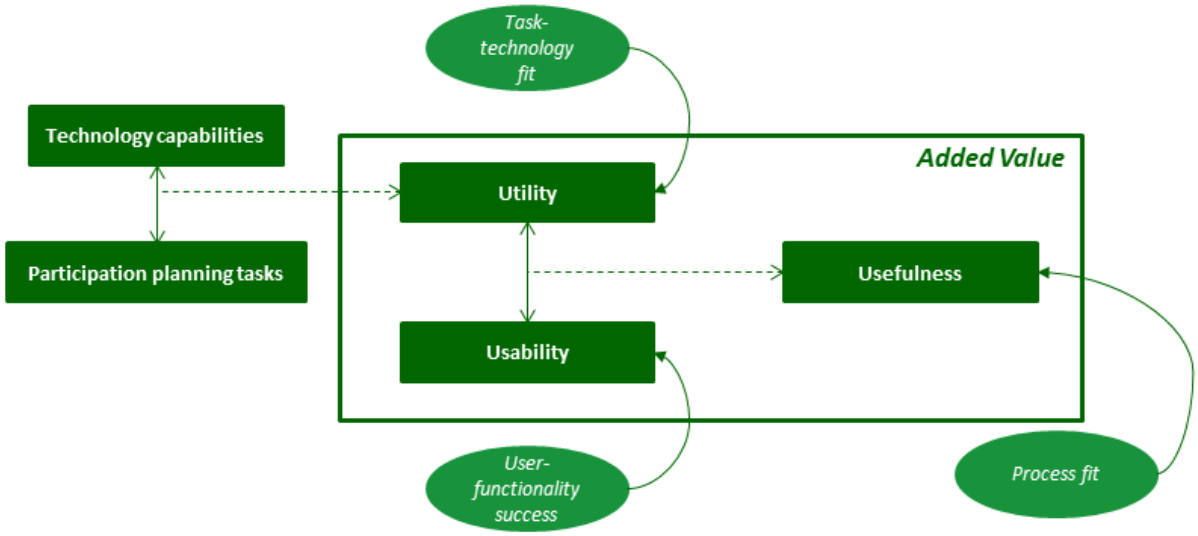


Figure 8: Adapted framework of Pelzer (2015) based on usefulness, utility and usability to assess added value.

3.6 Theoretical framework

So far, several methods, tools and overall concepts have been discussed, which are of importance in this research problem. In order to be able to measure these concepts properly, it is required to convert them into variables and indicators. A theoretical model is therefore derived from the theories which are discussed, and forms the basis of the research problem (Kumar, 2014: 366). The theoretical framework is based on the online PPGIS environment as a method in the spatial planning decision-making process, which should enhance public participation. VGI and 3D geo-information tools are used to potentially provide better understanding of plans and easier ways to communicate opinions and ideas. The effects are tested by analysing the added value of the online PPGIS environment. The added value is assessed by the use of the predefined indicators for usability and usefulness, of which the outcome is context-dependent.

Figure 9 shows the theoretical framework in which the concepts, phases and variables are shown with their related indicators and ultimate goal of the research. The focus of this research and of the conceptual framework is the online PPGIS environment, which makes use of 3D geo-information and VGI. The latter two are seen as tools in the PPGIS environment, and have their own indicators; providing easier ways to understand and communicate planning decisions via 3D geo-information, and providing easy ways to let people participate in the planning decisions via VGI. The environment is part of the variable and concept PPGIS which is a special type of digital public participation which makes use of GIS. In municipalities, public participation is generally only involved in one of the latest phases (solution evaluation) of the decision-making process;

however in an idealistic view, public participation should be introduced in the first four stages. The online PPGIS environment is tested in spatial planning projects, of which one will be located at the beginning and the other at the end of the decision-making process. To analyze the added value, indicators of the variables are used. The measurement of these indicators and their outcome are however influenced by context, which is something to take into account. The results from each indicator can be assessed to find the extent of added value in more detail for the online PPGIS environment in one or more phases in the decision-making process. The exact research approach is explained in the next chapter.

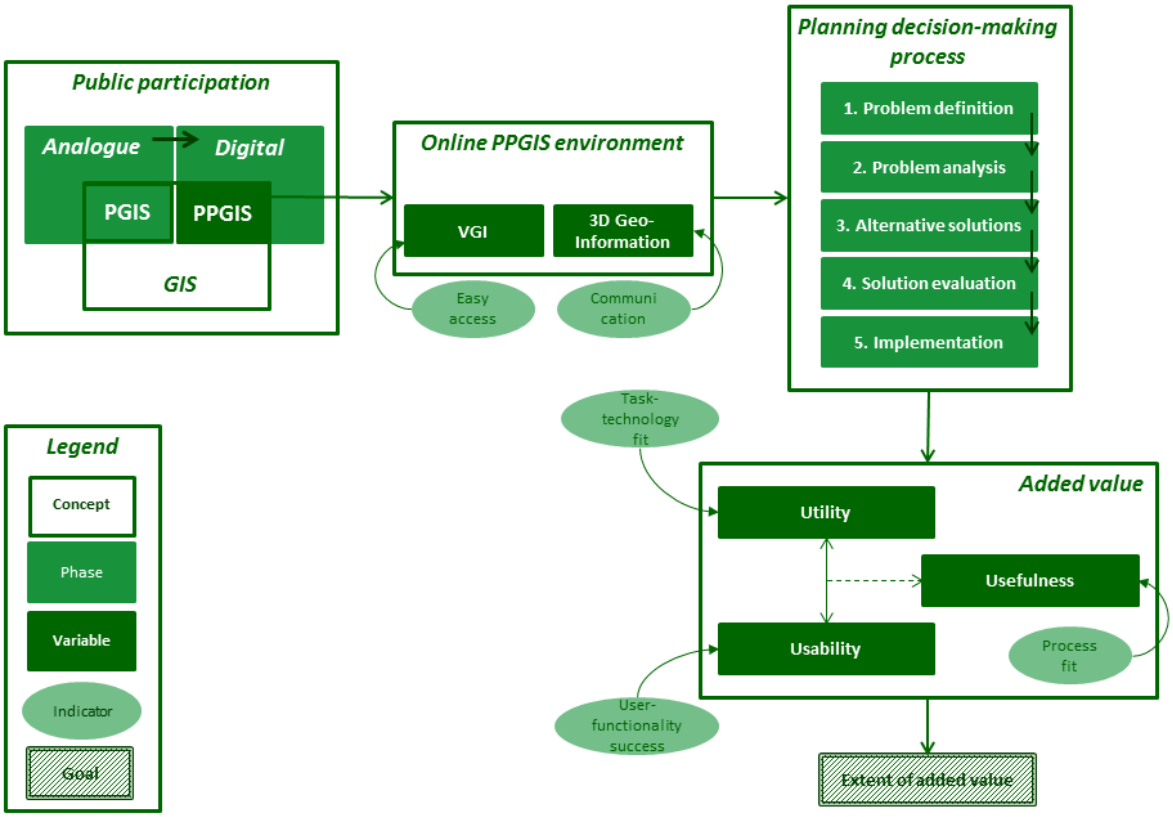


Figure 9: Conceptual framework on the added value of an Internet-based PPGIS environment, with VGI and 3D geo-information.

4. METHODOLOGY

This chapter describes the methodology used in this research, which includes the study design. The study design explains *how* the theoretical framework is executed. Furthermore, the resources that are required for doing this research are identified, which is described as the technical design.

4.1 Study design

4.1.1 Case study design

This research focuses on the municipality of Rotterdam, for which a case study design is used. Accessibility of cases herein is the main selection criterion, as it influences the quality of this study directly. Especially in small-N research, accessibility is of importance (Blatter & Haverland, 2012). Furthermore, as it is shown to be difficult to find an appropriate planning project which would approve for including this research, accessibility is of interest. Representativeness is not of interest for this case selection. Firstly because without accessibility, representativeness is not of value. Secondly, as in the planning field not a singular project can be found which is exposed to identical circumstances, it is impossible to find representative cases which could be used as generalization of the whole. Furthermore, generalization is not the scope of this research and considering the context-sensitivity of planning projects it is not even possible. I.e. it is about in-depth knowledge of specific cases, which ultimately allows for advice to the municipality of Rotterdam.

The case study areas comprise two particular projects in urban planning and urban design, at a local level. The case study areas are situated in one of the early or latest stages of the decision-making process. Case study site selection is based on recommendations from interviewees of the municipality of Rotterdam, via the so called snowballing method, on the accessibility and purpose of the planning projects. In an ideal study design, the comparison of the traditional participation methods and the proposed Internet-based PPGIS method, shows a 'before-and-after' construction. In research methodology, this is known as a *before-and-after design*, which can be described as two sets of cross-sectional data collection on the same population, meant to find changes between two points in time in a phenomenon or variable. The change is measured by the difference of the variables, before and after the observation (Kumar, 2014: 364). In the ideal situation, the impact of each factor is measured, which means that as well in the beginning as in the end of a planning process, these situations should be tested in order to find the real impact and added value on public participation in the decision-making process. However, planning projects are usually highly time consuming and due to limited time in this research, it is not feasible to do a before-and-after study. Therefore, it is chosen to focus on two case study areas which were available to this

research. Since each project is context-dependent, the two outcomes are not representative to explain change as of a before and after study.

4.1.2 Questionnaire construction

The tests will be done by the use of a questionnaire. A *questionnaire* can be defined as a written list of questions, of which a respondents group is expected to answer and record them (Kumar, 2014: 379). According to Seeger (2008), ways to investigate the use and role of facilitated-VGI is by letting citizens share their expertise of a particular area, let them assist in site selections and provide the availability to express their opinion on a proposed design. In this questionnaire, participants will receive the opportunity to give scores on a scale from 1 (completely disagree) to 5 (completely agree) to indicate to what extent they agree or disagree with the statements or questions given in the survey. This method is based on the 'Likert scale', which is mainly used to measure the attitudes of participants towards certain statements. The statements should be constructed in a way that persons with different point of view can respond to it differentially (Likert, 1932). The attitudes using 'Likert type data' are usually coded on a scale from 1 to 5 (although other scales are considered as well), with the following labels:

1	=	Strongly disagree	[1.00 – 1.49]	Very negative attitude
2	=	Disagree	[1.50 – 1.49]	Negative attitude
3	=	Neutral	[2.50 – 3.49]	Neutral attitude
4	=	Agree	[3.50 – 4.49]	Positive attitude
5	=	Strongly agree	[4.50 – 5.00]	Very positive attitude

The results of the statements show a value for each of the enlightened added value criteria (see Section 4.1.5). For the construction of the survey questions, it is essential that the statements are *not* statements of facts, since in this way people with opposing opinions could still agree on a statement of a fact. However, statements of *desired behavior* will allow people to show their actual attitude towards statements (Likert, 1932).

4.1.3 Population of interest

The citizens are the (external) *stakeholders* within this research, since they are the research participants who will be affected by the project's activities and research' findings (Kumar, 2014: 384). The stakeholders that have attended the provided public hearing for the particular planning project are the population of interest for this research. The population thus encompasses the 'active' citizens that are directly involved by the plans of the case study project and are able to compare the two participation methods. The size of the taken sample is dependent on the size of the project, the amount of citizens that are being affected by the planning project, and the amount that is willing to participate in the decision-making process. The type of citizens

can be of influence to the amount of respondents and the given attitudes as well when looking at age, gender, origin, or even level of education, which are factors that contribute to the context of the situation.

4.1.4 Research conduction

For conducting the tests and the questionnaire, the population was those attending the public hearing for the particular planning project. This means that all participants first have made use of the present method (public hearing) in one phase of the planning decision-making process after which they were introduced to the proposed participation method. The public hearing is performed offline and it makes use of 2D drawings (and very occasionally 3D drawings). Citizens' opinions are collected via minutes taken at the public hearing. After citizens have participated in the public hearing, they have been invited to make use of the online PPGIS environment as well and to participate in this research. In the online PPGIS environment, plans have been presented in 2D and in 3D geo information, for which people could give their ideas, opinions or remarks on the plans via VGI. The VGI encompasses the placement of a point (marker) on the map in which comments can be provided for that particular place and plan. During the public hearing, e-mail addresses were collected of the attendees, to which URLs to the online PPGIS environment and online questionnaire were sent. The questionnaire contained detailed questions to evaluate participants' attitudes on several indicators to each participation method. The questionnaire questions were focused on the indicators of usability and usefulness, as identified in Pelzer et al. (2014) and were phrased in statements on a Likert scale, in order to catch these attitudes.

4.1.5 Assessment criteria

The assessment criteria or added value indicators are derived from studies of Pelzer. Pelzer et al. (2015: 108) describe three variables of utility for which they provide three questions which connects utility to the framework of usefulness. The dimensions and questions are provided in Table 4, which are adapted to this research. Their value towards this research and approach in research is given as well.

Utility indicators	Description	Value and approach
Tasks	What are planning and participation tasks, in the case of traditional and proposed PPGIS methods?	Find out the kind/sort of planning tasks (decision-making process) and the role of participation for both participation methods. Is related to research questions, from which an answer on this is given (see Section 1.2.2 and Chapter 3).
Technology	What is technology, in the case of traditional and proposed PPGIS methods?	Give an overview of the used technology for both participation methods, or what could be done/what is currently possible, according to literature. Is related to research questions, from which an answer is given (see Section 1.2.1 and Chapter 3).
Fit	What is the relation ('fit') between tasks and technology, in the case of traditional and proposed PPGIS methods?	Find out to what extent the tasks and technology of both participation methods are matching, and thus where improvements can be made, based on interviews and literature. Is related to research questions, from which an answer on this is given (see Section 1.2.3).

Table 4: Utility variables to explain the Task-Technology-Fit according to Pelzer et al. (2015:108).

As becomes clear from the study of Pelzer et al. (2015), utility is an indicator to consider before 'developing' and 'evaluating the proposed PPGIS method. In this research, interviews have been conducted to understand where the focus lies within the municipality of Rotterdam, and a literature review shows the focus of research based on relevant literature. Furthermore, a literature study is used to give answer to several research questions, which are helpful to explain the utility variable. The interviews with internal users and stakeholders within the municipality of Rotterdam were useful to determine the current fit of the present or traditional participation method(s) used for planning tasks and show where improvements can be made on the field of participation technology (see Section 1.2.3 Focus). Furthermore, the findings from the interviews are used to compare to the results, in order to strengthen conclusions. In this research, the planning tasks only consider the decision-making tasks in which citizens are allowed to participate, hence the participation process. The literature study shows a clear understanding of what is possible in the field of technology nowadays and forms the focus of this research in developing the Internet-based PPGIS environment that matches the 'fit' of the identified planning tasks and technology possibilities (see Chapter 3). Also, the 'fit' can be described as an outcome, including the decision or solution quality, the attitudes towards the technology or participation method and the thereby the intention to use it (Furneaux, 2012: 99 in Pelzer et al., 2015: 110).

Earlier studies of Pelzer et al., (2014) provide indicators of usability, as a second element in determining the added value of a PSS. The usability variables were depicted from studies of Arciniegas (2012), Goodspeed (2013), te Brömmelstroet (2010) and Vonk (2006). The indicators of the usability variable are shown in Table 5 together with their description as shown in Pelzer et

al. (2014). Furthermore, their value for this research are shortly described, which is based on the extent to which the indicators are applicable to both non-digital and digital participation methods.

Usability indicators	Description	Value and approach
Calculation time	The time participants have to wait before an analysis is conducted	The participants do not have to perform any analysis on both traditional as well as proposed participation methods. Also, since the traditional participation method is offline, no calculation time is present; therefore this indicator is not used.
Communicative value	The extent to which the visual output is useful for the participants	Does the participation method help in communicating the plans? This is a good indicator, and is used as the 'level of communication'.
Data (quality)	The extent to which the input data is considered valid	Data quality itself does not play a major role in the participation process; however it is useful as an indicator to check whether the plans are made understandable by the provided data and presentation of the data. It is used as the 'presentation quality'.
Flexibility	The extent to which the tool can be applied for different planning tasks	This is an important indicator, since the purpose of the tool is also meant to be used in different phases of the participation process and for different planning projects. In this, context is thus an important factor. It is used as the 'level of flexibility'.
Integration	The extent to which the tool takes all the relevant dimensions into account	This indicator is used to see to what extent the exchange of information, knowledge and ideas between municipality and citizens is taken into account in the participation method. It is used as the 'level of integration'.
Interactivity	The extent to which the tool can directly respond to questions and suggestions of the users	This indicator can be used on different 'levels'; it can be used to focus on the interactivity of and with the method itself (for example the use of VGI in the digital method), and on the interactivity of participation generated by the method in the participation and planning process (the ladder of (e-) participation). It is chosen to focus on the provided ways for citizens to respond on planning designs, thereby used as the 'level of interaction'.
Level of detail	The extent to which the tool's level of detail matches the perspective of participants	This is a good indicator to see whether different perspectives, i.e. 2D or 3D, non-digital or digital will result in better understanding for participants. It is used as the 'level of detail'.
Reliability	The extent to which the outcomes of the tool are considered reliable	Reliability of the outcome is not per se of importance, though trust is in determining whether participants will find the tool useful and will be using it in the future. Therefore it would be more valuable to use trust as an indicator, to compare both participation methods. It is therefore used as the 'level of trust'.
Transparency	The extent to which the underlying models and variables of the PSS are visible to users	This indicator is useful to question the transparency of decisions made in the planning process, however transparency could lead to trust and it thus shows similarities with the trust indicator. It is therefore chosen to combine this indicator in the 'level of trust'.
User friendliness	The extent to which participants are able to use the tool themselves	This indicator is especially useful for the digital participation method. User friendliness for the non-digital traditional participation method can be found in the extent to whether participants find the method easy to participate, without any constraints. It is used as the 'usability constraints'.

Table 5: Indicators for Usability with description and value to this research, derived from Pelzer et al. (2014).

Pelzer (2015) performed questionnaires, interviews and workgroups on several case studies. Based on these studies, he defined dimensions of usefulness as given by the respondents themselves (shown in Table 6). For these dimensions, which are being used as indicators for usefulness in this research, a short description is given. As these dimensions are given as indicators in this research, it was deemed necessary to do a sensitivity analysis on these indicators, in order to estimate what indicators are found most important or least important in the decision-making process. The importance values given to the usefulness indicators, were calculated for scores between 0 and 1 by which they were multiplied for the given Likert attitude value. The larger the difference between de mean value and the weighted mean value for both participation methods presumably suggests less importance to the decision-making process.

Usefulness indicators	Description
Learning about the object	Do citizens and get a better understanding of the plans and ideas by the use of the proposed participation method against the traditional one? It is used as the 'knowledge level'.
Learning about others	Do citizens get better insight and understanding on the motives and grounds of the plans made by the municipality? This indicator is not used in this research, as it would not be applicable to the online participation method.
Communication	Does the proposed participation method provide better ways for communication on the plans and knowledge exchange? It is used as the 'statement' indicator.
Collaboration	Does the proposed participation method ensure better collaboration in the decision-making process? It is used as the 'level of involvement'.
Efficiency	Does the proposed participation method save resources (time, money, amount of work, steps needed to be taken, or other valuable resources in the planning process)? It is used as the 'participation efficiency'.
Consensus	Does the proposed participation method have open information? This indicator is not used as it was not found applicable to both studied participation methods.
More informed outcome	Does the proposed participation method add relevant and valid information which leads to a satisfying outcome? This indicator is left out as well, as the participation efficiency would cover this as well.

Table 6: Indicators for Usefulness, with their description. The indicators were identified by Pelzer (2015) as dimensions of Usefulness.

Whereas utility is used to define the focus of this research, both usability and usefulness indicators are used as a framework to construct survey questions in order to evaluate added value. In this research, usability is focused on the fit between the functionalities of the participation methods in comparison with the users' needs, whereas usefulness is focused on the fit of the participation method in the decision-making process. The framework is used to find the extend of the added value of the online PPGIS environment, in comparison to the public hearing. The composed questionnaire is provided in Appendix III.

4.1.6 Analysis of the data

The online questionnaire is focused on the evaluation of the participation methods to be able to find the added value, based on a Likert scale. The added value will be analyzed by the use of the explained indicators, for which respondents can indicate whether and in what way they think the indicator relates best to tested present or proposed participation method. There is a difference between Likert type items and Likert scale data. Therefore it is important to differentiate between the two, since both require different analytical approaches. A Likert scale is constituted by Likert items; if a series of four or more Likert items together forms a composite for one variable, the items should be measured as a scale. However, if Likert items are not a composite of one variable, the items should be measured individually; i.e. item-by-item analysis. In the latter case, there is no attempt to combine the responses from the Likert items into one or more composite scales (Boone Jr. & Boone, 2012). Analysis for both types are different; Likert scale data can be analyzed as interval type data with the mean as the best measure for central tendency and standard deviation to describe the scale, whereas Likert type data should be analyzed as ordinal type data with the mode or median as the most appropriate measure to find the central tendency and frequencies to describe the variability. If it is meant to find associations between variables, it is best to analyze Likert scales for variance techniques, such as the t-test, ANOVA, Pearson's r and regression analysis on the summated calculated scores. For finding associations, Likert type data can be best analyzed via Kendall tau B or C or Chi-square when data is combined into two nominal categories (Boone Jr. & Boone, 2012). However, as this is not an explanatory research, it is not of scope to link variables to each other, only to describe the data. In general, Likert type data responses can be best shown as a distribution of responses, such as using a bar chart. An overview of the data analysis procedures for Likert Type data and Likert Scale data can be found in Table 7.

Data analysis	Likert Type Data	Likert Scale Data
Central Tendency	Median or Mode	Mean
Variability	Frequencies	Standard Deviation
Associations	Kendall tau B or C	Pearson's R
Other statistics	Chi-square	ANOVA, t-test, regression

Table 7: Overview of suggested data analysis procedures for Likert type and Likert scale data (Boone Jr. & Boone, 2012).

The questionnaire is made up of questions based on the indicators which, are the composites of one variable (usability or usefulness). It is necessary to see whether these indicators have internal consistency, which would indicate that it is valuable to measure the indicators on a variable scale. For scale analysis, mean values can be used to explain the central tendency and standard deviations can be used to explain variance. The test which is used to estimate this

internal consistency of the indicators is Cronbach's Alpha. Cronbach's Alpha uses a score between 0 and 1, for which the 'breakpoint' lies at 0.7. The higher the score, the more it proves internal consistency of items, meaning that these items can be used as a single scale. The scale analysis is useful for providing a clear overview of the attitudes in a scale towards the participation methods. However, to gain more insight in the specific details within the scale, it is found to be useful to also use item-by-item analysis. Otherwise, interesting information for each item will be lost in the summated scores of the scale. It is therefore chosen to use both approaches. The test results of the indicators for each participation method are compared to each other and used to explain the extent of the added value of the online PPGIS environment in the decision-making process.

4.2 Technical design

4.2.1 Data requirements and pre-processing steps

The main source of data for this research is derived from the questionnaires, which have been conducted for the case study projects within the municipality of Rotterdam. However, in order to conduct the questionnaire, it was required to firstly develop the online PPGIS environment, as it is also used as a subject in the questionnaire. The environment had to be made up of planning designs for the particular project in 2D and 3D geo-information and furthermore required VGI. Whereas VGI does not require pre-processed data since users are able to collect data themselves, the 2D and 3D geo-information does require pre-processed data of the planning designs. The pre-processing steps encompass access to the planning designs, the geo-referencing of the planning designs in order to use them as geo-information, the conversion of the geo-referenced planning designs into shapefiles in order to use them in a 3D geo-information environment, and the conversion of shapefiles into GeoJSON files in order to use them on a 2D base map in a Leaflet JS based web service. Furthermore, publicly accessible data is required for the creation of a 2D map and a 3D geo-information environment, such as base maps. Table 8 gives an overview of the required data and its pre-processing steps.

Required data	Type/format	Source	Pre-processing steps
Planning Designs	PDF/JPEG	Project manager/ contact person	Geo-referencing; Conversion to shapefiles (points, lines and polygons); Conversion to GeoJSON.
2D base map	WMS/Tilelayer	Open Streetmap; Mapbox	Calling of the 2D base map in JavaScript using Leaflet Library in which GeoJSON objects are loaded to add the planning designs.
3D environment and base map	WMS/WFS	ESRI ArcGIS 3D Webscene (AHN2 + BAG)	Creation of a publicly shared 3D scene of the project area with added shapefiles of the planning designs.
VGI	GeoJSON	Citizens/users	-

Table 8: Overview of the required data and pre-processing steps.

Data for the online 2D map is derived from Web Map Services (WMS) and tilelayers of Open Streetmap and Mapbox, which are open source products. Data for the 3D geo-information environment is derived from ESRI's ArcGIS Online 3D scene of Rotterdam, which is provided to those who have an ESRI Online account. This 3D scene is a combination of a 2D map (by ESRI) which is used as baselayer on which 3D objects are projected. The 3D objects in the 3D scene are in fact derived from a combination of the BAG objects and the AHN2 heights (Algemeen Hoogtebestand Nederland). Out of these, an average height has been calculated for each BAG object, to create 3D buildings. The municipality of Rotterdam has its own height data, which is more accurate, has higher density and is more up-to-date than the well-known alternative AHN2. However, the newest version of the 3D model of the municipality of Rotterdam was not completed, therefore it was chosen to use the ArcGIS Online 3D scene as an alternative.

The planning designs were provided by the contact persons for each case study project. These designs were originally made in CAD systems, but were disseminated as PDF files (or JPEG). These PDF files needed to be geo-referenced according to the correct coordinate system: OGC/CRS WGS 1984, which is the supported coordinate system for web applications, Web Map Services (MapBox, Google Maps, Open Streetmap) or tilelayers. The geo-referenced development plan for the NNO project is shown in Figure 10.

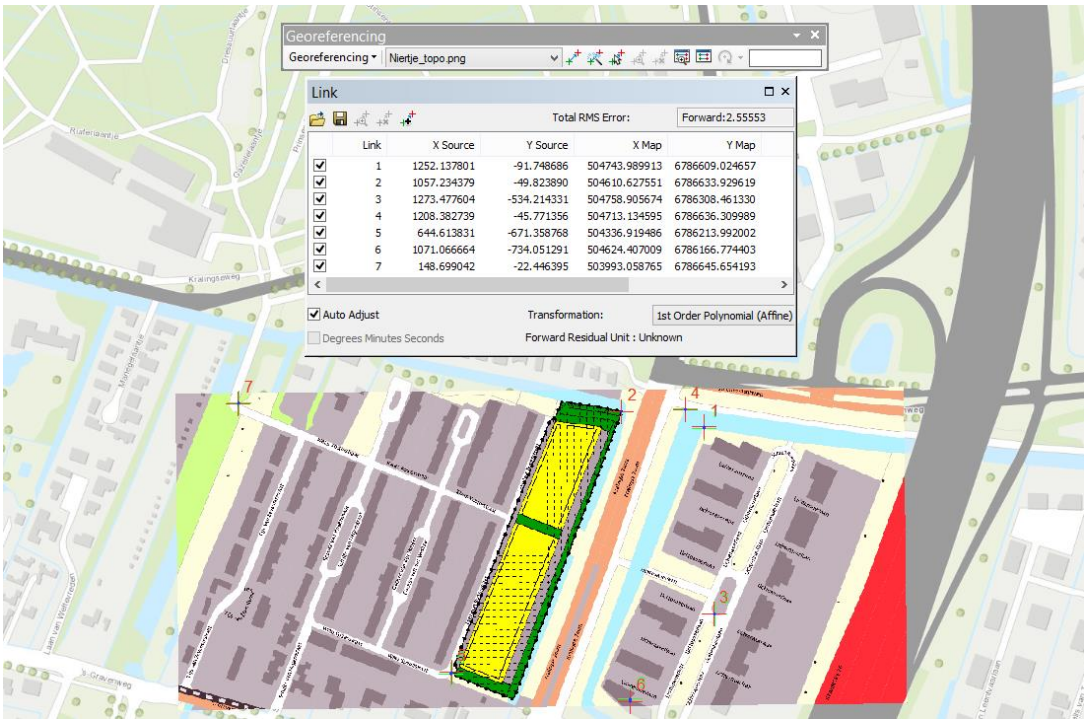


Figure 10: The geo-referencing of the development plan for the NNO project in ESRI ArcMap.

The georeferenced planning designs needed to be traced in order to create shapefiles, consisting of lines (for example streets), points (for example trees) and polygons (for example buildings/houses). An example of the traced planning designs for one of the traffic access scenario's is shown in Figure 11. Furthermore, the shapefiles needed to be converted into GeoJSON files, which can be used in web applications and is supported by Leaflet as well; the applied JavaScript library.

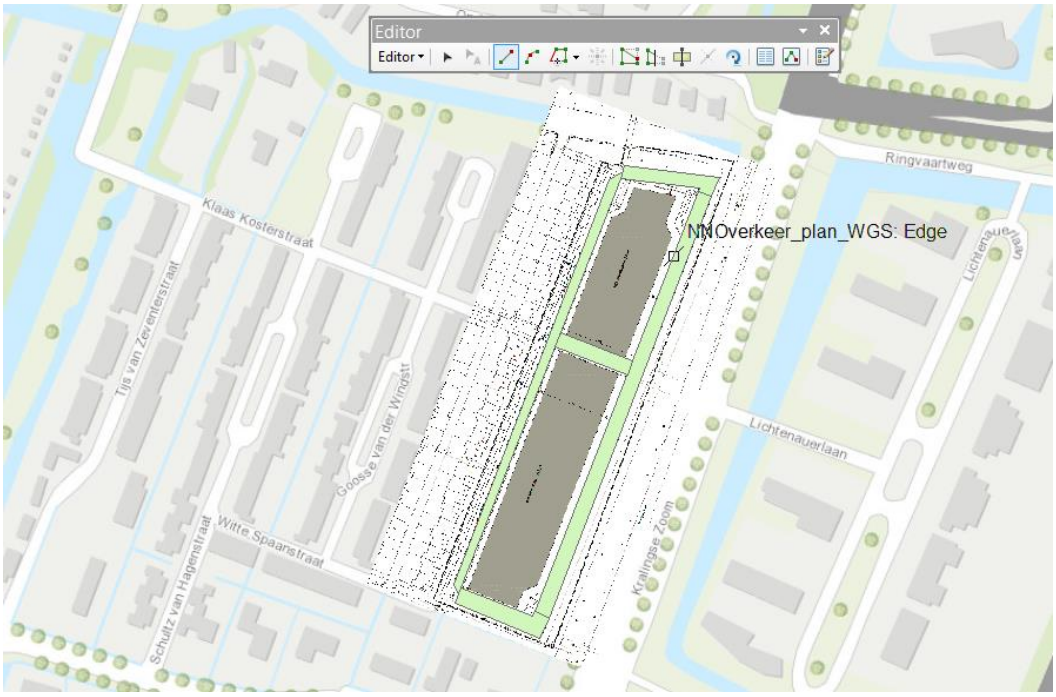


Figure 11: The traced traffic access design for the NNO project, edited in ESRI ArcMap.

4.2.2 Web-Service Oriented Architecture (SOA)

SOA is an architecture that is used to build software applications or web services. SOA allows for the reuse of existing assets, thereby providing interoperability between heterogeneous applications and technologies. It provides the opportunity to meet different information requirements of multiple users in a dynamic and flexible way. SOA makes use of three key actors, which can be explained in the publish-find-bind paradigm (see Figure 12). The publish-find-bind pattern works as follows: a service provider has to register its service at a public registry, thereby publishing its service. Consumers are the service requestors who require and search for information services. These information requests are able to find the services by using the service registry (or broker), and if found, the consumer gets bound to that particular service which was provided by the service provider. The interoperability is obtained via XML-based open standards (WSDL, HTTP, SOAP, UDDI, etc.), which encompass standards on defining, publishing and using web services (Yue, 2013; Mahmoud, 2005). The concept of the publish-find-bind paradigm of SOA is kept in mind for the development of the online PPGIS environment, in which the planning

designs are published as a service in a web application, for which the citizens as service requestors may require information of the planning designs. Furthermore, citizens are able to publish their own information, as they are allowed to add information in the web service as well.

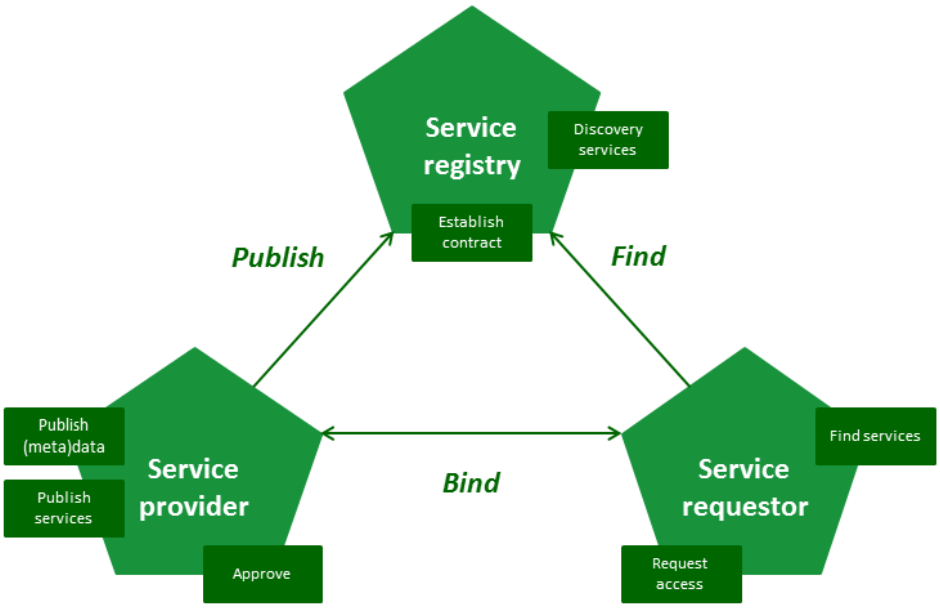


Figure 12: A SOA publish-find-bind construction (after Yue, 2013).

4.2.3 Development of the online PPGIS environment

It is chosen to develop the online PPGIS environment by using the open-source JavaScript library 'Leaflet'. Leaflet is based on the three principles: simplicity, performance and usability, which are found to be applicable in the interactive PPGIS environment. Leaflet has an easy to use and well-documented API, and can be extended by many different plug-ins (Leaflet, 2015). One of these plug-ins is the Esri-Leaflet plug-in, which supports Esri basemaps and feature services. It also supports tiled maps, image services and dynamic maps, and provides well-documented API references as well (GitHub, 2015). The online PPGIS environment uses tile layers from Mapbox as basemaps in the 2D map.

Mapbox is an online mapping platform for web developers, which makes it easy to integrate any spatial locations into web or mobile applications. Different tools and APIs can be mixed and matched to add geographic locations to the webpage. It is even possible to add live data to an application, by the use of special building blocks to perform spatial analysis. Mapbox tokens can be used to access maps, OpenStreetMap, other tiles and building blocks from Mapbox into Leaflet (Mapbox, 2015).

The development of a web application requires some knowledge and understanding of programming languages. The most important ones however are HTML, CSS and JavaScript. HyperText Markup Language (HTML) is a code which is used to design web documents. It is made

up of elements and attributes. The HTML-documents are in fact ASCII-files, which means that they can be edited in a normal text editor. The formal extension of a HTML-document is .html (Handleiding HTML, 2012). In general, HTML is used to define the content of the webpage (W3Schools, 2015). Cascading Style Sheet (CSS) is a code which is used to specify the (good looking) lay-out of an HTML-document by the use of style sheets. CSS is developed by the World Wide Web Consortium (W3C) and makes use of additional elements and attributes which can be referred to in an HTML-document (Handleiding HTML, 2012). JavaScript (JS) is a programming language to program the behaviour of a webpage (W3Schools, 2015). This means that JavaScript can be used to make an interactive webpages. Most JavaScript prompts can be executed on the client-side, since browsers mostly have a JavaScript interpreter. Therefore it may also be referred to as front-end development. However, JavaScripts may also be executed on the server-side, of which node.js in recent years has a great share. This is called back-end development. Node.js is a JavaScript runtime based on an asynchronous event driven framework (Node.js, 2015). The development of the online PPGIS environment mostly consists of front-end development. Other often used programming languages in web applications are Python, PHP and SQL. Python is a programming language that is easy to use and is powerful in its performance (Python Software Foundation, 2015). It has an open-source license which makes it freely usable and distributable. It offers many possibilities for web development, of which standard libraries for HTML, XML and JSON are included or can be accessed via multiple freely available plugins (Python Software Foundation, 2016). The development of the online PPGIS environment did not require the use of Python scripts, although it could have been used for the integration of SMGI to for example extract Twitter tweets on a planning object. PHP is a scripting language which can be used on the server side. It is a powerful language in the development of interactive webpages. Furthermore, it is freely usable and distributable as well (W3Schools, 2016a). PHP is used in the online PPGIS environment to ensure a save connection to the spatial database, and communicates with SQL. Structured Query Language (SQL) is a standard language when working with databases. It executes queries on a (spatial) database which lets you access or manipulate data from that database (W3Schools, 2016b). It is used for the online PPGIS environment to make a connection to the online spatial database in CartoDB.

4.2.3.1 2D shapefiles to web map

The created shapefiles of the planning designs needed to be integrated into the web environment. In ArcMap it is possible to convert the shapefiles to different formats, such as GML, KML or even JSON. However, the format GeoJSON is the preferred format for usage in Leaflet. Therefore, QGIS is used for conversions of shapefiles to GeoJSON. GeoJSON is a useful format to integrate in a Leaflet based web environment (Stack Exchange, 2015). GeoJSON is a geospatial data

interchange format in which geographic data structures can be encoded. It is based on JavaScript Object Notation (JSON), of which a standard is defined in IETF RFC 4627. GeoJSON supports the geometry types: Point, LineString, Polygon, MultiPoint, MultiLineString and MultiPolygon. Feature objects are geometric objects with additional information or properties, which can be used as a set of features and are contained by FeatureCollection objects (GeoJSON, 2008). The planning designs which are converted to GeoJSON are integrated in the leaflet environment by the use of JavaScript. Each GeoJSON object can be accessed via JavaScript, which allows the use of different colours, symbols or events on each object. In Figure 13 an example is given of the GeoJSON objects as used in the online PPGIS environment in the NNO project, with 5 traffic access scenario's.

Figure 13: The GeoJSON files of the planning designs, applied in the online PPGIS environment for the NNO project. The GeoJSON objects depicted in orange represent building area, and depicted in grey represent the traffic access scenario's.

4.2.3.2 3D scene to web map

The created shapefiles of the planning designs were used in a 3D scene in ArcGIS Pro, from which the 3D scene can be edited and uploaded to ArcGIS Online. In order to use the 3D scene in the web application, it was required to firstly publicly share the 3D scene for which a short URL was then provided. This URL is embedded in the HTML part of the online PPGIS environment, which creates the possibility to view the planning designs in a 3D environment. The example of the 5 traffic access scenario's is used again in Figure 14 to show the applied 3D environment for the NNO project.

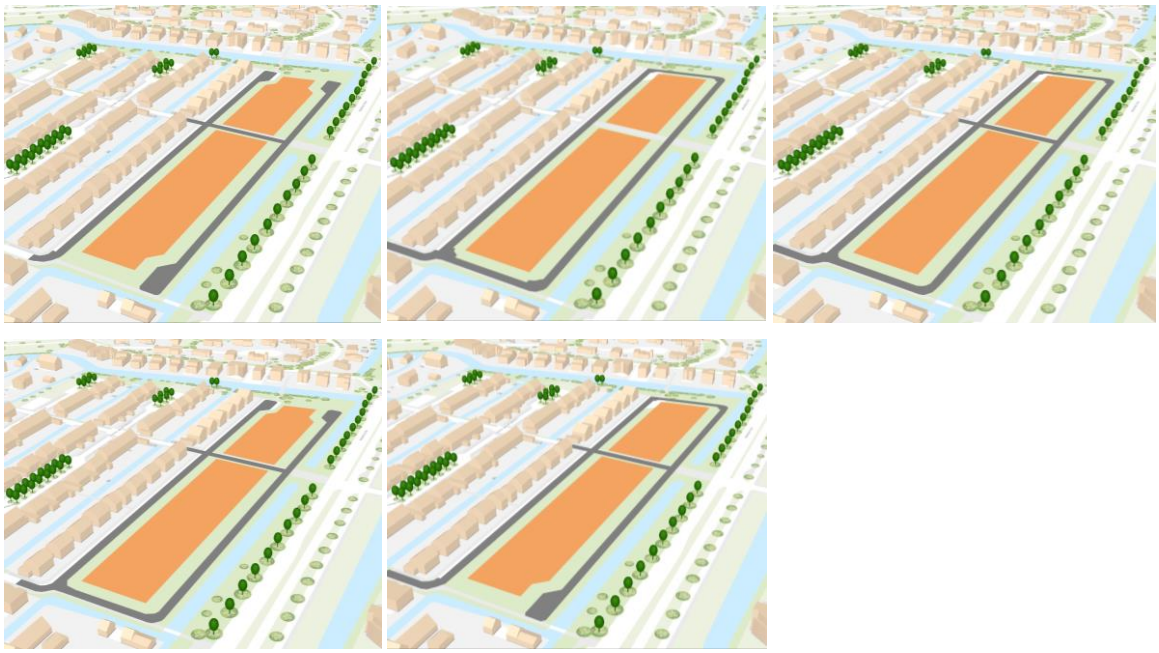


Figure 14: The shapefiles of the planning designs in a 3D visualization, applied in the online PPGIS environment for the NNO project. The shapefiles depicted in orange represent building areas, and depicted in grey represent the traffic access scenario's.

4.2.3.3 VGI in the web map

The online PPGIS environment also makes use of VGI, which allows users to add markers on a map in which participants can place comments to the specific planning project. The VGI possibility is added in the online PPGIS environment by the use of a Leaflet plugin called Leaflet Draw, which allows for the drawing of points (markers), lines, polygons and circles. These objects are GeoJSON objects as well. Moreover, the drawn objects need to be recorded or saved to a spatial database, in order to re-use them again. For this reason, a CartoDB spatial database is used, which allows to enter SQL queries to define where the GeoJSON objects have to be sent to and extracted from. CartoDB is a cloud-based GIS platform, in which spatial data can be stored, accessed and manipulated (via SQL) and from which maps can be easily created, customized and visualized (CartoDB, 2016).

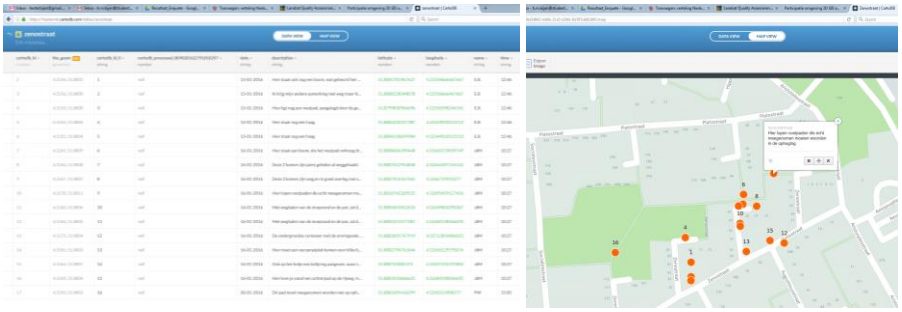


Figure 15: Example of the data view of the spatial database and the map view of the collected data in CartoDB.

The online PPGIS environment is hosted online via the Dutch domain http://www.participatie-online.nl which serves as a portal from which the online PPGIS environments for each of the case study projects can be visited (see Figure 16). The services of the online PPGIS environment are thus published on this domain. The direct URL to the Zenostraat project is http://www.participatie-online.nl/zenostraat.html (see Figure 17) and the URL to the NNO project is http://www.participatie-online.nl/noordelijkniertje.html (see Figure 18). Since it is undesirable to let participants add information outside the project area, the web map environment was bound to that particular location. The case studies are explained in the next chapter, which describes the kind of planning projects and therefore the focus for the online PPGIS environments.

Figure 16: Online portal to find the online PPGIS environments for the case study planning projects within the municipality of Rotterdam.

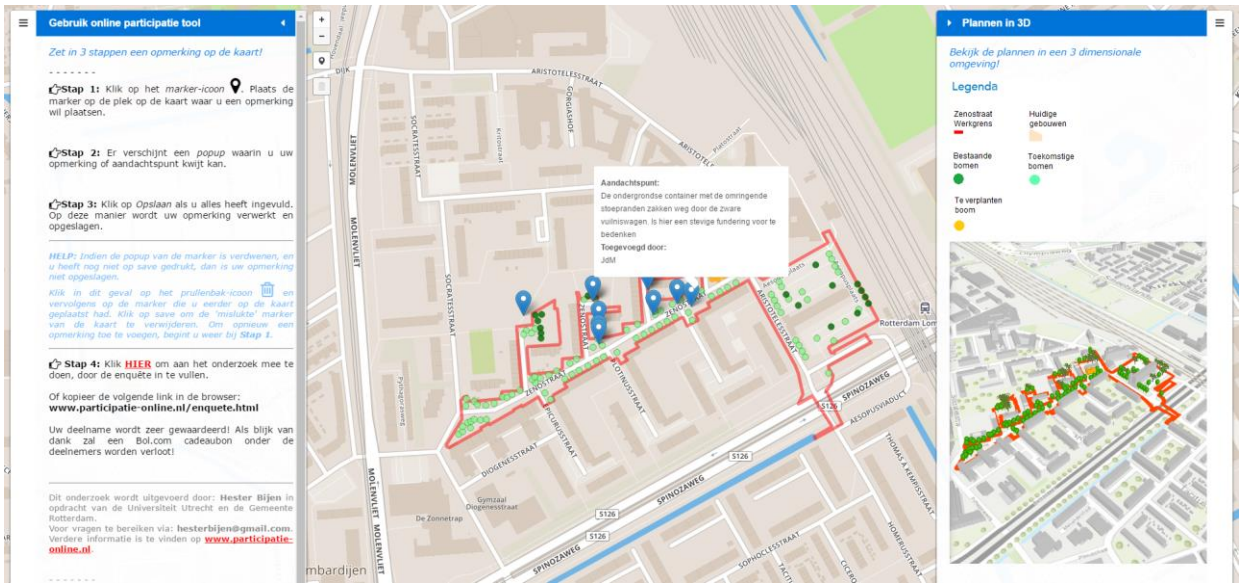


Figure 17: The online PPGIS environment for the Zenostraat project in which the added VGI points are shown. The 3D environment is shown in the right sidebar, which can be shown in full screen as well.

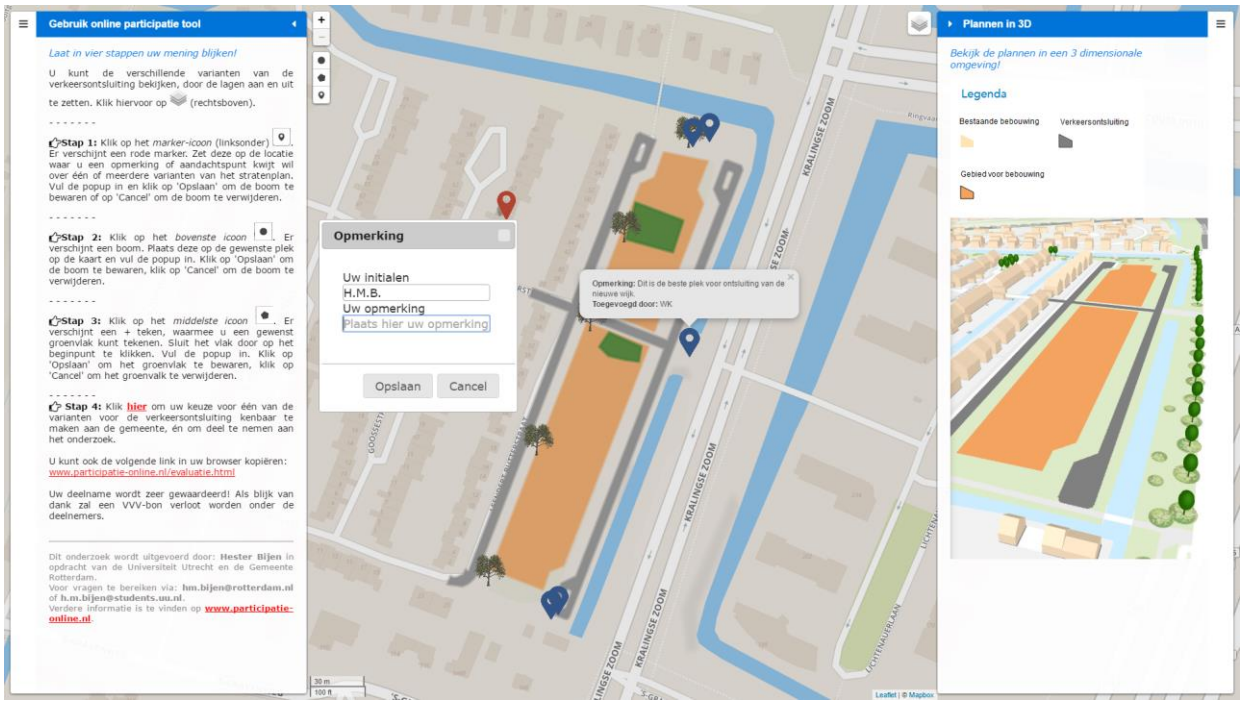


Figure 18: The online PPGIS environment for the NNO project with the added VGI points and polygons. In this project, not only comments could be placed on the map. Desires and ideas for tree locations (points) and green locations (polygons) could be drawn as well. The 3D environment is shown in the right sidebar, which can be shown in full screen as well.

5. CASE STUDY

5.1 Municipality of Rotterdam

To give an introduction to the municipality of Rotterdam, several insights will be given into the organizational structure. The municipality of Rotterdam has multiple departments. One of them is 'Stadsbeheer' (City administration), which is the department for which this research is done. The municipality is divided into six districts (see Figure 19). Each district has its own office and some diverse outposts which make sure every district gets the effort it needs; i.e. a decentralized structure. The department 'Stadsbeheer' is cooperating with 'Openbare Werken' (Public Operations), 'Schone Stad' (Clean City) and 'Toezicht en Handhaving' (Supervision and Maintenance) (Gemeente Rotterdam, 2015a).

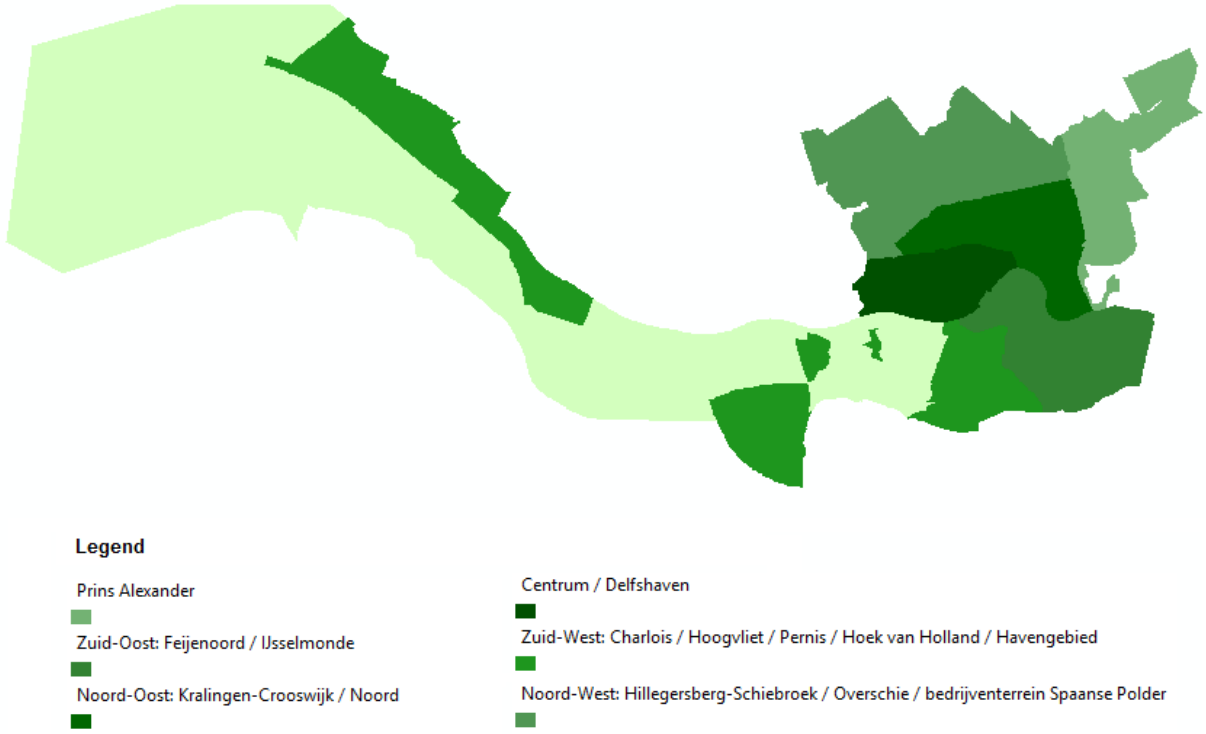


Figure 19: The six sites with offices for among other the department 'Stadsbeheer' within the municipality of Rotterdam (after Gemeente Rotterdam, 2015).

The municipality of Rotterdam makes use of the 'omnibus enquête', which is a yearly survey for citizens in the municipality of Rotterdam. Each year, around 3000 citizens participate in this survey and this survey gives insights in the opinions and desires of the citizens. The most recent survey shows results of decreasing interest and use of the 'stadskrant' (city paper). This paper is meant to communicate information about certain events or (planning) decisions to the citizens and can be seen as a traditional, yet present method to enhance public participation, by informing

the public. The results show a decrease in the amount of citizens that have seen the 'stadskrant' at least once in the year 2014-2015 (see Table 9). The content of the paper is valued with a 6.6, the level of understanding with a 7.0 and the usefulness with a 6.0 (Gemeente Rotterdam, 2015b). These numbers show a decrease of usage of the newspaper to inform the public, which means this present method of public participation is becoming less effective as it used to be.

City newspaper	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Have seen it once in the previous year	68%	73%	70%	68%	67%	60%	55%	50%	47%	48%

Table 9: Use of the city newspaper (Stadskrant) amongst the citizens in the municipality of Rotterdam. The newspaper is used as a traditional way of public participation (Gemeente Rotterdam, 2015b).

Another trend that can be indicated via the survey is the increasing use of social media (see Table 10), of which Facebook is the largest one. At least 54% of the citizens of Rotterdam make use of Facebook. The ages of the use of social media are also quite large, ranging from 16 to 85 years. The results show that in total 67% of the citizens make use of social media (Gemeente Rotterdam, 2015b). These results show the use of social media (SMGI) provides opportunities for enhancing public participation.

Social Media	2011	2012	2013	2014	2015
Makes use of Social Media	47%	52%	55%	X	67%

Table 10: Use of social media amongst citizens of the municipality of Rotterdam. Social media is or can be used as a new form of public participation (Gemeente Rotterdam, 2015b).

Another result from the omnibusenquête shows the internet use and amount of visits of the site of the municipality; www.rotterdam.nl (see Table 11). The results show that in general 79% of the citizens make use of the internet every once in a while and that in particular 70% of the citizens also make use of the website of the municipality. The website of the municipality can already be seen as a digital environment for enhancing public participation, where plans and information are provided to the public and where the citizens can get in contact with the local authority. The large amount of increasing internet use shows the potential for an Internet-based PPGIS environment.

Visits on rotterdam.nl	2011	2012	2013	2014	2015
Percentage internet users which visit rotterdam.nl once in a while	55%	64%	60%	64%	70%
Report mark on traceability of information	6,7	6,7	6,8	6,7	6,7
Report mark on understandability of information	7,2	7,1	7,2	7,1	7,1

Table 11: Use of the internet in general and the municipality's website in particular (Gemeente Rotterdam, 2015b).

The trends that are indicated are showing a decreasing interest in offline communication via newspaper and an increasing interest in online communication about topics concerning the municipality of Rotterdam. These trends make the idea of using an interactive application for public participation in the form of an online PPGIS environment in spatial planning more viable and attractive, hence the choice for the municipality of Rotterdam as case study.

A nice example of online participation within the municipality of Rotterdam is Delfshaven. Delfshaven is a neighbourhood area within the municipality of Rotterdam, which has very active citizen participation. Delfshaven has its own citizen's commission that allows and stimulates people to be actively involved in events and happenings within the neighbourhood. This kind of participation mainly concerns citizen initiatives, to which the municipality can react or grand permission. They furthermore can allow citizens to access funds. These initiatives do not include spatial planning decisions, since they are mainly focused on small scale maintenance, local events or social activities within the neighbourhood. However, it can be used as an example of public participation that has been visualized online, on an interactive web map. It is a small example of the integration of VGI in public participation GIS in which citizen initiatives are presented. The web map example is shown in Figure 20. It is however one of the few online participation methods that are presently in practice within the municipality of Rotterdam.

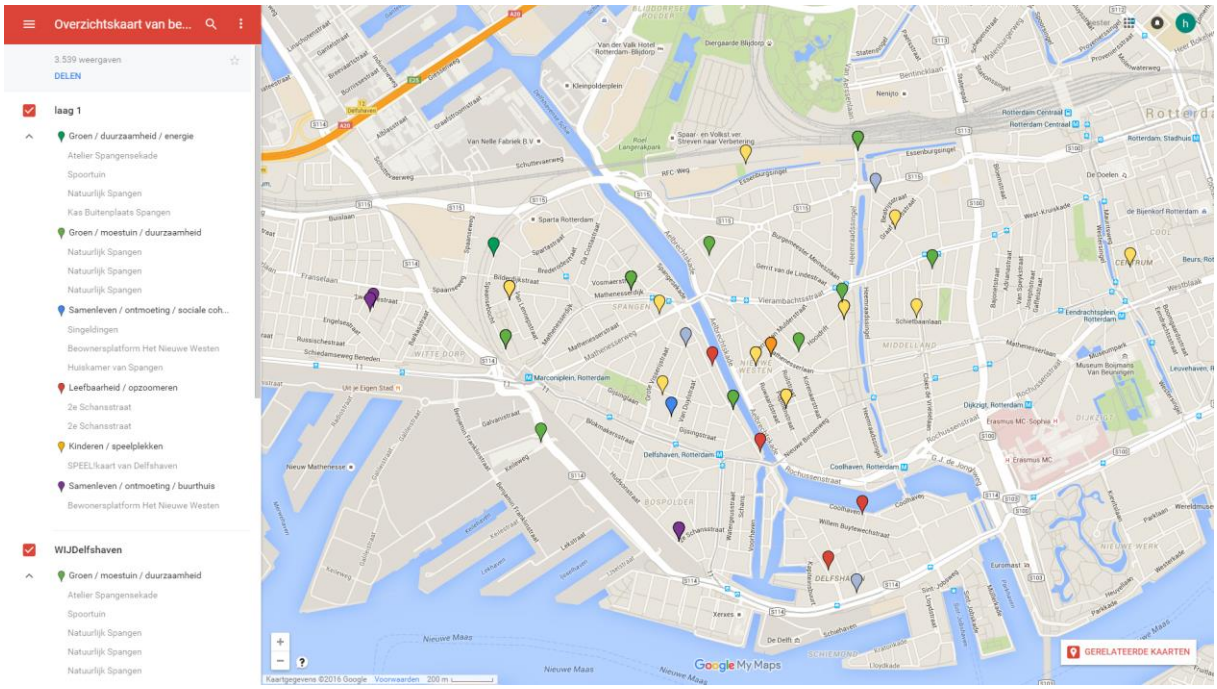


Figure 20: An example of a specific type of public participation, concerning citizen initiatives, visualized on a digital interactive map. The map has been integrated on the website of the citizens commission www.wijdelfshaven.nl, on which even Social Media, via Twitter tags on '#wijdelfshaven' are shown (via Gebiedscommissie Delfshaven, Karin de Goederen and Monique Groeneweg).

Currently, an important focus within the geo-information department of the municipality of Rotterdam is 3D geo-information. The municipality of Rotterdam is working on their newest 3D model, which is partly based on preferences of, and requirements for all possible users of an online 3D environment. It is to be used as a standardized tool in the planning decision-making process. Part of this is to include public participation, for which the added value of the use of the 3D environment still needs to be addressed to both citizens and stakeholders in the planning decision-making process. Stakeholders in this project are the municipality of Rotterdam, Future Insight, organizations connected to '*Five Cities Connect (5CC)'*-project and V*irtualCitySystems*. By the time that this 3D project of the municipality will focus on public participation, it is unfortunately too late for this research to take part in the project. However, this research will be valuable as pre-research for further development of the online 3D environment for public participation, as it will be used by the city of Rotterdam. This research is therefore of great value to the municipality of Rotterdam to connect 3D geo-information with public participation.

5.2 Case study areas

5.2.1 Zenostraat

The Zenostraat is a street in the area 'IJsselmonde', which is part of the neighborhood Lombardijen (see Figure 21). The project is a maintenance project and is executed by the municipality department 'Stadsbeheer'. The project is thus located at the end of the decision-making process in which public participation is used. The maintenance project comprises not only the Zenostraat, but all direct neighboring streets as well. The immediate cause for this are the projects' characteristics; it is about the sewerage beneath the Zenostraat, which is out-dated and therefore needs replacement. Simultaneously, the complete street will be heightened to its original instance level, since the underlying ground has subsided due to high groundwater levels, partly caused by the outdated sewerage system. One of the main impacts for the direct sight of the street, is the placement and replacement of the trees. Due to the high groundwater levels, and the heightened streets, trees will have to be replaced and heightened as well in order to ensure their survival. Furthermore, a couple of new trees will be placed in the area. The construction and maintenance of this project will take place at the Zenostraat, Aristotelesstraat and Aesopusplaats, and is expected to be completed at the end of 2016. The maintenance plan is shown in Figure 22.

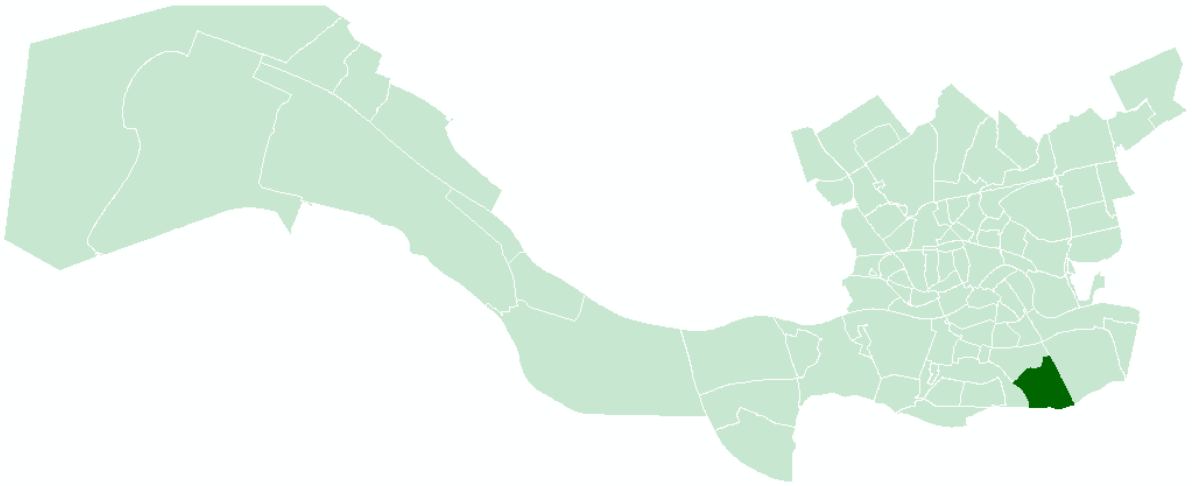


Figure 21: Case study area of the Zenostraat in the neighborhood Lombardijen as part of the municipality of Rotterdam.

Figure 22: Maintenance plan for the Zenostraat project, caused by the out dated sewerage system which is the accountability of the municipality department 'Stadsbeheer'.

At the 14th of January 2016, a public hearing was organized for all citizen stakeholders of this maintenance plan. At this meeting, the plan was shown to the citizens on large posters. Afterwards, the citizens were asked to fill in the attendance list and their e-mail addresses. They could furthermore indicate whether they were interested in participating in this study. The online PPGIS environment has been designed for this maintenance plan, by mainly focusing on the placement and replacement of the trees. The reason for this can be seen in Figure 22, since the plan mainly shows the placement and replacement of trees; no additional detailed information could be observed from this plan in the way it was provided (a CAD file which was converted to a PDF file).

In total, 30 citizens were present that evening, of which 16 citizens had given their e-mail address. On the 15th of January 2016, an e-mail was sent to all 16 citizens, in which it was explained what this study is about, what they could do in the online PPGIS environment and how they could contribute to this research. To enlarge the response as much as possible, the choice was made to raffle a coupon (VVV-bon) of 25 euro's. A deadline was set as well on the 1st of February; 2 weeks after sending the invitations. After these 2 weeks, 11 citizens had responded and completed the survey. The results of the ideas and opinions given in the online PPGIS environment are shown in Appendix IV.

5.2.2 Noordelijk Niertje Oost

Noordelijk Niertje is a neighborhood that is located within a part of the municipality 'Kralingen-Crooswijk' (see Figure 23). The most eastern part of this neighborhood is still to be developed; Noordelijk Niertje Oost (NNO). It is therefore the accountability of the municipality department 'Stedelijke Ontwikkeling'. For decades, initiatives have come and gone, though without any real consequences. The current approach of a part of the municipality of Rotterdam 'Kralingen-Crooswijk' has resulted in a project development plan for this area. The project is thus located at the beginning of the decision-making process in which public participation is used. The location of the area and its project boarder are shown in Figure 24.

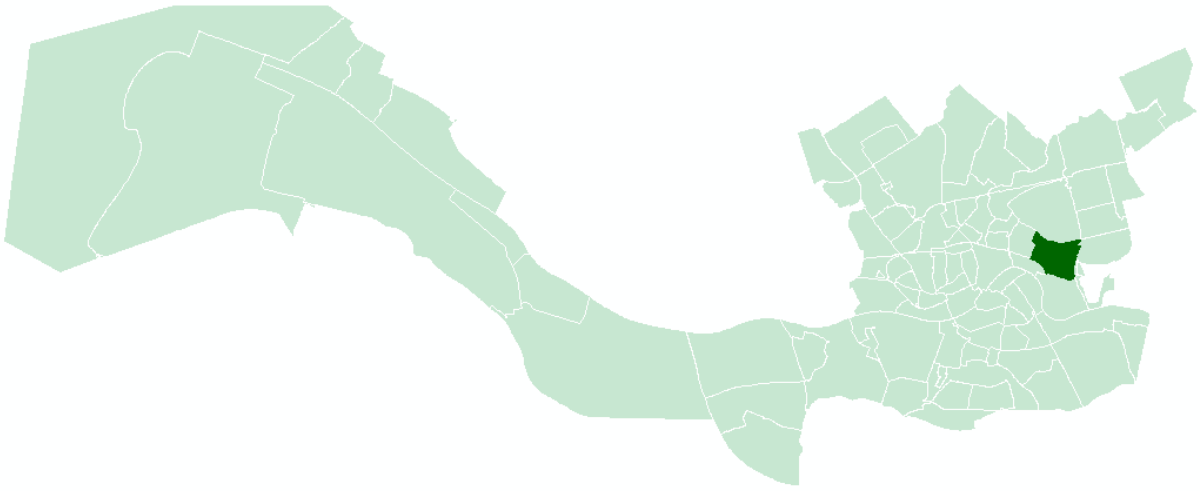


Figure 23: Case study area of Noordelijk Niertje Oost in the neighborhood Kralingen-Oost as part of the municipality of Rotterdam.

Figure 24: The area 'Noordelijk Niertje Oost' in the neighbourhood Kralingen, framed by the projectboarder in orange (Gemeente Rotterdam Stadsontwikkeling – BOdG ruimtelijk advies, 2015).

The development plan is based on a development plan for the 'Kralingse Zoom', which was made definite on the 28th of January, 1999 and which comprised the area for Noordelijk Niertje (Oost). The current project development plan for Noordelijk Niertje Oost (NNO) was accepted on the 26th of November, 2015, however this plan is not yet finalized. The plan shows locations for buildings, streets and green areas. The development plan states that houses can be built on the building locations, with a maximum of 30% of the total building area. This percentage is calculated on a maximum of 58 houses to be built. Some parts of the green areas can be used for streets as well. Also, within the project area, play provisions for children have to be included with an area of at least 250m2, for which the green areas can be used. This last requirement is something that inherited from the development plan for 'Kralingse Zoom' from 1999. The development plan is shown in Figure 25, which can also be accessed on www.ruimtelijkeplannen.nl.

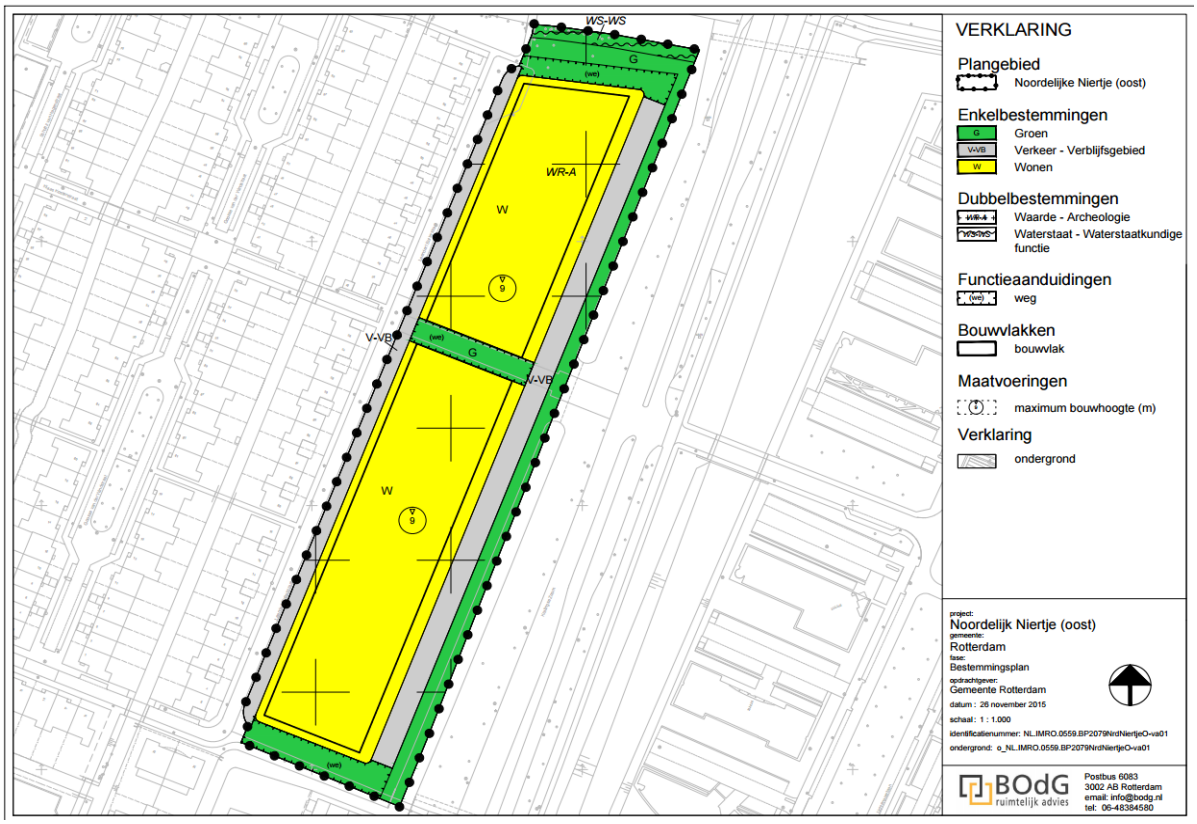


Figure 25: The development plan of the area 'Noordelijk Niertje Oost'. Accepted by the 26th of November, 2015 (Gemeente Rotterdam Stadsontwikkeling – BOdG ruimtelijk advies, 2015).

Given the fact that the development plan for NNO is only accepted and not final, citizens can still raise objections against this project plan. Nonetheless, landscape architects within the municipality of Rotterdam have already been working on conceptual designs for this area, especially on traffic accesses in the neighborhood. At the 20th of January, 2016, a public hearing was organized in order to welcome citizens with their concerns and to present the first concept versions for traffic access in the project area. Five scenarios were presented during this evening, for which a 'simple' drawing was shown at first to give an overview of the concept designs and ideas (see Figure 26). Secondly, three of these five versions were shown in more detail which had the preference of the landscape architects (see Figure 27). These examples give some insight in the level of detail and level of clarity for which plans are shown and presented at the NNO public hearing.

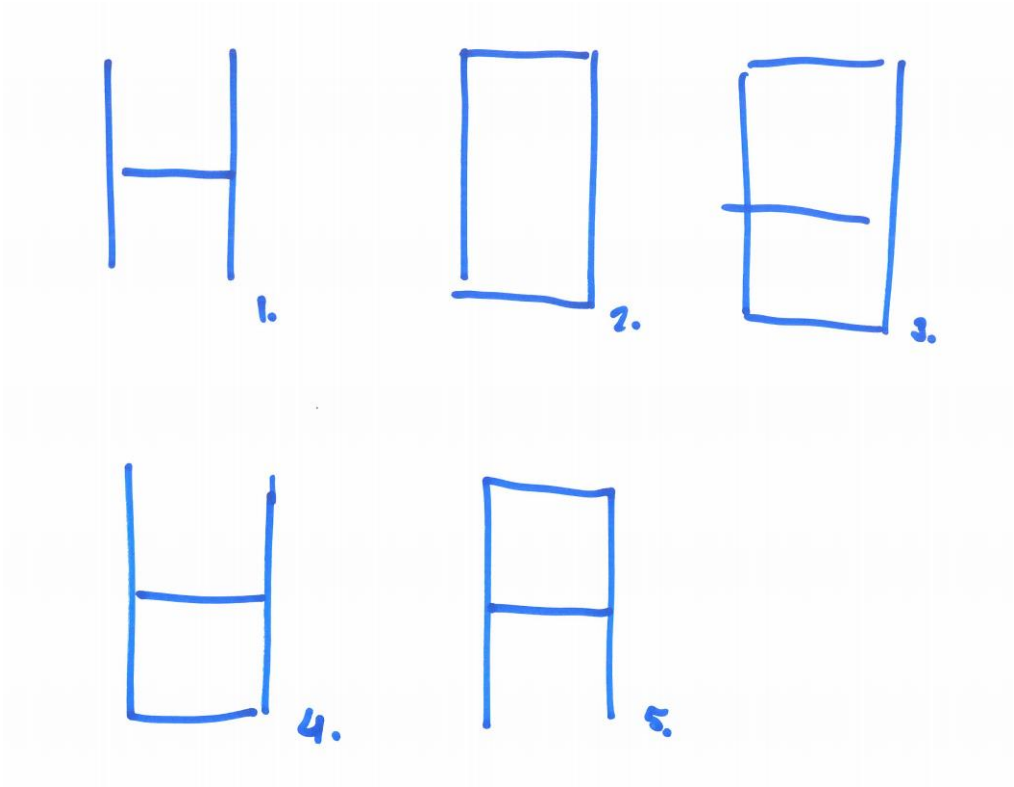


Figure 26: Example of the 'simple' drawing of the five available concept versions for traffic access in NNO, as it was shown on the public hearing on the 20th of January, 2016.

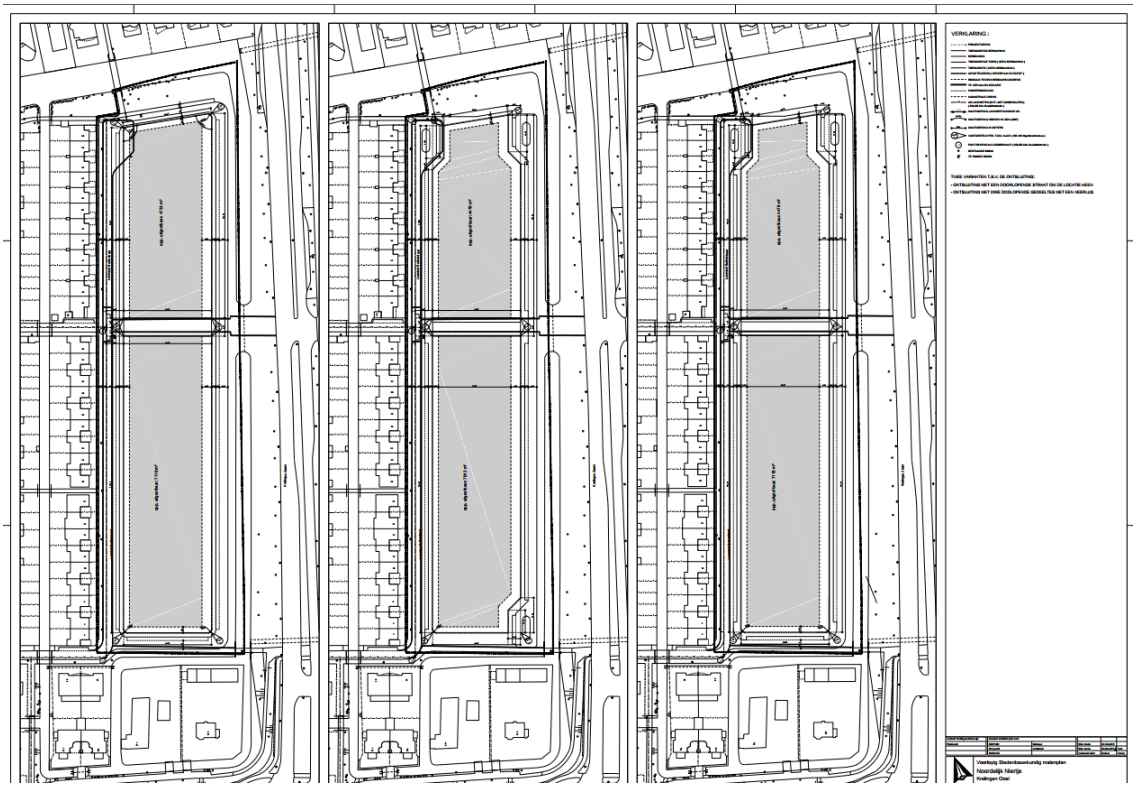


Figure 27: Example of the detailed concept design as it was shown on the public hearing on the 20th of January, 2016. These planning designs were used as well to create shapefiles in order to be used in the online PPGIS environment.

In total, 60 citizens were present at the public hearing on the 20th of January, 2016. At arrival, they were asked to fill in the attendance list, by writing down their name, address, and e-mail address. The attendance list contained 46 e-mail addresses, to which an invite concerning further information about the project plans and a detailed description about this research was sent via e-mail. Unfortunately, 5 of the 46 e-mail addresses were copied wrongly. Out of these 41 people, to whom a request to participate in this research was sent, only 15 citizens have responded, of which 14 respondents have completed the entire questionnaire.

This study was a welcome addition in the NNO project, since it was desired for this project to increase the level of participation by making use of an interactive tool. The online PPGIS environment was designed for this project in such a way that it fitted the desires of the project managers. Therefore, the VGI possibility was enlarged by not only providing citizens the opportunity to give their opinion or ideas on the project plan, but also by giving them the opportunity to indicate preferences for trees or green locations in the neighborhood. These tree and green locations were desirable for the NNO project team, which they would like to use in further planning and design. The visualization focused on showing the five options of traffic access scenarios in the project area. Therefore, the citizens could view these five options in the 2D environment and in the 3D environment. Unfortunately, it became evident afterwards that the project managers' desires for the implementation and topic of public participation did not match the citizen' desires at all. This negatively influenced amounts of responses and attitudes towards the online PPGIS method. In the accompanying online questionnaire, an additional question was asked about the concept designs of the traffic access, to find out which of these five traffic access options was most preferred by the citizens. The results for the traffic access scenarios and the provided map of the ideas and opinions given in the online PPGIS environment are shown in Appendix V.

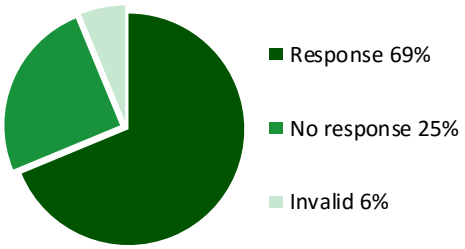
6. ANALYSES & RESULTS

As explained before, the applied research method consisted of an online questionnaire, in which two Likert scales for usability and usefulness, derived from recent studies of Pelzer, were used to assess added value. The questionnaire consisted of Likert items accompanied by a few more detailed and open questions on a specific topic, such as 3D Geo-information, the use of shadows, Level of Detail (LoD) and the use of VGI. As a reminder, the usability scale was intended to cover added value of the application's or participation method's specific characteristics (user-functionality success), whereas the usefulness scale assessed the attitudes towards the implementation of the application in the decision-making process (process-fit). Through the questionnaire, the tested online PPGIS environment was then compared to the public hearing, representing the traditional public participation method at the municipality of Rotterdam. It was shown before that analysis for Likert scales and Likert items should be carried out in a slightly different way; Firstly, central tendency in Likert scales is best analyzed by mean values, while median values are more valuable for Likert items. Secondly, variability analysis is best studied via standard deviations in Likert scales, whereas distributions are more meaningful for Likert items. The Cronbach's Alpha test is used to assess whether Likert items within a Likert scale can be analyzed as summated scores for analysis in a general sense. One of the usability indicators – the level of participation - is not presented as a Likert scale within the questionnaire and is therefore excluded from scale analysis. It does however show what voice respondents feel they have or could have via the participation method in future usage. Furthermore, the applied research method has been applied in two case study areas; the Zenostraat and the Noordelijk Niertje Oost (NNO). In the following sections, the analysis for both case study areas is discussed on the basis of the two Likert scales and their subsequent items. At first, general statistics on demographic characteristics are presented for each case study area.

6.1 General statistics of the case study areas

The first case study area in which the questionnaire was obtained, is the Zenostraat. In total, eleven responses were gathered, out of the sixteen e-mail addresses to which an invitation was sent for participating in this research. However, only fifteen of these e-mail addresses proved valid. The response rate is thus 69% of the total amount of approached citizens via e-mail, and even 73% of the amount of reached citizens. Although the total amount of responses is low, the response rate is high. The second case study area was the Noordelijk Niertje Oost, for which in total 14 valid responses were obtained, although one response was invalid. For this area, to 46 e-mail addresses an invitation was sent for the online questionnaire, of which five were invalid. The amount of response is thus low. The response rate is 30% of the total amount of approached

citizens via e-mail, and 35% of the reached citizens. A possible explanation for the difference in responses is that the topic on which the NNO citizens were invited to participate in, did not adhere to their interest concerning the NNO project area. For both case study areas it must be stated that assumptions are made with care. The response rates are shown below for each case study (see Figure 28 and 29).



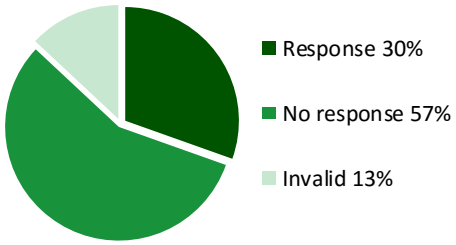
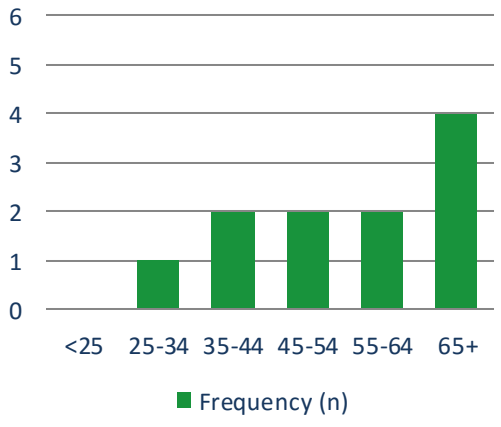


Figure 28: (left: Zenostraat) and Figure 29: (right: NNO): Response rates for each case study area.

Moreover, of the Zenostraat responses, seven were female and four were male. Furthermore, most respondents fell into the oldest age category 65+ (four out of eleven), which could have been of influence on their experiences towards a digital and online environment for public participation. From the NNO responses, four respondents were female, while eleven were male. Also, most respondents fall within the older age categories 55+ (see Figure 30 and 31).



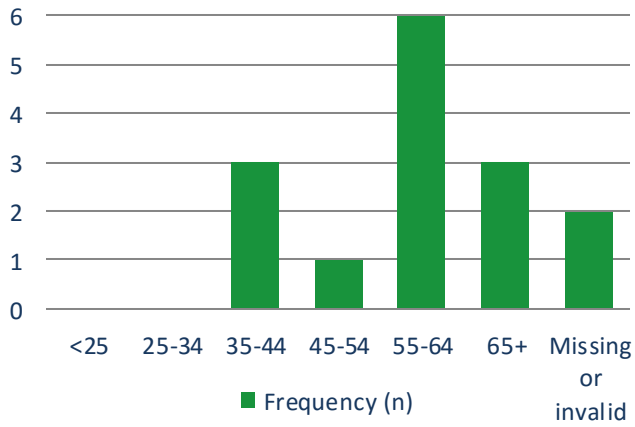


Figure 30: (left: Zenostraat) and Figure 31 (right: NNO): Respondents' distribution in age categories.

6.2 Usability scale

For both case study projects, one part of the questionnaire consisted of usability questions. All questions were applied to both participation methods; the public hearing and the online PPGIS environment. In both case studies, the alpha score is above the required minimum of 0,7 which indicates that the usability items have high internal consistency and could therefore be measured on a usability scale (Table 12). Table 12 shows descriptive statistics as well, which can be used for the scale analysis. Firstly, usability scale analysis will be done for the Zenostraat, after which the NNO will be discussed.

Participation method per case study	N	Mean	St. Dev.	Min.	Max.	Alpha
Public Hearing Zenostraat	11	3,95	1,222	1	5	,949
Online PPGIS environment Zenostraat	11	3,74	0,988	1	5	,829
Public Hearing NNO	14	3,87	1,095	1	5	,845
Online PPGIS environment NNO	14	3,41	1,095	1	5	,841

Table 12: Usability scale descriptive statistics and Cronbach's Alpha test score (>0,7).

The central tendency within Zenostraat is hardly deviating for the two participation methods, as the attitudes towards both methods are positive. The mean value for the public hearing is slightly higher than for the online PPGIS environment, although both fall within attitude category 4 ("agree"). Therefore, in general it can be assumed that respondents agreed with the added value of both participation methods' characteristics; the user-functionality success was found sufficient. The variability, when looking at the standard deviation, tells us that on a normal distribution, the distribution has a smaller range for the online PPGIS environment than for the public hearing. In other words, 95% of the distribution will lay closer to the mean value of the online PPGIS environment (+ 1,976 and -1,976) than to the mean value of the public hearing (+2,444 and -2,444) [1].

The central tendency for NNO, which is based on the mean value for the studied participation methods, shows that in general respondents' attitudes towards the public hearing are slightly more positive than towards the online PPGIS environment, although both fall within category 3 ("neutral"). In general, respondents are thus slightly more in agreement about the added value of the public hearing's characteristics. Again, the user-functionality success was found sufficient in both participation methods. The variability shows that the distribution is equal to both participation methods, as for both methods 95% of the distribution lies between +2,190 and -2,190 from the mean value of the participation method.

[1] Hereby it is assumed that responses lie on a 95% interval, thereby meaning that the distribution includes two times the standard deviation.

6.3 Usability items

The usability scale gave an overview of the attitudes of the respondents towards each participation method, which makes it easier to compare the two dimensions. According to the Alpha scores, the summated items make a good scale, for which it can be argued that analysis of the individual items does not matter anymore. This is because if there were large deviations to be found, it probably was not a good scale in the first place, i.e. it is not likely to find a lot of variation. The scales are thus used because of their internal consistency, and show somewhat equal distributions. However, the scales are a quantitative measure, which do not contain further detail. With respect to content of each item, it is interesting to discuss them as well. Furthermore, results for these items are compared to the interviews made to initially state the research problem and focus. Table 13 and Table 14 give an overview of the mean, median, minimum and maximum values of all usability items as observed at the case study areas. Each table shows results for one of the participation methods.

When looking at the Zenostraat at first, individual items within the usability scale show lowest mean values for the *level of interaction* and for the *level of detail* in the public hearing. These values still fall within category 4 ("agree"). Furthermore, both items show median values of 4, which indicates that these indicators are found sufficient in the public hearing. The online PPGIS environment shows a lowest mean value for *presentation quality*, which falls within category 3 ("neutral"). The presentation quality furthermore has a median value of 3, which indicates that improvements can be made on this indicator. The highest mean values are found for both participation methods in the *level of flexibility*. The highest mean for the public hearing is also found in the *level of integration*. All of these highest results fall within category 4 ("agree"). Median values for these public hearing results are 5, which indicates that the level of flexibility and the level of integration are found to be of a high enough quality. The median value for the level of flexibility for the online PPGIS environment is 4, which indicates that it is found to be of a sufficient level.

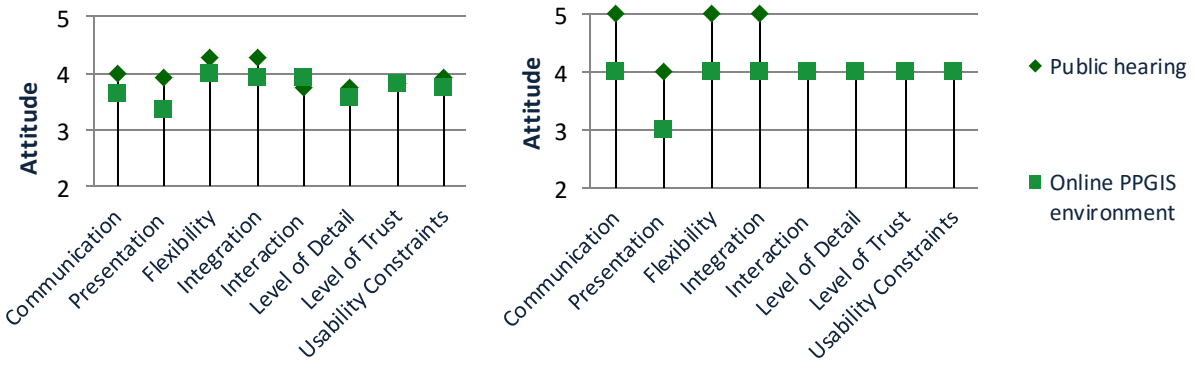
Within the NNO project, the public hearing shows lowest mean values on the items *presentation quality* and *level of detail*. The online PPGIS environment shows lowest mean values on the *presentation quality* and the *level of interaction*. All lowest values fall within category 3 ("neutral"), which indicates that improvements can be made on these items, in both participation methods. The highest mean value for NNO for the public hearing is shown for the *usability constraints*, while for the online PPGIS environment the highest mean value can be found for *flexibility*. Both values fall within category 4 ("agree), therefore it can be assumed that these items are found sufficient for the particular participation method.

The mean values show that attitudes towards the online PPGIS environment are overall slightly less positive than towards the public hearing. Furthermore, the mean values show

deviating results between the two case study areas, for which the NNO results are overall a bit lower. However, in order to study individual items, median values are shown to be more valuable[2]. The Figures 32-35 show differences in mean and median for each usability item between the public hearing and online PPGIS environment. These figures allow to compare to the two participation methods to each other, from which larger differences can be better observed when looking at the median values.

Usability items Public Hearing	N	Mean	Median	Min.	Max.
Communication Zenostraat	11	4,00	5	1	5
Communication NNO	14	4,07	4	1	5
Presentation Zenostraat	11	3,91	4	1	5
Presentation NNO	14	3,14	3	1	5
Flexibility Zenostraat	11	4,27	5	1	5
Flexibility NNO	14	4,29	4	3	5
Integration Zenostraat	11	4,27	5	1	5
Integration NNO	14	4,21	4	2	5
Interaction Zenostraat	11	3,73	4	1	5
Interaction NNO	14	3,93	4	1	5
Level of Detail Zenostraat	11	3,73	4	1	5
Level of Detail NNO	14	3,14	3	1	5
Level of Trust Zenostraat	11	3,82	4	1	5
Level of Trust NNO	14	3,79	4	1	5
Usability Constraints Zenostraat	11	3,91	4	1	5
Usability Constraints NNO	14	4,36	4,5	2	5

Table 13: Descriptive statistics of Usability items for the Public Hearing, for both case study areas.



Comparison of Mean values between Public Hearing and Online PPGIS environment for Zenostraat

Comparison of Median values between Public Hearing and Online PPGIS environment for Zenostraat

Figure 32 (left: Mean) and Figure 33 (right: Median): An overview of differences in mean and median values between the public hearing and the online PPGIS environment on the usability items for the Zenostraat.

[2] The median value is a method to find the middle value of all given scores. On a scale from 1 to 5, a median value above 3 would indicate that at least half of the respondents gave a score 4 or 5. Otherwise, a median value below 3 would indicate half of the responses to be of score 1 or 2. See Table 7 in Section 4.1.6 for usage and analysis Likert type data.

Usability online PPGIS environment	N	Mean	Median	Min.	Max.
Communication Zenostraat	11	3,64	4	2	5
Communication NNO	14	3,21	3,5	1	5
Presentation Zenostraat	11	3,36	3	2	4
Presentation NNO	14	3,14	3	1	5
Flexibility Zenostraat	11	4,00	4	2	5
Flexibility NNO	14	3,93	4	3	5
Integration Zenostraat	11	3,91	4	2	5
Integration NNO	14	3,43	4	1	5
Interaction Zenostraat	11	3,91	4	1	5
Interaction NNO	14	3,14	3	1	4
Level of Detail Zenostraat	11	3,55	4	1	5
Level of Detail NNO	14	3,36	4	1	5
Level of Trust Zenostraat	11	3,82	4	2	5
Level of Trust NNO	14	3,64	4	1	5
Usability Constraints Zenostraat	11	3,73	4	2	5
Usability Constraints NNO	14	3,43	4	1	5

Table 14: Descriptive statistics of Usability items for the online PPGIS environment, for both case study areas.

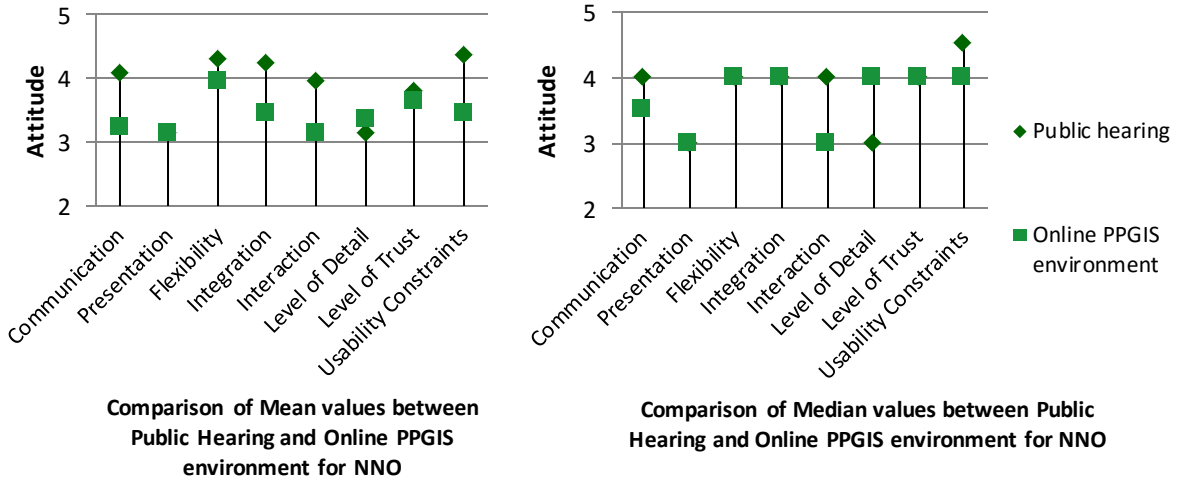


Figure 34 (left: Mean) and Figure 35 (right: Median): An overview of differences in mean and median values between the public hearing and the online PPGIS environment on the usability items for the NNO.

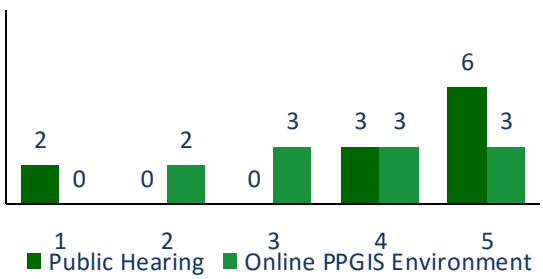
In the following sections, the results of the participation methods for each usability item are explained in more detail, based on the descriptive statistics as shown in Table 13, Table 14 and Figures 32-35, and by using frequency distributions which are shown in the corresponding graphs (Figure 36-51).

6.3.1 Level of Communication

The level of communication is used to measure the performance of the participation method for communicating planning designs from the municipality to the citizens. For the Zenostraat, both mean and median values (Figure 32 and Figure 33) show higher results for the public hearing. These values indicate that the communicative value is found good, whereas for the online PPGIS environment results it is assumed that the communicative value is found sufficient. When looking at the distribution of both participation methods (see Figure 36), it becomes clear that respondents' reactions towards the communicative value of the online PPGIS environment is more equally distributed, whereas the public hearing shows higher frequencies for positive attitudes.

Results for the NNO case study area show higher mean and median values for the public hearing as well, however these indicate that the communicative value is found sufficient in both participation methods. The variability also shows a positive distribution for both participation methods, for which similar attitudes thus can be concluded (see Figure 37).

When looking back to the interviews, poor communication was initially identified as the main problem in public participation. These results however, show that the studied public hearings are overall valued positively. The studied public hearings are a snapshot in the entire decision-making process, in which plans are well communicated in that particular moment. It does therefore not give insight in the communicative value throughout the decision-making process, which was likely to be meant by the interviewees.



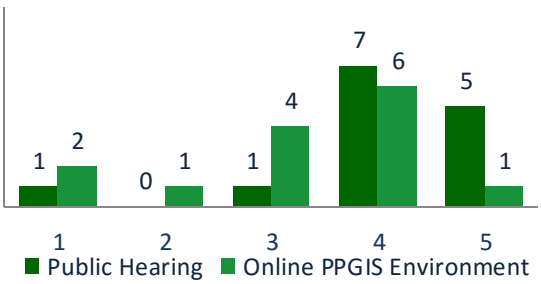


Figure 36 (left: Zenostraat) and Figure 37 (right: NNO): Attitude frequencies for the level of communication.

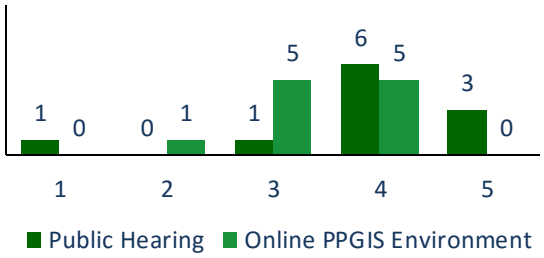
6.3.2 Presentation quality

The presentation quality measures the level for which the presented plans in the participation method can easily be understood by the public. Results of the Zenostraat show that mean and median values are slightly deviant (Figure 32 and 33). The central tendency for the public hearing can thus be seen as a slightly positive response; at least half of the respondents agreed or fully agreed to the given statement, i.e. the presentation quality is of a sufficient level in the public hearing. On the other hand the central tendency for the online PPGIS environment explains shows an equal amount of responses which have negative attitudes towards the

presentation quality, as there are with a positive attitude; i.e. the presentation quality could thus be improved in the online PPGIS environment. When looking at the frequencies (see Figure 38), a slightly positive distribution can be found for the public hearing and the online PPGIS environment.

Results for NNO show equal mean and median values for both participation methods (Figure 34 and 35), which indicate a neutral central tendency towards the ability of the participation methods to present planning designs; i.e. the presentation quality could be improved in both participation methods. The frequencies for NNO show a comparable or equal distribution of the responses for both participation methods (see Figure 39).

The interviewees, which were used to state the initial research problem and focus, pointed out that 3D is mainly used within the municipality as a communication tool for which they expected added value in public participation. The online presented plans however, are shown to be not of high enough quality to be understood very easily, which means even 3D visualizations need verbal or textual explanations to be fully understood by the public. In order to efficiently use 3D for communicating plans in an understandable manner, some additional features thus need to be taken into account as well.



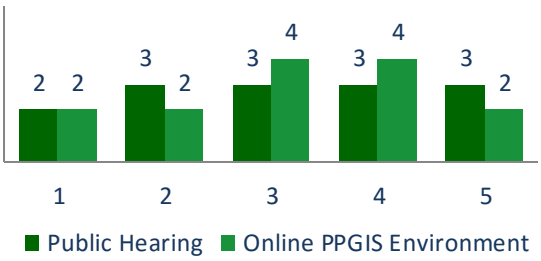


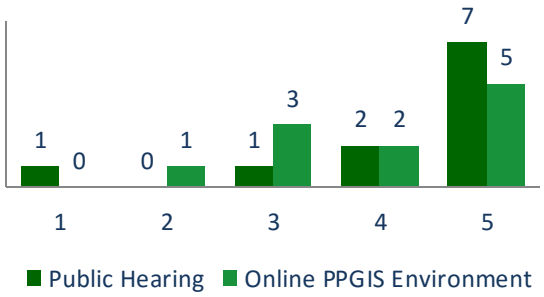
Figure 38 (left: Zenostraat) and Figure 39 (right: NNO): Attitude frequencies of the presentation quality.

6.3.3 Level of Flexibility

The level of flexibility is used to discover the suitability for the participation method to be used in one or more phases of the planning decision-making process. For the Zenostraat, the research was conducted in the last phase of the decision-making process; the implementation phase. Results of the Zenostraat show for the mean and median of the public hearing slightly higher values than for the online PPGIS environment (Figure 32 and 33). The central tendency towards the public hearing indicates that at least half of the respondents have fully agreed to the statement; i.e. attitudes towards the public hearing for its flexibility in the decision-making process are very positive. The median value for the online PPGIS environment indicates a positive attitudes towards the statement, although at least half of the respondents can be found in the scores 4 ("agree") and 5 ("fully agree"); i.e. the flexibility is found sufficient. When looking at the frequencies (see Figure 40), for both participation methods positive responses are found as well.

Results for NNO show that the mean values are higher for the public hearing than for the online PPGIS environment, while equal for median values (Figure 34 and 35). The central tendency indicates positive attitudes towards both participation methods, since at least half of the respondents agreed to whether the participation methods should be used in other stages of the decision-making process as well. The frequency graph (see Figure 41) shows positive responses towards both participation methods as well. Overall, it can be said that both participation methods are found to be suitable and valuable to be used as participation method in different stages of the decision-making process.

The interviewees indicated that it is necessary for the municipality to communicate more to citizens in order to improve public participation. Results above show congeniality between the initially stated issue by interviewees and the citizen respondents, as the participation methods as communication tools are appreciated in multiple stages of the decision-making process. Therefore, another point of action or improvement is here pointed out that can be made in the future, as public participation is currently not used in multiple stages of the decision-making process within the municipality of Rotterdam.



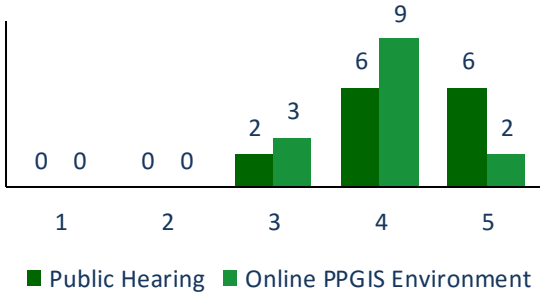


Figure 40 (left: Zenostraat) and Figure 41 (right: NNO): Attitude frequencies on the level of flexibility.

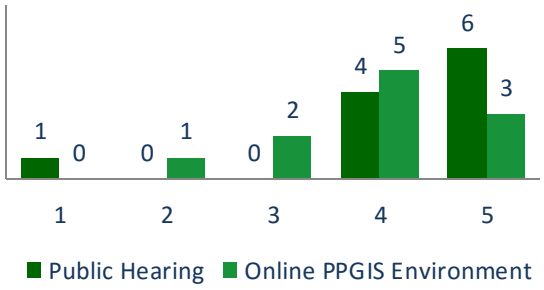
6.3.4 Level of Integration

The level of integration explains whether the participation method provides suitable ways and possibilities for the exchange of information, knowledge and ideas between municipality and citizens. Results for the Zenostraat show that for both mean and median values, the public hearing scores higher than the online PPGIS environment. These results can be interpreted in a way that attitudes for the level of integration towards the public hearing are slightly more positive than towards the online PPGIS environment; the level of integration is shown to be good for the public hearing, while sufficient in the online PPGIS environment. The frequencies of the Zenostraat results show a positive distribution towards both participation methods as well (Figure 42).

Results for NNO show that for mean values, the public hearing scores higher, while for median values both participation methods score equal. It therefore indicates that the central tendency for the level of integration is positive towards both participation methods, since at least half of all respondents have agreed upon the suitability for exchanging information via the

participation methods. Furthermore, the variability shows positive frequency graphs (see Figure 43). Overall, it can be said that both participation methods provide suitable ways for the exchange of information, knowledge and ideas between municipality and citizens.

Interviewees indicated that there is not enough support for citizen participation, while these results show that the methods in itself proved suitable ways to participate. Again, this is concerning one moment in the decision-making process, which therefore does not indicates that enough support is given throughout the decision-making process. It does however indicate that the used and provided participation methods should be enough to offer support when applied in multiple stages in the decision-making process.



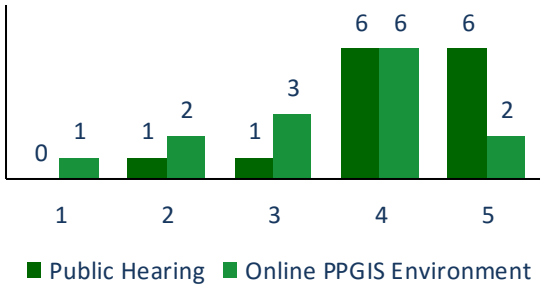


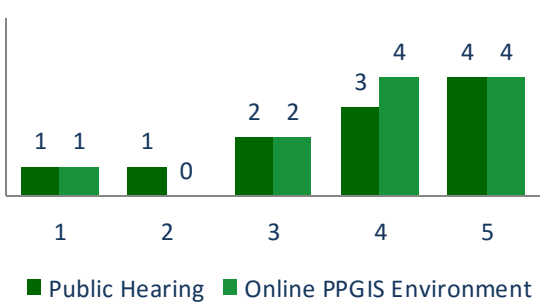
Figure 42 (left: Zenostraat) and Figure 43 (right: NNO): Attitude frequencies on the level of integration.

6.3.5 Level of Interaction

The level of interaction is used to gain insight into whether the participation methods provide the opportunity to make comments or place remarks on the presented plans. This item is thereby partly focused on the use of VGI in the online PPGIS environment. The results for the Zenostraat show that the mean and median values are quite similar for both participation methods, for which the mean value is even slightly higher for the online PPGIS environment. These values indicate that at least half of the respondents can be found in the scores 4 ("agree") and 5 ("fully agree"). Frequencies (see Figure 44) of the Zenostraat results show that for the level of interaction, both participation methods have positive frequency distributions. Therefore, the central tendency and variability indicate that both methods are found sufficient in providing ways for making directed comments and remarks.

Results for NNO show a higher mean and median values for the public hearing than for the online PPGIS environment (see Table 13 and Table 14). It can therefore be said that the central tendency on the interaction item is positive towards the public hearing, while neutral towards the online PPGIS environment. The variability shows slightly positive results for both participation methods (see Figure 45). Overall, it can be said that the provided ways for giving remarks or place comments on the presented plans via the provided participation method are found sufficient.

Interviewees indicated that communication could also be improved via online participation, though it was furthermore said that it would lead to an increase of participants and thus an increase of work for urban planners, which is often not desired. Respondents indicated that it was unclear whether their comments were going to be used, showing a low level of trust. This trust issue seems valid by what is stated by interviewees; i.e. citizens are sceptic about the use of online participation in the decision-making process, because it is shown before that some urban planners do not appreciate citizen involvement.



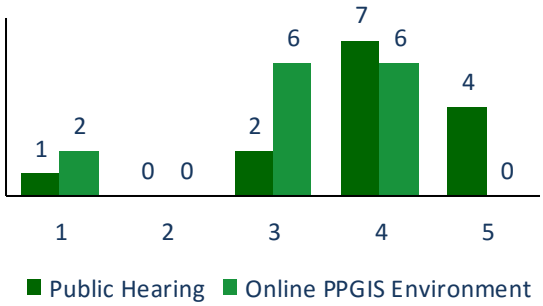


Figure 44 (left: Zenostraat) and Figure 45 (right: NNO): Attitude frequencies on the level of interaction.

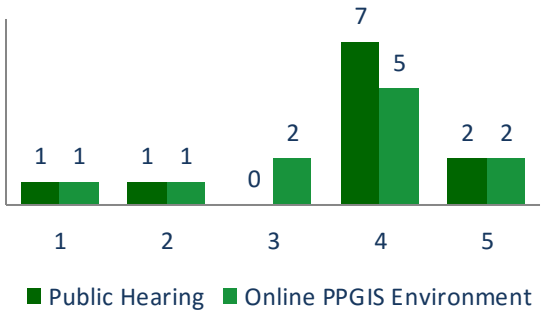
6.3.6 Level of Detail

The indicator for the level of detail explains whether the presented planning designs and drawings are shown in high enough quality and detail. This item aims to find potential preferences for using 3D visualizations next to the 2D maps. Results for the Zenostraat show that mean and median values are similar for both participation methods. These values indicate that the central tendency of the attitudes towards both participation methods are positive, since at least half of the respondents agreed to the statement. Furthermore, frequencies (see Figure 46) show a slightly positive variability for both participation methods. For this statement the overall conclusion accounts that the outcomes of central tendency and variability are quite similar for the two participation methods; both methods are found to provide understandable plans, with sufficient level of detail.

Results for NNO show higher mean and median values for the online PPGIS environment. The central tendency can be explained as neutral towards the public hearing, for which improvements can be made on this item in the public hearing. The central tendency is positive towards the online PPGIS environment and is therefore found sufficient. Looking at frequencies (see Figure 47), slightly positive frequency graphs are found for both participation methods. Although the central tendency is of slightly higher value towards the online PPGIS environment, the overall outcome still shows that the level of detail is sufficient in both participation methods.

The initial assumption was that 3D visualization, with higher level of detail, would be found helpful in understanding and communicating planning designs. This was furthermore

suggested by the interviewees, who thought that 3D could be of added value in improving communication. Since the online PPGIS environment made use of 3D visualizations, it was therefore expected that attitudes towards this method would have been higher than towards the public hearing in both case study areas.



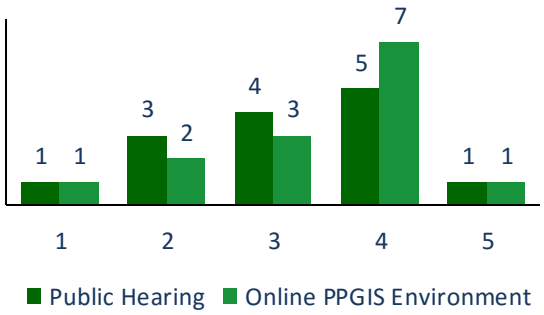


Figure 46 (left: Zenostraat) and Figure 47 (right: NNO): Attitude frequencies on the level of detail.

6.3.7 Level of Trust

The level of trust measures the transparency of knowledge exchange and planning designs within or via each participation method. The item asked the respondents whether they would think the participation method is a good method for making planning designs comprehensible and easily accessible to the public. Results for the Zenostraat show equal mean and median values for both participation methods. This means that the attitudes of the respondents are equally positive towards both participation methods, with at least half of the respondents agreeing to the statement concerning the level of trust. The frequencies show a slightly positive distribution for both participation methods (see Figure 48). It can be concluded that both participation methods are considered sufficient in making planning designs more easily accessible to the citizens and providing transparent knowledge exchange between municipality and citizens in both directions.

Results for NNO show that mean and median values are similar towards both participation methods, indicating that the central tendency is positive. The frequencies show a positive distribution for both participation methods (see Figure 49). Overall, central tendency and variability show that positive attitudes can be found towards both participation methods. Thereby it can be said that the two methods give sufficient insight in data and information exchange.

Although results show that both participation methods provide a sufficient transparency of knowledge exchange, thereby generating a sufficient level of trust, it was furthermore indicated by respondents that they do not know and therefore do not trust whether the online PPGIS method is used in the decision-making process. This makes it somewhat discouraging to participate, which was also indicated in the interviews. Furthermore, it was indicated in the interviews that public participation could also be discouraging to urban planners.

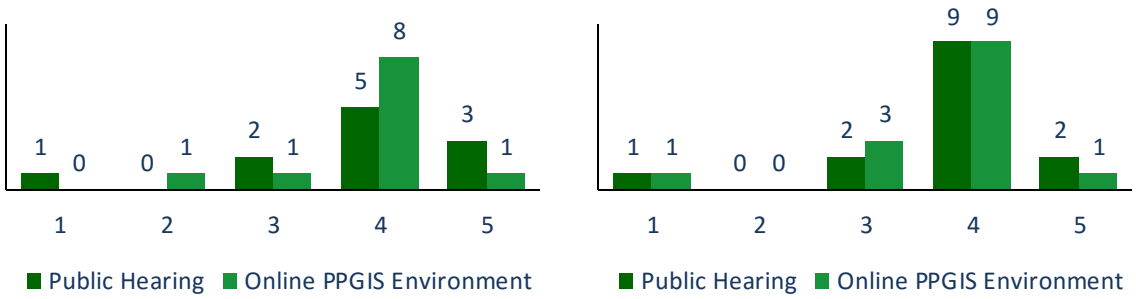


Figure 48 (left: Zenostraat) and Figure 49 (right: NNO): Attitude frequencies on the level of trust.

6.3.8 Usability Constraints

The indicator for usability constraints measures participants' opinions on whether there are any contraints attached to the participation method, which could restrain themselves or others from participating. For assessing further detail, an additional question has been used as well, which is discussed in Section 6.6. When looking at the Zenostraat, mean and median values are equal towards both participation methods (Figure 32 and 33). It can be stated that the attitudes of the respondents on the statement concerning usability constraints are thus positive, since at least half of the respondents have agreed with the statement. The frequencies of the Zenostraat responses (see Figure 50) show a slightly variability. Both varability and central tendency show that in general for both participation methods no negative usability constraints are to be found, since the attitudes are considerably good.

Results for NNO show that mean and median value are higher for the public hearing than for the online PPGIS environment. The central tendency thus indicates highly positive attitudes towards the public hearing, and positive attitudes towards the online PPGIS environment. Frequencies show positive variabilities for both participation methods, though higher peaks can be found for the public hearing in category 4 and 5 (see Figure 51). Both central tendency and variability show similar results; i.e. usability constraints are hardly found in the public hearing and online PPGIS environment. Furthermore, no usability constraints were initially identified by the interviewees.

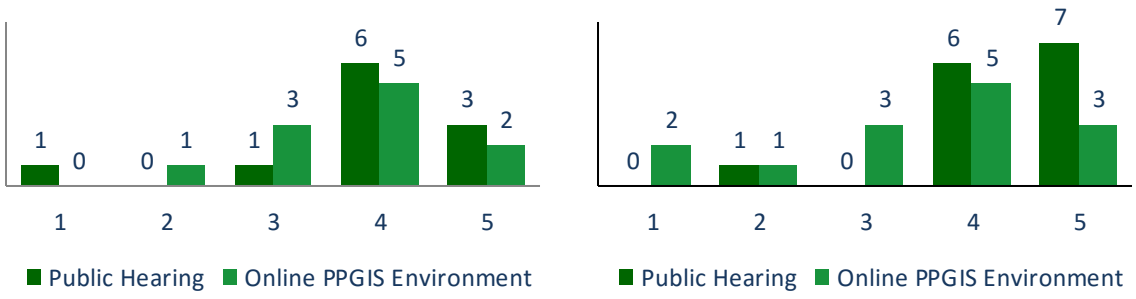


Figure 50 (left: Zenostraat) and Figure 51 (right: NNO): Attitude frequencies of the usability constraints.

6.3.9 Level of Participation

The level of participation was used to find out what role citizens think they take in the decision-making process by the use of one the participation methods. This usability indicator is not measured as Likert item, though will be analyzed by looking at frequencies, mean and median values as well. As shown in Figure 52 and 53, the levels of participation, which were presented as a list to the respondents, are shown with their frequencies. The levels range from no participation, to full citizen power. Therefore, the indicator to find the level of participation can be related to a combination of the participation ladder of Arnstein (1969) and the roles of public participation in decision-making by Kingston (2007). The following denotation can be used, to be able to link the values of the descriptive statistics to the correct category for the level of participation (see Table 15):

1 =	"no participation"	(1 – 1.49)
2 =	"information receiving"	(1.50 – 2.49)
3 =	"opinion giving, no further actions"	(2.50 – 3.49)
4 =	"opinion giving, as advice or consultancy"	(3.50 – 4.49)
5 =	"consensus"	(4.50 – 5.49)
6 =	"full citizen power"	(5.50 – 6)

Participation method per case study	N	Mean	Median	St. Dev.	Min.	Max.
Public Hearing Zenostraat	11	2,82	3	0,874	2	4
Online PPGIS environment Zenostraat	11	2,45	2	1,130	1	5
Public Hearing NNO	14	2,93	3	0,475	2	4
Online PPGIS environment NNO	14	2,43	3	0,756	1	3

Table 15: Descriptive statistics of the Level of Participation as usability indicator.

Results for the Zenostraat (see Figure 52) show that both methods have highest frequencies in the second lowest participation level, in which respondents feel as if they only take an information receiving role in the decision-making process. Subsequently, it can be compared to Arnstein and Kingston, for which both participation methods can be placed on one of the lower rungs of this ladder. When looking at mean scores in Table 15, the public hearing has a slightly higher average than the online PPGIS environment. Based on the mean scores, the public hearing would thus fall within the category 3: opinion giving, no further actions. The online PPGIS environment falls within category 2: information receiving. The same accounts for the central tendency when looking at the median values. The median value for the public hearing is higher than for the online PPGIS environment. It means that for the public hearing, at least half of the respondents feel as if they have a higher participative role than only receiving information, while

for the online PPGIS environment, at least half of the respondents feel as if they only have an information receiving participative role or less. The public hearing thus gives participants the impression that they have a slightly more active role in the participation process, although it still only comprises giving opinions. The results for the online PPGIS environment can partly be explained by the fact that there is no proof whatsoever that their opinions and ideas will indeed be used in the process. This is also one of the most common remarks given in response to the questionnaire. Further studies, analysis and practical usage in the spatial and urban planning field should are required to exclude these kind of uncertainties as felt by the respondents. Furthermore, it would help if urban planners are also open to public participation in the planning process by urban planners, as was indicated in the interviews.

Results for NNO show highest frequencies for both participation methods in the third participation level, in which respondents feel as if they are offered the opportunity to give their opinion in the decision-making process. However, no further actions with these remarks are expected. When looking at mean scores in Table 15, the public hearing has a slightly higher average level of participation than the online PPGIS environment. Based on the mean scores, the public hearing would fall within category 3: opinion giving, no further actions, while the online PPGIS environment falls within category 2: information receiving. The central tendency however, when looking at the median values shows that the median value is equal to both methods. Therefore, the central tendency towards both methods can be explained that citizens are allowed to give their opinions, however it is not expected that much will be done with these opinions. Reaching a higher level on the participation ladder could be a future goal for improvement of public participation methods used at the municipality.

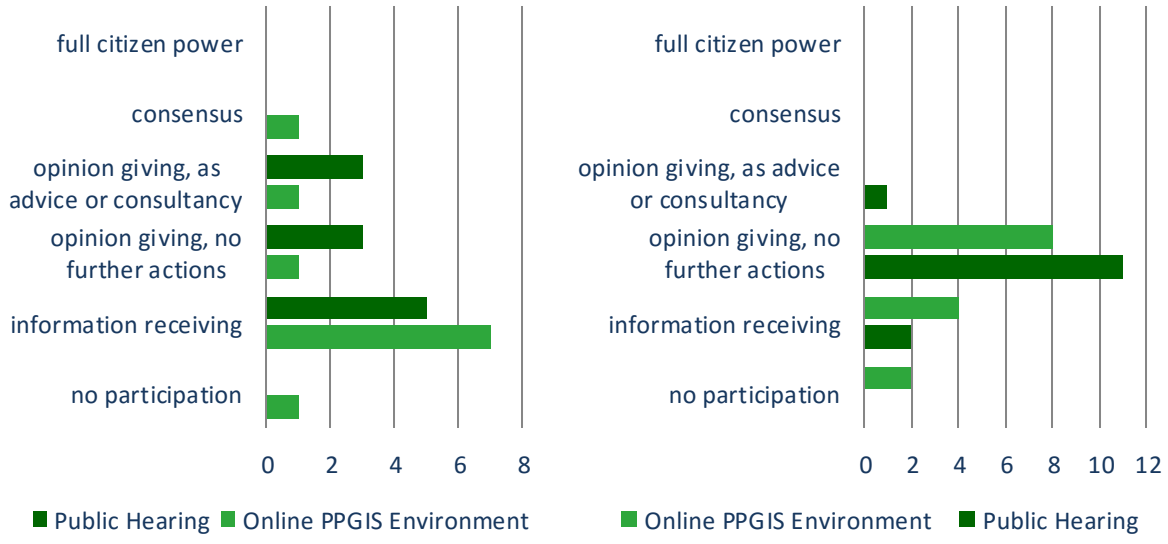


Figure 52 (left: Zenostraat) and Figure 53 (right: NNO): Frequencies for the level of participation for each participation method.

6.4 Usefulness scale

The descriptive statistics of both case study projects for the summated scores in the usefulness scale are provided in Table 16. Within the Zenostraat, the alpha for the public hearing items is above 0,7 while it is below this turning point for the online PPGIS environment items. These scores would indicate that for the public hearing, scale analysis would give more valuable results, than when doing so for the online PPGIS environment, as there is less internal consistency between the items and their answers for the online PPGIS environment. Furthermore, when looking at results of NNO, the public hearing and the online PPGIS environment both have an alpha above 0,8, which suggests that scale analysis is valuable for both participation methods, as they both have high internal consistency. For convenience, scale analysis will be done for all results.

In Table 16 it is shown for results of the Zenostraat that the mean value of the public hearing is slightly higher than for the online PPGIS environment. Both mean values indicate positive attitudes as they both fall in category 4 ("agree"). The central tendency thus shows positive attitudes towards the usefulness of each participation method in the decision-making and participation process, i.e. the process-fit. When looking at the variability, the standard deviation shows that the distribution of the attitudes lies closer to the mean value of the online PPGIS environment than to the mean value of public hearing.

Results for NNO show a higher mean value for the public hearing than for the online PPGIS environment as well. The central tendency is therefore slightly lower towards the online PPGIS environment, as respondents have neutral attitudes towards this method. Respondents have positive attitudes towards the public hearing. The variability, derived from the standard deviation again shows that attitudes lie closer towards the mean value of the online PPGIS environment than towards the mean value of the public hearing.

Participation method per case study	N	Mean	St. Dev.	Min.	Max.	Alpha
Public Hearing Zenostraat	11	3,75	0,892	2	5	,771
Online PPGIS environment Zenostraat	11	3,57	0,789	1	5	,688
Public Hearing NNO	14	3,54	1,206	1	5	,888
Online PPGIS environment NNO	14	3,09	1,083	1	5	,800

Table 16: Descriptive statistics and Cronbach's alpha for each method in the two case study areas.

The individual items within the usefulness scale are discussed in the next section, in respect to content of the items. These are the items: knowledge, involvement, efficiency and statements. For these items, sensitivity analysis is done, in order to estimate what respondents find important factors on participation in the decision-making process. Therefore, the usefulness items are analyzed for the unweighted data, and are compared to the mean and median values derived from the weighted data.

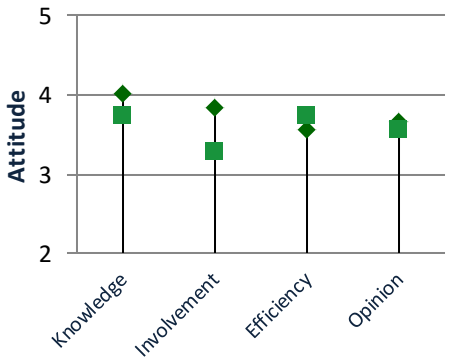
6.5 Usefulness items

When looking at the mean values of the Zenostraat project at first, the knowledge usefulness indicator has highest mean scores for both participation methods (Table 17). The mean value for the public hearing is slightly higher than for the online PPGIS environment, though both fall in category 4 ("agree"). Consequently, it can be said that the attitudes of the respondents for the knowledge indicator towards both participation methods are positive. It is interesting to see that for the Zenostraat, the efficiency indicator shows the lowest mean value for the public hearing, while highest for the online PPGIS environment. Still, both values fall in the fourth category ("agree"), indicating positive attitudes. The lowest mean value for the online PPGIS environment can be found for the involvement indicator, which indicates neutral attitudes.

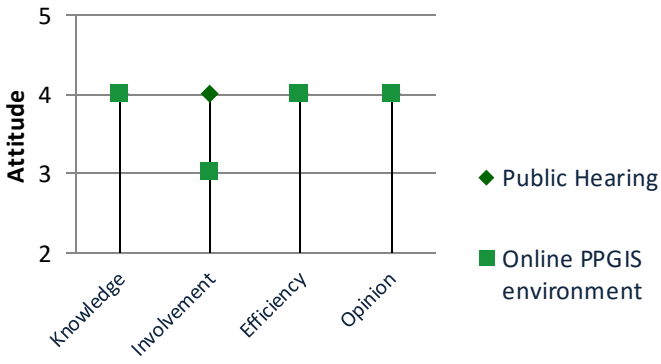
For the NNO project, highest mean values are found in the knowledge indicator, while higher for the public hearing than for the online PPGIS environment. These values indicate positive attitudes towards the public hearing, and neutral attitudes towards the PPGIS environment. Lowest mean values are found in the efficiency indicator, with again higher mean values for the public hearing than for the online PPGIS environment. Still, these values indicate neutral attitudes towards both methods. Table 17 and 18 give an overview of the descriptive statistics for the usefulness items for both case study areas. Furthermore, the Figures 54-57 show differences in mean and median for each usefulness item between the public hearing and online PPGIS environment, from which the two methods can be compared.

Usefulness Public Hearing	N	Mean	Median	Min.	Max.	*Importance factor (0-1)*	*Weighted mean*
Knowledge Zenostraat	11	4,00	4	2	5	*0,855*	*3,16*
Knowledge NNO	14	3,93	4	2	5	*0,843*	*3,01*
Involvement (consensus) Zenostraat	11	3,82	4	2	5	*0,873*	*2,86*
Involvement (consensus) NNO	14	3,71	4	1	5	*0,929*	*2,90*
Efficiency Zenostraat	11	3,55	4	2	5	*0,855*	*3,20*
Efficiency NNO	14	2,86	3	1	5	*0,900*	*2,33*
Opinion Zenostraat	11	3,64	4	2	5	*0,873*	*3,09*
Opinion NNO	14	3,64	4	1	5	*0,914*	*2,87*

Table 17: Public Hearing descriptive statistics of the usefulness items for each case study area, including their importance factor and weighted mean values.



Comparison of Mean values for usefulness scale between Public Hearing and Online PPGIS environment for Zenostraat

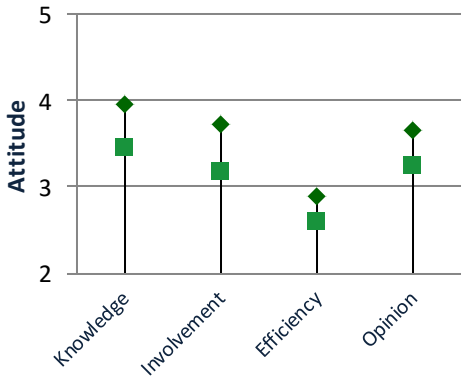


Comparison of Median values for usefulness scale between Public Hearing and Online PPGIS environment for Zenostraat

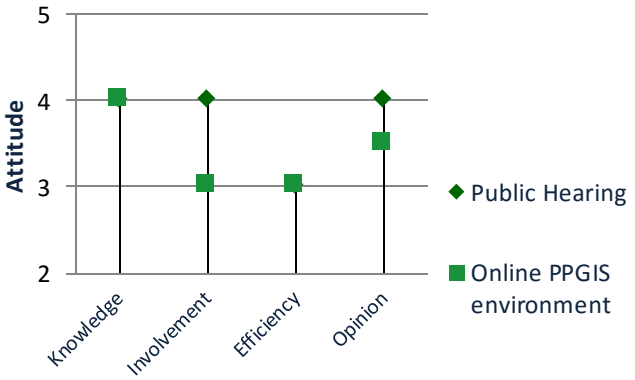
Figure 54 (left: Mean) and Figure 55 (right: Median): An overview of differences in mean and median values between the public hearing and the online PPGIS environment on the usefulness items for the Zenostraat.

Usefulness Online PPGIS environment	N	Mean	Median	Min.	Max.	*Importance factor (0-1)*	*Weighted mean*
Knowledge Zenostraat	11	3,73	4	3	4	*0,855*	*3,16*
Knowledge NNO	14	3,43	4	1	4	*0,843*	*3,01*
Involvement (consensus) Zenostraat	11	3,27	3	1	4	*0,873*	*2,86*
Involvement (consensus) NNO	14	3,14	3	1	5	*0,929*	*2,90*
Efficiency Zenostraat	11	3,73	4	3	5	*0,855*	*3,20*
Efficiency NNO	14	2,57	3	1	4	*0,900*	*2,33*
Opinion Zenostraat	11	3,55	4	1	5	*0,873*	*3,09*
Opinion NNO	14	3,21	3,5	1	5	*0,914*	*2,87*

Table 18: Online PPGIS environment descriptive statistics of the usefulness items for each case study area, including their importance factor and weighted mean values.



Comparison of Mean values for usefulness scale between Public Hearing and Online PPGIS environment for NNO



Comparison of Median values for usefulness scale between Public Hearing and Online PPGIS environment for NNO

Figure 56 (left: Mean) and Figure 57 (right: Median): An overview of differences in mean and median values between the public hearing and the online PPGIS environment on the usefulness items for NNO.

Table 17 and 18 show the average importance factor and the weighted mean value. The weighted mean value is calculated for the individually weighted scores for each respondent, which gives different results for the weighted mean than when using the averaged importance factor. The importance factor is therefore only shown to give an indication of the importance of an item, though it has not been used to calculate the weighted mean values. The mean and weighted mean values also have been plotted against each other, to visualize the differences between the two (see Figure 58 and Figure 59).

Firstly, it is noticed that all weighted mean values are lower than the unweighted mean values, which accounts for both participation methods in both case study areas. This can be explained mathematically, since the importance factor ranges between 0 and 1. Therefore, it implies that only if the importance of an item scores 100% (which is equal to the value 1), the weighted score will have the same mean value. Otherwise, the weighted mean value will be lower. However, the interesting things to notice from these figures are the differences between the two values. A large difference between the two values for a particular item would imply that respondents find this item less important in the decision-making process, and subsequently, a small difference would imply higher importance in the decision-making process. The highest and lowest differences have been depicted in respectively red and green, which show simultaneous results for the public hearing and the online PPGIS environment. Results from the Zenostraat give the largest differences for both participation methods for the knowledge item, while results from NNO show the smallest differences for both participation methods for the involvement item. However, the differences for each usefulness item not similar between the two case study projects.

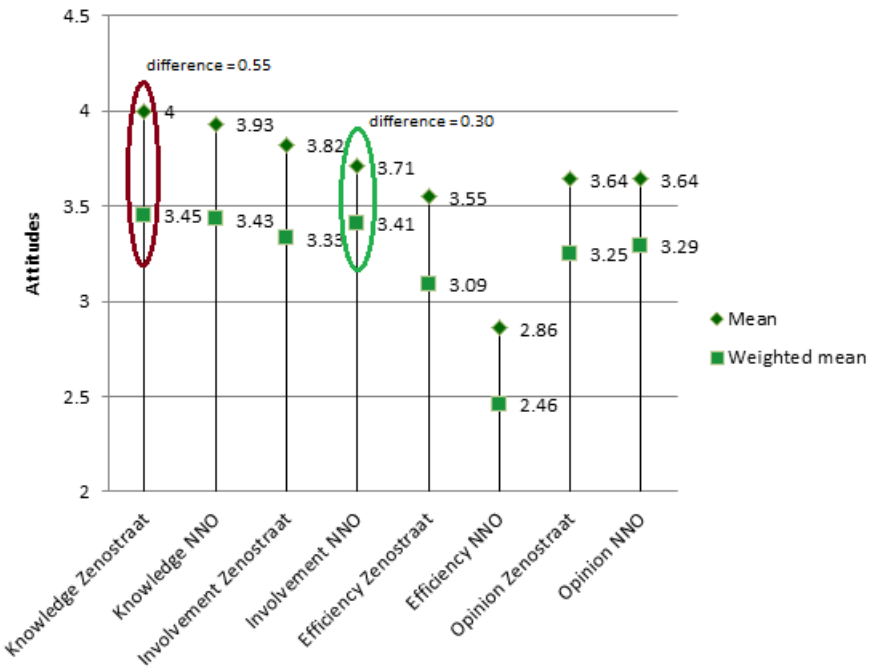


Figure 58: Differences between mean and weighted mean values for the public hearing.

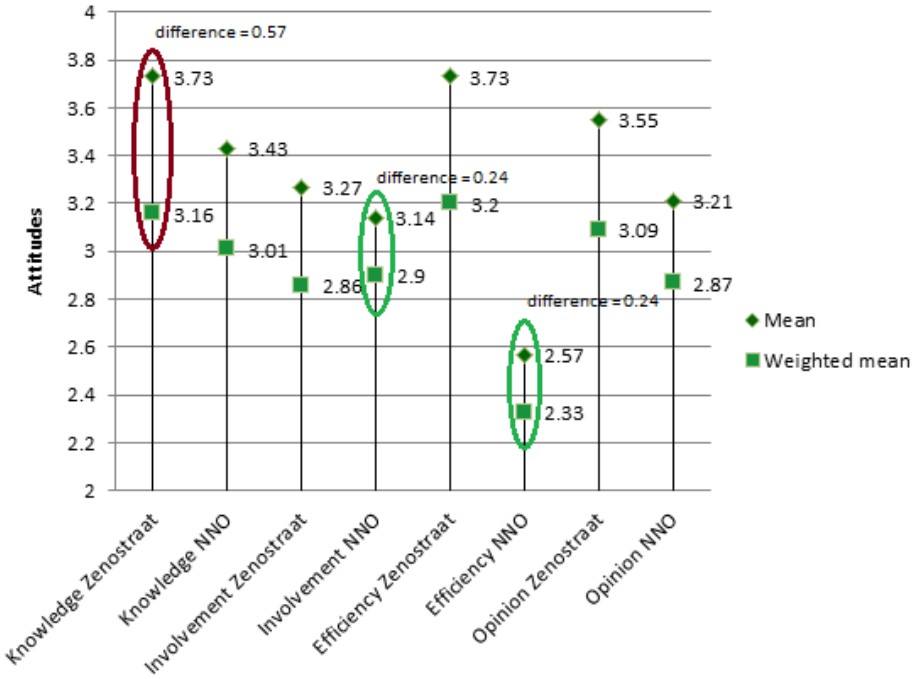


Figure 59: Differences between mean and weighted mean values for the online PPGIS environment.

6.5.1 Knowledge level

The knowledge level is used to estimate whether respondents find the participation method a good method gaining knowledge about the project during the decision-making process. The central tendency for the Zenostraat, shows similar mean and median values for each participation method (Figure 54 and 55). The central tendency is thus positive towards both participation methods; i.e. at least half of all respondents found the participation methods a good method for gaining knowledge during the decision-making process. Furthermore, the variability shows equal highest frequencies for the fourth category ("agree") (see Figure 60). Figure 58 and 59 show that the largest differences between mean values and weighted mean values are found for the knowledge level[3]. Therefore, this would indicate that although respondents have positive attitudes about the knowledge level towards both participation methods, it is of least importance to them for participating in the decision-making process.

Results for NNO also show higher mean values for the public hearing, though similar median values for both participation methods (Figure 56 and 57). It indicates that the central tendency of the unweighted data is positive towards both participation methods. Furthermore, it is derived from these median values that at least half of all respondents found the participation methods a good method for gaining knowledge during the decision-making process; i.e. the knowledge level during a planning process is sufficient. Furthermore, the variability analysis shows highest frequencies for the fourth category ("agree") as well (see Figure 61). Both central tendency and variability analysis thus show similar results for both participation methods. The largest difference between mean value and weighted mean value can also be found for the knowledge level for both participation methods[4]. Both imply that this indicator is of least importance to respondents in the decision-making process.

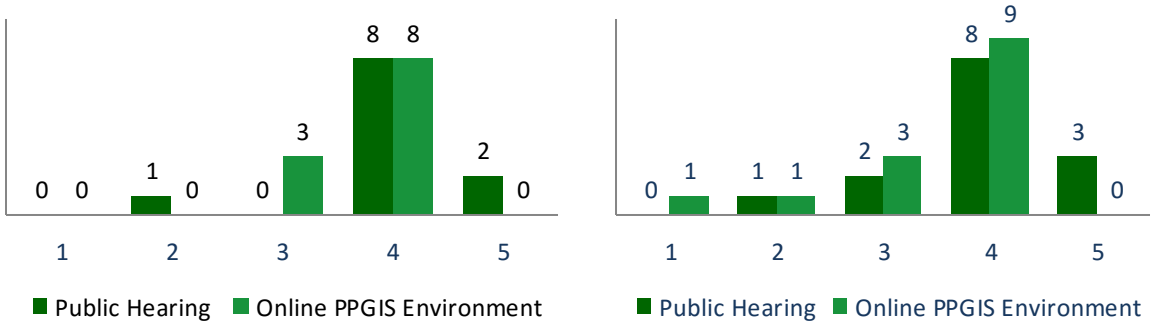


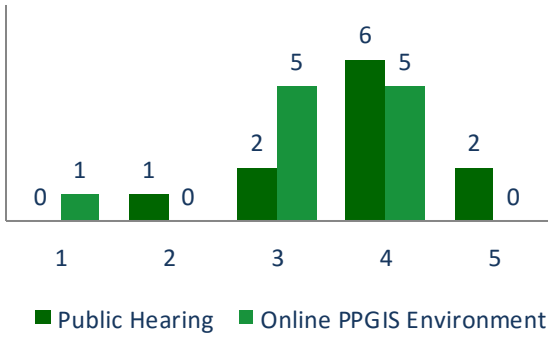
Figure 60 (left: Zenostraat) and Figure 61 (right: NNO): Attitude frequencies for the knowledge level.

[3] Difference = 0.55 for the public hearing and difference = 0.57 for the online PPGIS environment.
[4] Difference = 0,55 for the public hearing and difference = 0,42 for the online PPGIS environment.

6.5.2 Level of involvement

The level of involvement estimates how well the participation method provides ways for citizens to participate and reach consensus within the participating groups in the decision-making process. For the Zenostraat, results show higher mean and median values for the public hearing than for the online PPGIS environment (Figure 54 and 55). Therefore, it can be said that while respondents have positive attitudes towards their involvement within the planning process in participating in the public hearing, respondents have neutral attitudes towards this item in participating in the online PPGIS environment. The central tendency thus shows that at least half of the respondents have a neutral or more negative attitude towards the online PPGIS environment, while at least half of the respondents have positive attitudes towards the public hearing. The same accounts for variability; highest frequencies are found in category 4 ("agree") for the public hearing, while in category 3 ("neutral") and 4 ("agree") for the online PPGIS environment (see Figure 62). The difference between mean and weighted mean value is 0,49 for the public hearing and 0,41 for the online PPGIS environment. For the public hearing, this is the second largest difference to be found, though for the online PPGIS environment the difference is lower. This can be explained mathematically, since the higher the mean value, the larger the difference will be to the weighted value, since it is multiplied by the importance factor which lies between 0 and 1.

For NNO, the central tendency also shows higher mean and median results for the public hearing. It also shows that respondents have positive attitudes towards their involvement within the planning process in participating towards the public hearing, while respondents have neutral attitudes towards the online PPGIS environment. The variability shows highest frequencies in category 5 ("fully agree") for the public hearing in category 3 ("neutral") for the online PPGIS environment (see Figure 63). The difference between mean and weighted mean value is 0,30 for the public hearing, and 0,24 for the online PPGIS environment which are the smallest difference to be found (see Figure 58 and 59). These differences indicate that respondents from NNO find this item the most important measure for participation within the decision-making process.



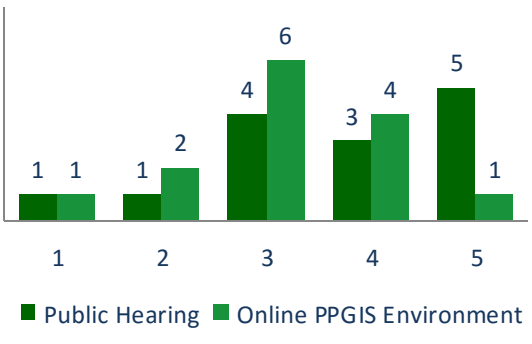


Figure 62 (left: Zenostraat) and Figure 63 (right: NNO): Attitude frequencies for the level of involvement.

6.5.3 Participation efficiency

The efficiency item explains whether participation within the planning process is found efficient by use of the participation method. For the Zenostraat, both participation methods have similar mean and median values, which indicate positive attitudes. Consequently, when looking at the variability, both participation methods show highest frequencies in category 4 ("agree") (see Figure 64). The difference between mean and weighted mean value is 0,46 for the public hearing, and 0,53 for the online PPGIS environment, of which no particular importance order is derived.

Results for NNO show similar mean and median values for both participation methods as well. The central tendency is neutral towards both participation methods. The variability shows highest frequencies in the third category ("neutral") (see Figure 65). Consequently, both central tendency and variability show that attitudes towards both participation methods are neutral in the efficiency of participation in the participation methods within the decision-making process. The difference between mean and weighted mean value for the public hearing is 0,40, while 0,24 for the online PPGIS environment. The fact that the difference is that low for the online PPGIS environment can be explained by the low mean value it initially had. It therefore does not indicate that respondents find participation efficiency most important within the decision-making process. In the NNO case study area, it is made clear that improvements can be made on participation efficiency as it was furthermore indicated by respondents that the content for the participation method did not match the desires and expectations of the citizens. This can also be a consequence of poor communication, which was repeatedly identified by the interviewees as the main problem in public participation within the municipality of Rotterdam.

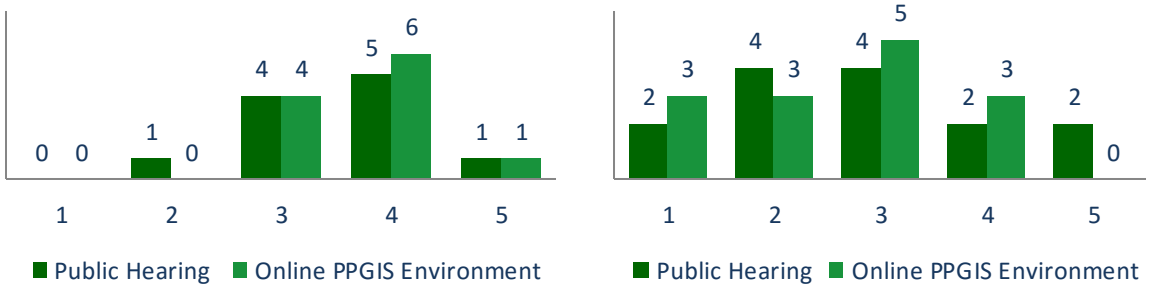


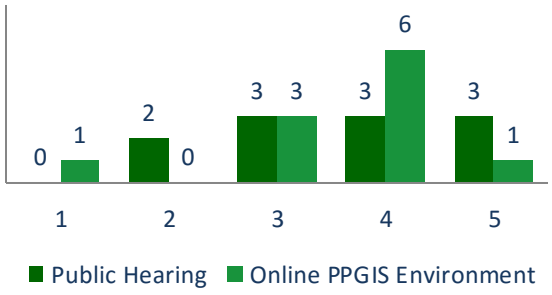
Figure 64 (left: Zenostraat) and Figure 65 (right: NNO): Attitude frequencies of the participation efficiency.

6.5.4 Statement

The last usefulness indicator was the item to estimate the possibilities given in the participation methods for providing a statement during the decision-making process. For the Zenostraat, both participation methods have similar mean and median values. The central tendency is thus equally positive towards both participation methods. The variety of responses shows a slightly positive distribution for the public hearing, while it shows a clear peak for the online PPGIS environment in category 4 ("agree") (see Figure 66). The Zenostraat results for the

statement item show for both central tendency and variability positive attitudes towards both participation methods. The difference between the mean and the weighted mean value is 0,39 for the public hearing and 0,46 for the online PPGIS environment. No particular importance order is derived from these values.

Results for NNO show slightly higher mean and median values for the public hearing than for the online PPGIS environment. Still, the central tendency is positive towards both participation methods, as at least half of the respondents have agreed to whether the participation methods provide enough possibilities for giving a statement or opinion during the decision-making process. The variability of responses shows a slightly positive frequency for both participation methods, with equal distributions for category 3 ("neutral"). The online PPGIS environment shows a clear peak for category 4 ("agree"). The central tendency and variety show positive attitudes towards both participation methods (see Figure 67). The difference between mean and weighted mean value is 0,35 for the public hearing and 0,34 for the online PPGIS environment. Again, no particular importance order can be derived from these.



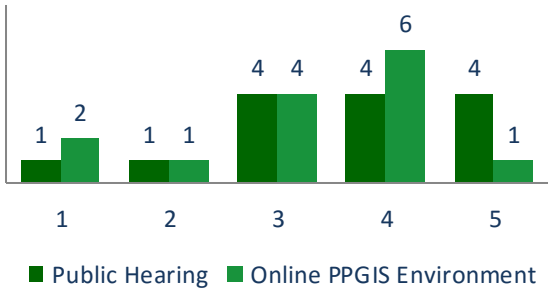


Figure 66 (left: Zenostraat) and Figure 67 (right: NNO): Attitude frequencies for the statement item.

6.6 Answers and reactions to the participation methods

Within the questionnaire, several open questions have been asked to the respondents. Furthermore, reactions have been given voluntarily to each participation methods as well. These answers and reactions are helpful in gaining further knowledge about peoples' attitudes and opinions towards the studied participation methods and their tools.

For the usability item 'usability constraints', an open question was asked for each participation method, to discover what these perceived constraints could be. Within the Zenostraat project, four responses were given in reaction to the public hearing, while six responses were given to the online PPGIS environment. Constraints for the public hearing consider the fact that the public hearing is bounded to one moment in place and time, in which it is hard to see small planning presentations or to get insight in plans. Constraints for the online PPGIS environment are about the fact that people need access to and have experience with computer and

internet. Furthermore it is not possible to ask clarifying questions and there is still limited information provided. Also, positive reactions towards the online PPGIS environment were given. These consider that there are no place and time constraints, and that a good overview of the situation is provided in which remarks can be given in reaction to the proposed plans. A critical comment concerns the ignorance of what will happen with these online reactions, which is associated to a low level of trust towards the participation method.

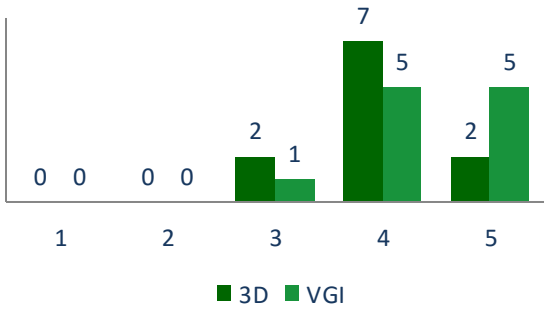
Within the NNO project, on the usability item 'usability constraints', five responses were given in reaction to the public hearing, while eight responses were given to the online PPGIS environment. Constraints for the public hearing are about the fact that the public hearing is taking too long due to too many details, resulting in a limited time for answering all public questions and thus to get a chance to speak. Furthermore, it is said that communication is poorly done by the municipality, especially to the citizens that were not present at the public hearing. Constraints for the online PPGIS environment considers the fact that there is no interaction with other citizens, and that it takes time to learn to work with the program and to read and understand the digital plans. It was also indicated that the 3D viewer was not working on specific internet browsers or on (mobile) devices, though this was specifically pointed out in the working instructions. Furthermore, it was stated that it is clear that the online environment offers many possibilities for participation if the municipality would not limit citizens in giving feedback by making the environment too structured. This latter remark could be very useful for future practice.

The online PPGIS environment used VGI and 3D visualizations as a tool. The added value of these tools are studied as well by the use of Likert scales, to show how well these tools are performing as participation tool, and what added value respondents think the tools have. For the Zenostraat project, the mean value for the use for 3D geo-information is slightly lower than for VGI. Both tools have equal median values, which means that respondents have positive attitudes towards the used technology tools. The frequencies are shown in Figure 68, which show a clear peak in category 4 ("agree") for 3D and a positive graph for VGI (see Figure 64).

For the NNO project, the mean value for the use of 3D geo-information also slightly lower than for VGI. Based on average values, both technology tool are thus considered useful in online participation. Looking at median values, the same conclusion can be drawn; both have equal median values, which indicate that respondents have positive attitudes towards the used technology tools. The frequencies are shown in Figure 65 for which highest frequencies can be found in category 4 ("agree") for the use of 3D geo-information and in category 4 and 5 ("fully agree") for the use of VGI, thus a positively skewed graph for VGI.

While both tools are found useful in using them in an online participation method, it was initially assumed by interviewees that 3D would be an important key in improving communication

from municipality towards citizens. Improvements thus need to be made to help citizens fully understand 3D visualizations, as it is shown not to be that easy as initially assumed.



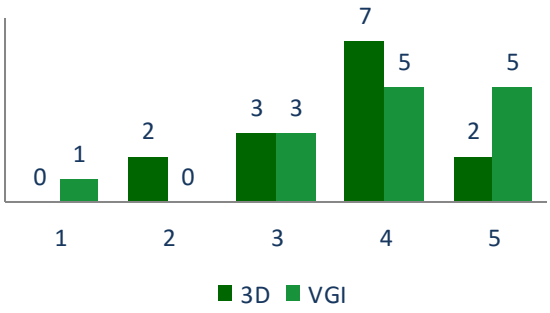
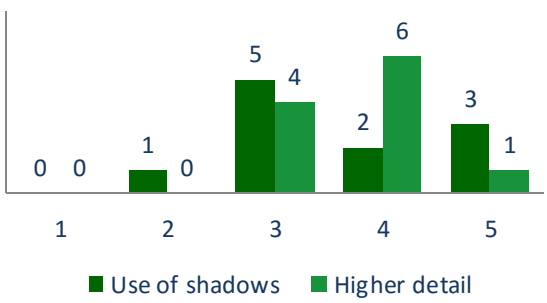


Figure 68 (left: Zenostraat) and Figure 69 (right: NNO): Attitude frequencies towards the used tools within the online PPGIS environment; 3D visualization and VGI.

Respondents gave their opinion on what the added value of both technology tools could be in their point of view. Within the Zenostraat project, nine answers were given towards the use of 3D, which mainly comprised that it was found useful for giving better insight in the plans on how it will look like in the future. For VGI, three answers were given. They mainly comprised that it was found useful to capture opinions, which are bounded to a location in order to prevent misunderstandings. For the 3D technology, further inside was asked to what extent shadows and a higher level of detail (LoD) could be used and is desired by respondents. For the use of shadows and the use of a higher level of detail, positive average responses are found. The median value for the use of shadows is however lower, which indicates more neutral attitudes. The median value for the use of a higher level of detail (LoD) indicates that higher detail would be appreciated. Frequencies are shown in Figure 70 and show similar results; highest frequencies for the use of shadows in 3D can be found in category 3 ("neutral"), while they can be found in category 4 ("agree") for the use of higher level of detail (LoD).

Within the NNO project, ten answers were given towards the use of 3D, which mainly comprise that it is found useful for giving better insight in the plans on how it will look like in the future, thereby making it more clear. Furthermore, it was stated that 3D is not a novelty anymore. Therefore it would be an obvious decision to make use of it in public participation. However, it was stated as well that more detail is needed in order to make those 3D visualizations useful for public participation. Furthermore, some respondents argued that they could imagine how future plans would look like perfectly fine by themselves, without the need for and use of 3D visualizations. For VGI, nine answers were given. They mainly comprise that it is found useful to capture opinions which are bounded to a specific location, which makes it possible to give remarks in an easier and more effective way than describing the problem on a public hearing. Also, it gives the feeling as to be seriously participating in the decision-making process and gives the possibility to enlarge

insight. However, most responses stated that the added value of the use of VGI for citizens shows off when it is made clear what will be done by the municipality with the collected responses. For the 3D technology, further inside was asked as well to what extent shadows and a higher level of detail (LoD) could be used and is desired by respondents. The use of shadows and the use of a higher level of detail both show positive responses. The median values for both 3D possibilities are equal and indicate that the use of shadows and the use of a higher level of detail (LoD) would be appreciated. Variability shows highest frequencies in category 5 ("fully agree") for both 3D possibilities (see Figure 71).



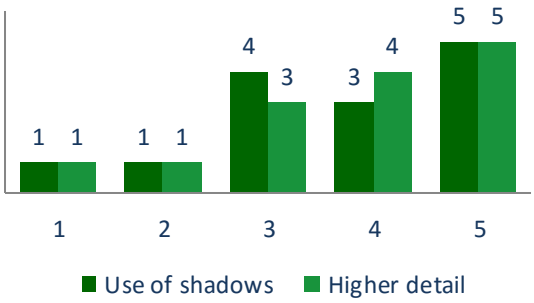


Figure 70 (left: Zenostraat) and Figure 71 (right: NNO): Attitude frequencies of possibilities for 3D visualizations regarding the use of shadows and the Level of Detail (LoD).

In the questionnaire, it was consequently asked how respondents would like to see the studied participation methods in practice. They had a choice out of four options: 1=only public hearing, 2=both public hearing and online PPGIS environment, 3=only online PPGIS environment or 4=other. Within the Zenostraat project, nine out of eleven respondents would like to see a combination of both participation methods in future decision-making processes. Two respondents chose option 4, of which one explained he would definitely want to see both participation methods as complementation of each other, though the timing of usage of them should be reconsidered. Since, as he stated, most plans already have no point for discussion any more by the time the municipality shows their plans to the public. The other respondent would like to see more regular consultation and meetings with citizens and municipality.

Within the NNO project, nine out of fourteen respondents would like to see a combination of both participation methods in future decision-making processes. Four respondents gave alternative options in addition to the use of both participation methods, such as introducing a delegation of the citizens group to work in a project group with other stakeholders, and giving feedback what will be done by the municipality with the given ideas and opinions.

As a closing of the questionnaire, respondents were asked for some final remarks. Within the Zenostraat project, four respondents gave these final remarks, of which two of these remarks were concerning the information which was provided in the 3D plans in the online PPGIS

environment. They expected that more information was provided. Furthermore, remarks concern the ignorance about what will happen with the VGI gained opinions and remarks, as it would be nice to get some reaction on them. Again, a relation can be made to the currently low level of trust towards the online PPGIS environment.

Within the NNO project, the final remarks on the questionnaire comprise that the online PPGIS environment is found useful, though not necessarily useful for all age groups. It is found an easy method to prove peoples' right, or gain insight in what citizens want. Furthermore, it is stated that the added value of the online PPGIS environment is evident for participation in the decision-making process, especially in addition to the public hearing. However, it was stated repeatedly that this project was rather not appropriate for doing research, since the citizens had other priorities considering the project plans, which has unfortunately been of influence to the amount and sort of the responses.

6.7 Conclusions

So far, results of both case study areas are described and analyzed. Of these results, it is interesting to make an overall conclusion by using advantages and disadvantages for public participation in the decision-making process, caused by the online PPGIS environment. As discussed in Section 3.2, Irvin & Stansbury (2004) have identified some of the main advantages and disadvantages of public participation in the decision-making process (see Table 2 and Table 3), which can be compared to the observed attitudes for the online PPGIS environment and public hearing. It was identified in the literature that the main disadvantages of a public hearing are the time and distance constraints. Similar disadvantages are observed for both case study areas for the public hearing, of which the main points are that it is bounded to one location and time, and that it is very time consuming. No time and distance constraints are observed for the online PPGIS environment. It is however indicated that constraints may concern availability of an internet connection, and that respondents feel that the method is pointless if the collected opinions and remarks are or will be ignored. The latter is similar to an identified disadvantage by Irvin & Stansbury (2004) to the decision-making process as well. An observed advantage for the public hearing encompasses the interaction with fellow-citizens and municipality, which is less possible via the online PPGIS environment. The main advantage for the online PPGIS environment is that public participation can be done online, in people's own time and in their own house. The use of both participation methods in the decision-making process can thus complement each other in advantages and disadvantages for public participation in the decision-making process.

7. DISCUSSION

The literature showed that applicability of present public participation methods does not always fit the usage and purpose within the decision-making process. This mismatch, often caused by time and distance constraints are observed at public hearings and traditional PPGIS methods. Furthermore, it shows an inefficient use of the participation methods, which could therefore be improved. This observation from literature matches the attitudes found towards the public hearing, while no time and distance constraints are found for the online PPGIS environment. Instead, novel constraints are observed such as accessibility of a web connection. Furthermore, it is found that this mismatch could partly be solved by improving the facilitation of participation, which is why VGI is identified as a public participation tool. The attitudes towards public hearing and online PPGIS environment are observed in two case study areas, which both have low amounts of responses. Therefore it is important to state that conclusions are made with care. It is observed from the literature that VGI can be used to provide efficient ways for letting citizens participate in the planning process. It is observed from results that VGI indeed can be used to facilitate participation in an efficient way, however it is not easy to use for all users. Moreover, the mismatch could be solved by improving communication towards citizens and between citizens and municipality, which is why 3D geo-information became identified by interviewees and the literature as a public participation tool. Poor communication from the municipality towards the public is furthermore the main identified problem from the conducted interviews. It was also shown in the literature that 3D visualizations can be used to ease understanding, thereby improving communication. Such positive attitudes are also observed in both case study areas. However, respondents indicated that the use of 3D geo-information is not per definition contributing to an easy understanding of the planning designs, as most citizens are not experienced in reading a map or a 3D environment. Communication can therefore exceedingly be improved if 3D is accompanied with textual explanations, easing the ways of understanding for citizens.

The most important theories on which this research is built, encompass the Ladder of participation (Arnstein, 1969) in combination with the identified roles of public participation in decision-making (Kingston, 2007), the decision-making process framework (Wu et al. 2010) and the added value framework (Pelzer, 2015; Pelzer et al., 2014). A combination of the ladder of participation and the roles of public participation in decision-making is used to observe citizen involvement in the decision-making process. It is shown to be a useful estimation for this purpose. The decision-making process is used as a general framework for the main steps in the planning process. The framework furthermore indicates desired interventions of public participation. Also, the framework is used to situate the case study areas beforehand within the decision-making

process, to observe whether the participation methods are desired in other parts of the process as well. From both case study areas it is observed that respondents find it valuable if the public hearing and online PPGIS environment would be used in other phases as well, which is a valuable lesson for the municipality of Rotterdam in itself. It was in fact stated by some of the interviewees that communication should not only be improved, it should also be increased. Thereby congeniality is found in applicability of public participation within the decision-making process. The added value framework is based on three variables; utility, usability and usefulness. Whereas Pelzer applies usefulness as a synonym of added value, it is found more valuable to explain added value from all three variables. Furthermore, indicators were used as assessment criteria for each variable, which are also derived from Pelzer's studies. After assessing the applicability of the indicators on both participation methods, some of the indicators were left out. Furthermore, it was observed that the provided variables and indicators in Pelzer do not have full coverage in studying online PPGIS in the decision-making process. Additional variables are therefore proposed in the study of online PPGIS, which are meant to (1) test the fit between citizens'- and municipality desires on the application of public participation; i.e. the before-design study, and (2) to test whether collected results are actually used by local authorities; i.e. the after-application study.

The used practice is focused on Likert scales, by which attitudes were observed on a scale from 1 to 5. It is found that many results within an indicator were slightly deviant between the two participation methods, though they resulted in similar assumptions. To be able to observe more differences between the studied participation methods, an attitude scale from 1 to 7 or 1 to 10 could be used instead. Furthermore, sensitivity analysis is performed on the usefulness scale, to see what indicators are of most importance to citizens. The importance level is derived from a Likert scale as well, which resulted in mathematical issues since the weighted results only match the unweighted results if a perfect score was given to the indicator. Therefore, it is shown that weighted results are lower for the unweighted results for each indicator. This study highly related on availability of case study areas, which unfortunately resulted in a low amount of responses. This low N, requires care for analysis and conclusions, but furthermore affects the empirical quality of this study. It could therefore be of interest if this study can be repeated in future research when a case study with a larger population becomes available.

The initial hypothesis stated that an online PPGIS environment can be of added value to the public participation in the spatial (urban) planning decision-making process. The hypothesis is tested by answering a couple of (sub)questions. The present and potential roles of (online) PPGIS, VGI and 3D geo-information are observed in the planning process. It is found that PPGIS is well-known in the decision-making process, though mainly focused on expert users instead of citizens. Furthermore, a shift is noticed from analogue to digital PPGIS, though the present use is mostly offline. VGI is well-known in the form of Open Streetmap, which is a completely voluntary practice.

In decision-making, facilitated-VGI could therefore be of potential value. This value has been studied before, though there is little evidence of present usage in the planning practice. In earlier studies, 3D geo-information has been proven to be of added value in communicating maps or designs, as it is easier to recognize the virtual environment. Furthermore, the use of 3D is upcoming; an increasing amount of local authorities work with 3D geo-information or are planning to implement it in their working process. The present use in public participation is however not found. It was observed in what ways these two participation tools (VGI and 3D) could be used to contribute to public participation in the spatial planning process. VGI is used as f-VGI, using the framework of Seeger (2008), in order to facilitate ways for participation, without time and distance constraints. 3D geo-information is used as a 3D scene, in which planning designs are presented. Locating the planning designs in a 3D virtual environment would enhance communication and understanding.

The advantages and disadvantages of the PPGIS environment have been derived from the questionnaire, from which comparisons are made with the public hearing. These are partly based on the added value variables (usability scale, and usefulness scale) and partly on open questions and further recommendations. Results show that the level of participation is estimated to be higher by the use of the public hearing than by the use of the online PPGIS environment, which is not consistent with initial assumptions. However, as respondents indicated repeatedly that it is unclear whether the collected remarks will be used in the continuation of the planning process, it is reasonable to assume for participants that the level of participation reaches no further than 'opinion giving, as advice or consultancy'. As indicated by Kingston (2007), trust is thus an important factor for the role of public participation in the planning process. Furthermore, in the interviews it was indicated that public participation is often not desired, especially not if it implies an increase of work to urban planners. This could be an important cause of the trust issues of citizens. If these uncertainties and trust issues can be removed in future usage, the role of public participation via the online PPGIS environment could potentially be estimated on a higher level.

Advantages of the online PPGIS environment are found in the online provision of planning designs or decisions. Therefore, time and distance constraints cannot be found, in comparison to the public hearing. Furthermore, positive attitudes towards the participation tools are found in which advantages are observed, such as interaction with other citizens for the public hearing, which is less possible in the online PPGIS environment. A feasible disadvantage of the online PPGIS environment is found if the municipality will not use or ignore the collected information in the proceedings of the planning process, thereby defeating its purpose. Therefore, trust should be gained. Furthermore, the online PPGIS environment should be matched to the participation preferences of the public at first, before applying it in the project's process. Therefore, the participation desires of municipality and citizens need to initially match each other, before the

technical design can be made. In the NNO project for example, the purpose of the online PPGIS environment did not match the preferences of the public, influencing the amount and attitudes of respondents.

The results are partly consistent with the initial expectations; it is not assumed that the online PPGIS environment would be better in every single variable and its indicator. It is assumed that primarily the questions related to the used participation tools, VGI and 3D GIS, in the online PPGIS environment would show indications of added value and would furthermore show a clear preference for the use of 3D geo-information. This is not per definition observed from both case study areas, since slightly higher results are observed for the use of VGI in both case study areas. This could be caused by the fact that not all planning designs required elements which could be shown in 3D, adding less value to the use of a 3D environment in comparison to a 2D map. It is however not consistent with observations from the literature and initially stated assumptions from interviews, as these indicated that even 2,5D visualization is already of added value in improving communication. Even though positive attitudes are observed for the use of 3D, it is expected for them to be higher. Furthermore, positive attitudes are observed towards the use of VGI in spatial planning, which is initially assumed and observed in the literature as well.

Results of the usability scale show positive mean attitudes for the Zenostraat towards both participation methods, with slightly higher values for the public hearing. The NNO project on average shows lower results than the Zenostraat project, with positive mean attitudes towards the public hearing and neutral mean attitudes towards the online PPGIS environment. The latter summated score was expected to be slightly higher, however due to the lacking fit of citizens' and municipality's desires, it is a legitimate inconsistency with the initial assumptions. The results for the usability items show more detail on the content of each usability indicator. For the public hearing, most results of both case study areas coincide with each other, however two deviating results are observed**.** These are the level of presentation and the level of detail, for which lowest mean attitudes are at NNO respondents for both indicators (see Table 13). These respondents indicate difficulties in understanding the planning designs on a digital map and environment, which serve as a possible explanation for the deviating results. For the online PPGIS environment, deviating results are observed for the level of interaction, for which the lowest mean attitudes is found at the NNO respondents (see Table 14). This indicator partly focuses on the use of VGI, thereby it is assumed that attitudes would be more positive. It is however indicated by these respondents as well, that the subject of VGI did not fit the desires and expectations of the citizens. Therefore, it is also concerned with a mismatch between citizens' and municipality's desires on public participation.

The usefulness scale also shows overall lower mean attitudes for the NNO project. Attitudes of Zenostraat respondents are positive to both participation methods in the decision-

making process, while attitudes of NNO respondents are positive towards the public hearing, and neutral towards the online PPGIS environment. Again, the public hearing has slightly higher results overall. The usefulness items show deviating results for the participation efficiency of the public hearing in the decision-making process, with lowest mean attitudes at NNO respondents. These lowest attitudes are again an issue of the mismatch of user desires. It is consistent with findings from the literature as well. For the online PPGIS environment, the same observation can be made for the participation efficiency, with again lowest mean attitudes of NNO respondents. The latter is however not consistent with initial assumptions. It can thus be argued that a fit between user desires is of remarkable importance to the added value and efficiency of the participation method.

This study focuses on a highly specific population, which resulted in a low amount of responses. Results, analysis and conclusions are therefore made with care. It was also highly challenging to find case study areas which was available include this research. Therefore, availability of the case study areas was the main case study selection criteria. It is of importance to keep in mind that findings are thus not representative for other parts of the municipality of Rotterdam. Conclusions can be used as advice, though they have to be handled with care if they are applied to other parts of the municipality. Furthermore, this study focuses on the citizen-user in finding added value of an online PPGIS environment. However, in order to gain a complete insight in the added value of an online PPGIS environment, expert-users should be included as well. Due to time limitations it was not feasible to do this two-side study. Moreover, due to time limitations as well, it was also not feasible to do a before-and-after study in order to observe added value in several phases of the decision-making process. This research is therefore limited in its wholeness. However, this study could be an interesting preliminary inquiry for further research on these topics, in specific if projects with higher population amounts are available. In fact, this idea for further research has been pitched at the urban development department of the municipality of Rotterdam, for which €10.000,- has been received to accomplish the research and change the current practice of involving the public in the planning process. Unfortunately, there is no one yet who wants to take on this task, which is again a problem of availability. It furthermore shows that the municipality of Rotterdam is aware of the need to change, though it is somehow lacking support. As a final remark, it is a limitation that it is unclear whether the collected results will be used in the continuation of the planning processes, resulting in trust issues in the effectiveness and participation level of the studied participation method.

This study gained insight into the use, applicability and added value of an online PPGIS environment to public participation in the planning decision-making process in a novel way. The results and conclusions are made on a small scale, but provide detailed knowledge of attitudes

towards the use and application of the proposed participation method and also produces some highly interesting perspectives and ways of thinking. Furthermore, it gives insight in the attitudes towards public hearings, which is a repeatedly used participation method by the municipality of Rotterdam. It thus not only provides an answer to the extent of the added value of an online PPGIS environment, it also shows how well the public hearing is performing and where improvements can be made. Some of the limitations which were identified for the public hearing, can hardly be improved by solely adjusting the public hearing. It therefore shows that highest added value can be found in the complementary usage of the public hearing and the online PPGIS environment, set in multiple stages of the decision-making process.

8. CONCLUSION

The present and potential role of public participation GIS (PPGIS) was shown to be present in spatial planning, though mostly analogue or offline tools can be identified. Furthermore, PPGIS is common in Planning Support Systems (PSS), of which the map table is a common example. The present participation tools mostly allow for the lower levels of participation of Arnstein (1969), in which citizens are informed about plans, while public opinions can be heard but not headed. A potential role for PPGIS in spatial planning can be found in improving ways of communications, for which the use of VGI and 3D geo-information was identified. A well-known example of VGI contributions is Open Street Map, in which maps are edited voluntarily by mostly non-experts. When applied in the decision-making process, contributions should be made according to a set framework. Thereby, facilitated-VGI has a better fit to its purpose. Social Media is also shown as an example of VGI, which is often used by local authorities to reach multiple users. However, due to big data characteristics it was not found useful in an online PPGIS environment. VGI shows the potential to allow low level ways to participate in the planning process. Furthermore, time and distance constraints can be reduced which are often found at public hearings and other traditional participation methods. Moreover, VGI could allow for more effective participation as it is made clear on a specific location what the remark, complaint or idea is about. On the other hand, 3D geo-information was found interesting as well, both in the literature and by interviewees. It is shown before that 3D can lead to better understanding of plans, as it is a better representation of the citizens' environment. This would lead to better communication towards citizens.

The studied online PPGIS environment made use of VGI and 3D geo-information. The planning designs could be accessed by citizens on a 2D map, on which they were allowed to place comments or give ideas. Furthermore, the planning designs were shown in a 3D environment, in order to create better understanding of the plans. The online PPGIS environment was tested in two case study areas which were available to this research; the Zenostraat and Noordelijk Niertje Oost. A questionnaire has been conducted in which attitudes were asked towards the online PPGIS environment and towards the public hearing which the respondents had visited on beforehand. Both case studies had low amounts of responses. The questions were based on indicators for the variables usability and usefulness, which together with utility form the framework of added value. The indicators and variables were derived from Pelzer, of which some additions were made in order to fit it to this research. Results showed that on the both scales, attitudes towards the public hearing were slightly higher than towards the online PPGIS environment. Moreover, each indicator showed a uniform pattern, though these values still indicate similar attitudes towards both methods. The usefulness scale had a slightly different approach, since sensitivity analysis had been included in this variable. Importance factors were used for each indicator, which could be used by

the difference between the mean value and weighted mean value of each indicator. The greater difference for an indicator towards each participation method, the less important the indicator would be in the decision-making process. The added value of the online PPGIS environment can be found as a complementary fashion to the public hearing in the decision-making process. Citizens appreciate the public hearing, though it was observed that some advantages are missing or disadvantages are found, which can be complemented by the online PPGIS environment. Disadvantages of the public hearing are time and distance constraints, while no time and distance constraints were observed at the online PPGIS environment as the planning designs and participation tools are provided online. On the other hand, citizen interaction was appreciated at public hearings, while these are less possible in the online PPGIS environment. These findings are consistent with initial assumptions. This research showed a novel way of applying the study of online PPGIS, which resulted in some interesting insights and perspectives. Furthermore, additional variables and indicators to the added value framework of Pelzer are identified for a complete assessment of added value of online PPGIS for public participation in the decision-making process. These comprise (1) the citizen-user and expert-user desires-fit, which is shown of remarkable importance towards participation efficiency, level of detail and level of presentation; i.e. the before-design study, and (2) the test for the use and implementation of collected remarks and ideas in the continuation of the planning process, in order to gain trust; i.e. the after-application study.

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Appendix I: Overview of the interviewees and summaries of the meetings

Name interviewee	Relevance to research	Date of interview
Karin de Goederen	Board level connections, knows what is going on at higher levels on public participation within the municipality of Rotterdam.	14-09-2015
Monique Groeneweg	Active in the areas of the municipality of Rotterdam. Lots of experience with public participation in planning projects, public hearings, etc.	14-09-2015
Rick Klooster	Founder of Future Insight, working on the 3D project in cooperation with the municipality of Rotterdam. Currently focused on a process based application of 3D visualization for internal users and public participation.	12-10-2015
Roeland van der Gugten	Urban planner, works at the urban development department, start of urban planning projects, architecture and design.	13-10-2015
Marijke Kooiman & Marco van Haandel	Active in the areas Feijenoord-IJsselmonde (Zuid-Oost). Public participation, connection to the citizens, knows what is going on at lower levels.	16-10-2015
Vesna Vitkovic	Site manager/ area director IJsselmonde, connections with project on 'de Veranda' concerning playground area.	05-11-2015

Table 19: Overview of the interviewees and their relevance to this research.

Karin de Goederen is an advisor in Stedelijk Beheer (SB) and she has insight in what is going on at higher decision levels within the municipality of Rotterdam. She has knowledge on what is preferred, concerning public participation. She explained that the municipality provides a lot of data – open data – of which the data content does not always align with the actual situation. She gave examples of this problem for the green areas within neighborhoods, for which she opted that citizens could be used to fill these 'gaps' via applications. She also gave examples of projects, in which public participation had a great share including applications in 3D. These projects were mainly concerning green areas, and the participation was mainly focussed on peoples' initiatives. Her focus was thus mainly on citizen initiatives and the use of public participation in enhancing the data quality of the municipality.

Monique Groeneweg is manager Openbare Werken (OW) in the cluster Stadsbeheer (SB), Centrum/Delfshaven. She has experience in working within the areas of the municipality of Rotterdam and has been directly in contact with the citizens. Therefore, she has knowledge of what is going on at citizen level, concerning public participation. The main problem she identifies is that the municipality should communicate more to the citizens. Furthermore, she stated that information and data should be more aligned with each other to make communication easier, even

within the municipality. Delfshaven was provided as an example of public participation with very active citizens. Her focus was also mainly on citizen initiatives as a type of public participation, and the fact that communication to citizens about planning projects should be more efficient.

Rick Klooster, is the founder of Future Insight; a company that shows the possibilities of all kinds of technologies to the municipality of Rotterdam. He is accountable for the communication between Future Insight and the municipality of Rotterdam concerning the Rotterdam 3D project, in which he has a great share. The 3D project is currently focusing on a new sprint, which concerns public participation. They will visit public hearings as well to gain insights in the opinions and perceptions of citizens on the use of a 3D GIS-based environment. Rick is a supporter of the use of 3D visualization, especially 3D GIS in spatial planning. His present focus is to use one 3D standard in the complete decision-making process, in which the opinion of the public needs to be included as well. He indicates the importance of analysing the added value of an online 3D GIS environment for public participation and usage in the planning decision-making process.

Roeland van der Gugten is originally a landscape architect and is currently working at the municipality of Rotterdam at *Ruimte & Wonen*, which is part of the department *Stads Ontwikkeling (SO)*. He is a *stedenbouwkundige,* and has therefore an important share in the planning decision-making process. Public participation is of influence in his work, since he, as an urban planner, needs to communicate his plans to the citizens of interest to gain the public opinion. As an urban planner (*stedenbouwkundige*), he also works a lot with 3D. The 3D visualization that is used by urban planners is however not 3D GIS, since it is mainly used as a communication tool. Public participation is described by him as a 'must' in the planning decision process. He also stated that an online participation tool would most certainly allow more people to participate in the planning process. More people indicates more opinions, which however could lead to an extra amount of work for the urban planners. His focus was therefore mainly on the effects of an online PPGIS (3D) environment for urban planners. Analysis of the added value of the planning tool in the planning process and usage of the citizen opinions are of importance.

Marijke Kooijman is area director at Feijenoord/IJsselmonde. She is not familiar with GIS but know GisWeb, which is a tool of the municipality of Rotterdam. Marco van Haandel was assisting Marijke in this conversation, he is also active in the area of Feijenoord/IJsselmonde. The main important problem they indicated, is that there is not enough support for citizen participation; communication could be better and participation should have a greater share in the planning decision-making process. Marijke also indicated that this is mainly the problem for spatial planning, since other projects show better results. The participation in planning could be improved, of which an online tool could be helpful in the planning process. She is interested in 3D,

however she cannot fully understand the meaning of this in public participation. An interesting project to which this research can be linked is given: de Veranda. This area has demand for playground for kids, for a couple of years now, however until now nothing has been agreed yet. Citizens cannot find any compromise with each other and with the municipality. Testing the tool on this project could maybe lead to something, thus added value can be proved.

Vesna Vitkovic works with Marijke Kooijman in the area Feijenoord/IJsselmonde and has been active in the project for the Veranda. She indicated that public participation is often not effective and sometimes even discouraging for both urban planners and citizens. She used the Veranda as an example, since these citizens had a lot of influence at higher levels in the municipality. Therefore, when the planning designs were likely to be approved, some citizens caused to make this decision undone. She furthermore opted that this project was not an ideal project to use as a case study in this research, as results might be influenced by previous experiences with the progression of the project.

Appendix II: Identification of participation methods used by the municipality of Rotterdam

Participation level	Participation method	Description of participation method
Consulting	Digital debates	Internet discussion via Queetz and internet forum. Goal: gather large amount of citizen opinions, to help shape the policy design.
	Surveys	Surveys via Google Forms or SurveyMonkey. Goal: gather opinions of representative amount of target group.
	Focus groups	Instrument to talk intensively with relatively small and homogeneous citizen groups. Goal: gain insight in opinions of different categories/groups of citizens.
	Public hearing and discussion	Public hearing has a central introduction, public discussion does not. Citizens get reaction of municipality board afterwards. Goal: gather responses of citizens for further plan design and development.
	Klankbordgroep	Fixed group of citizens for longer period of time, asked for opinions. Goal: gather opinions for design of new plans.
	Scenario method	Method for administrative unit (municipality, region, province, state) to construct different future scenarios. Goal: inform citizens on external processes and limitations, helps to enlarge the legitimacy of long-term policy.
	Schouw	Excursion (walking or cycling) at neighborhood, district or city level, together with politicians. Goal: to observe situations and talk with citizens.
	Councilmeeting	Local council organizes 1-2 times a year an informal meeting. Goal: parallel sessions about new policies.
	World café	Used for large groups in informal setting. Goal: have something to say.
Advising/ codecision	Expert group	Citizen group with expert level, for longer period of time. Goal: gain opinions and advice from experts.
	Citizen panel	Random citizen group, possible to set up digitally via OnzeWijk or NetQ. Goal: have something to say about policy issues, opinions are used for design of new plans.
	Rondetafelgesprek	Gathering of citizens once only. Goal: share thoughts and opinions on particular project.
	City debate	Combination of activities. Goal: gather citizens to gain as much as possible opinions and ideas about certain topic.
		Once only gathering of citizens, together with civil servants and politicians. Goal: work together on policy, based on knowledge, opinions and advices.
Co-production/ co-decision	Workshop studio	Participants have active role. Goal: make own design of certain area.
	Design workshop	Gathering of citizens that do not agree about certain topic. Goal: compromise, acceptable to all participants.
	Snelkookpan	Citizen group for longer period of time work together with civil servants and sometimes politicians on theme or product. Goal: unanimous result of product.
	Work group	Project group makes a plan and identifies different interests. Goal: consensus (win-win) for all stakeholders.
	Stakeholdermethod	Citizens take initiative. Goal: propose project idea, which has to be agreed upon in terms of implementation and budget.
	Project district program	Internet discussion via Queetz and internet forum. Goal: gather large amount of citizen opinions, to help shape the policy design.

Table 20: Identification of the participation methods used at the municipality of Rotterdam, classified to the levels in the ladder of citizen participation (Boomsluiter & de Rotte, 2013).

ICT enabled participation methods	Description of ICT enabled participation methods
Crowdfunding	Starting of a project in the neighborhood as citizen initiative.
Document sharing	In long term cooperation, documents can be shared via Dropbox or Google Docs instead of e-mails.
Movies and images	Easy and quick media sharing via Youtube (movies) or Instagram (images).
Digital co-creation	Smart techniques make it possible for citizens, entrepreneurs, etc. to work together on a city or street design. Joint sessions via www.socialimpact.nl

Table 21: Identification of the ICT enabled participation methods used at the municipality of Rotterdam. Important note: The ICT enabled participation methods are just meant as useful tools to enhance participation. It is therefore not classified to the levels in the ladder of citizen participation (Boomsluiter & de Rotte, 2013).

Appendix III: Questionnaire

(in Dutch)

Achtergrond informatie

***1. Wat zijn uw initialen?**

***2. Wat is uw geslacht?**

- Man
- Vrouw

***3. Wat is uw geboortedatum?**

Datum/tijd
DD/
MM/
JJJJ

***4. Waarom voelt u zich betrokken bij dit project?**

Communicatieve waarde

***5. De bewonersavond is een goede manier om plannen van de gemeente te communiceren**

1 Volledig mee oneens 2 3 4 5 Volledig mee eens

***6. De online omgeving is een goede manier om plannen van de gemeente te communiceren**

1 Volledig mee oneens 2 3 4 5 Volledig mee eens

Kwaliteit van de gepresenteerde plannen

***7. De plannen die gepresenteerd zijn op de bewonersavond zijn goed te begrijpen**

1 Volledig mee oneens 2 3 4 5 Volledig mee eens

***8. De plannen die gepresenteerd zijn op de online omgeving zijn goed te begrijpen**

1 Volledig mee oneens 2 3 4 5 Volledig mee eens

Flexibiliteit

***9. Een bewonersavond is ook van waarde in een eerdere of latere fase van het planproces**

1 Volledig mee oneens 2 3 4 5 Volledig mee eens

***10. De online omgeving is ook van waarde in een eerdere of latere fase van het planproces**

1 Volledig mee oneens 2 3 4 Volledig mee eens

Niveau van integratie

***11. Een bewonersavond is een nuttige manier om informatie, kennis en ideeën uit te wisselen over planontwerpen**

Volledig mee oneens 1 2 3 4 Volledig mee eens 5

***12. De online omgeving is een nuttige manier om informatie, kennis en ideeën uit te wisselen over planontwerpen**

Volledig mee oneens 1 2 3 4

Interactie niveau

***13. De bewonersavond geeft de gelegenheid gericht opmerkingen te plaatsen**

Volledig mee oneens 1 2 3 4 Volledig mee eens 5

***14. De online omgeving geeft de gelegenheid gericht opmerkingen te plaatsen**

Volledig mee oneens 1 2 3 4

Participatie niveau

***15. Hoe ervaart u uw rol in het planproces bij een bewonersavond?**

- U heeft helemaal geen inspraak
- U wordt van informatie voorzien
- Uw mening wordt gehoord, maar er wordt niet of nauwelijks iets mee gedaan
- Uw mening wordt gehoord, verwerkt en gebruikt als advies
- Onderhandelingen en bemiddeling vindt plaats
- U heeft totale inspraak. De macht ligt in handen van de bewoners

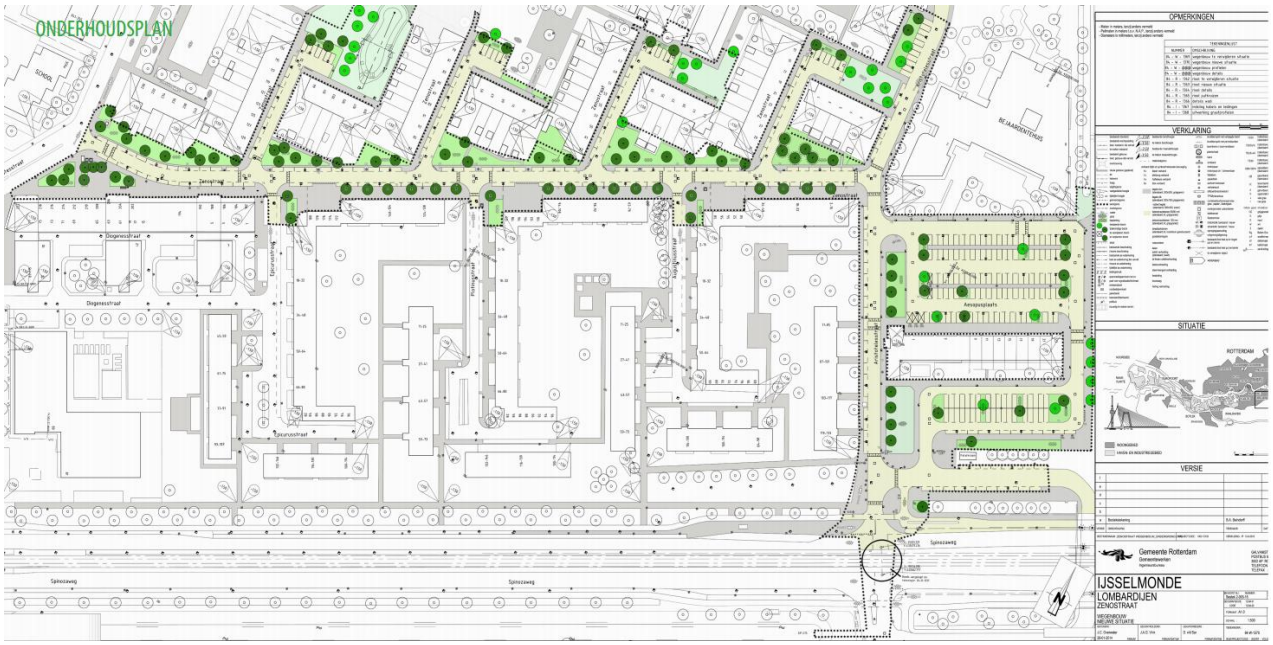
***16. Hoe ervaart u uw rol in het planproces bij de online omgeving?**

- U heeft helemaal geen inspraak
- U wordt van informatie voorzien
- Uw mening wordt gehoord, maar er wordt niet of nauwelijks iets mee gedaan
- Uw mening wordt gehoord, verwerkt en gebruikt als advies
- Onderhandelingen en bemiddeling vindt plaats
- U heeft totale inspraak. De macht ligt in handen van de bewoners

Detail niveau

Hieronder staan voorbeelden van een omgeving in 2D (platte kaart) en 3D (kaart met hoogte) om het verschil te kunnen zien.

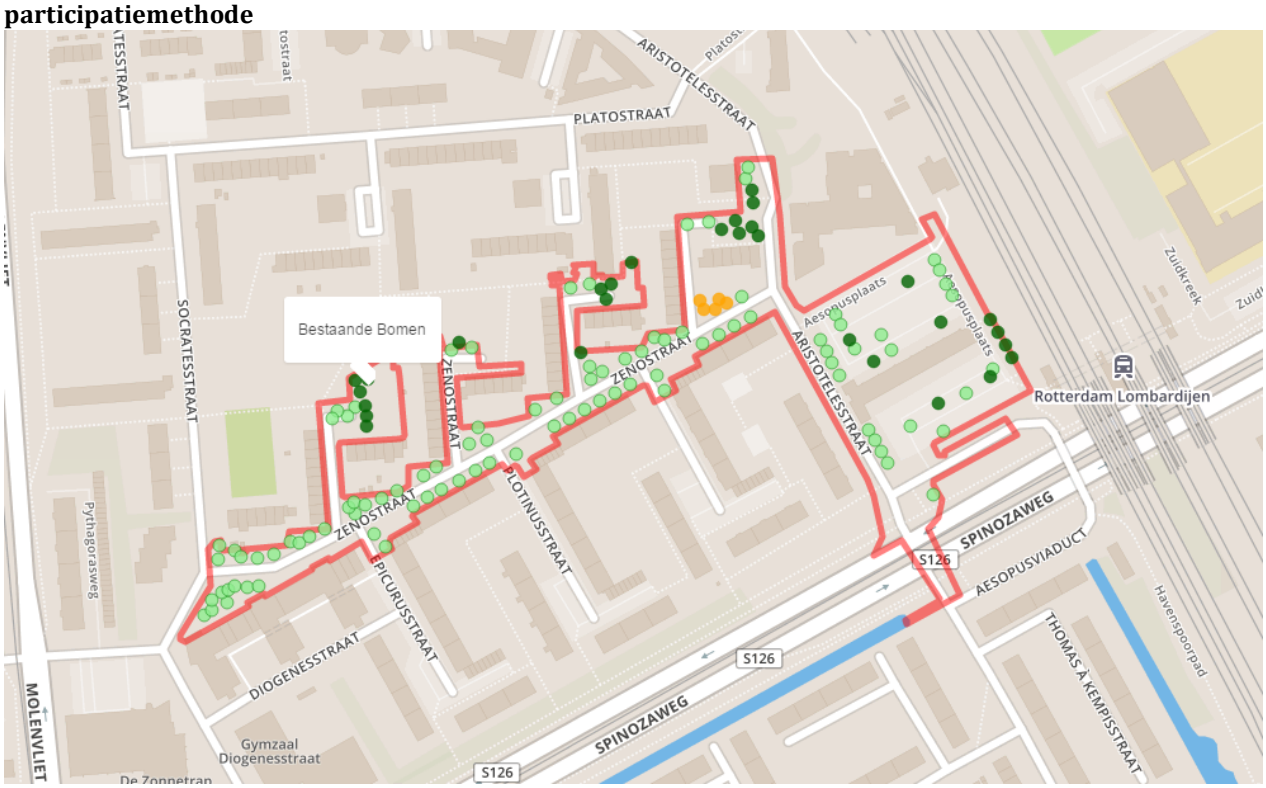
// Een voorbeeld van een 2 dimensionale (2D) omgeving; een onderhoudsplan zoals gebruikt tijdens de bewonersavond

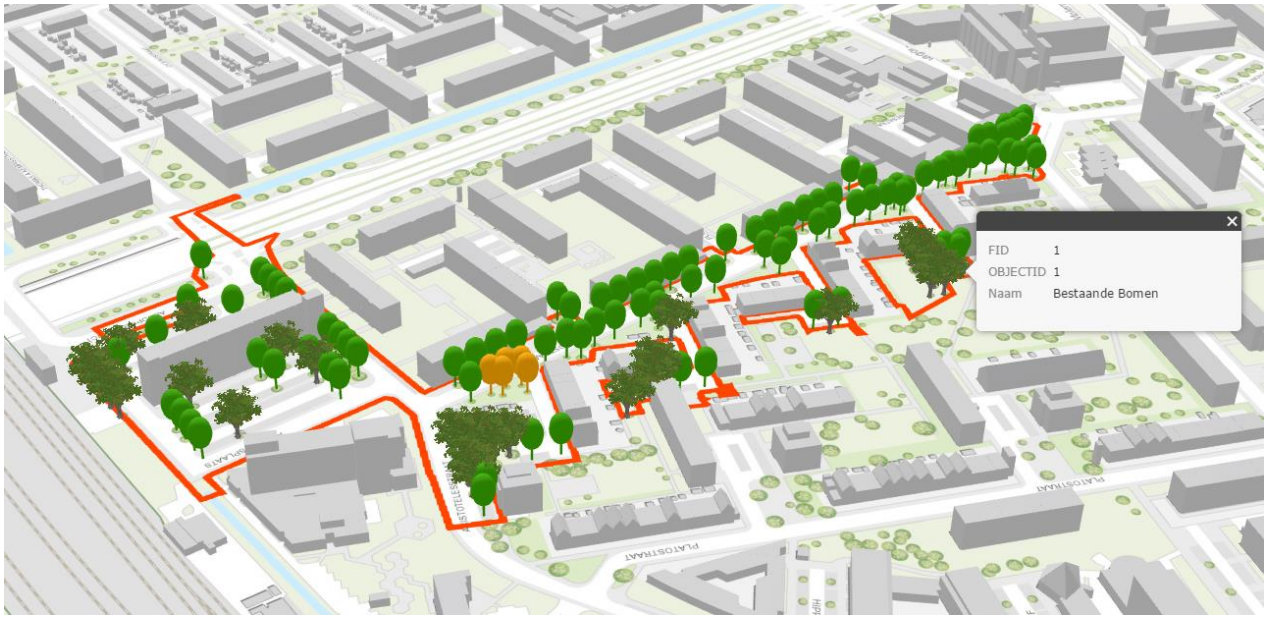


***17. De plannen worden op de bewonersavond in genoeg detail beschreven en weergegeven (overwegend in 2D).**

Volledig mee oneens				Volledig mee eens
1	2	3	4	5

// Een voorbeeld van een 2D en 3 dimensionale (3D) omgeving zoals gebruikt in de online participatiemethode





***18. De plannen worden op de online omgeving in genoeg detail beschreven en weergegeven (combinatie van 2D en 3D).**

Volledig mee oneens 1 2 3 4

Transparantieniveau

***19. De bewonersavond is een goede methode om gemeentelijke plannen inzichtelijk te maken**

Volledig mee oneens 1 2 3 4 Volledig mee eens 5

***20. De online omgeving is een goede methode om gemeentelijke plannen inzichtelijk te maken**

Volledig mee oneens 1 2 3 4

(Gebruiks)gemak om te participeren

***21. Ik ervaar geen drempels of problemen om deel te nemen aan een bewonersavond**

Volledig mee oneens 1 2 3 4 Volledig mee eens 5

22. Indien van toepassing, kunt u een voorbeeld geven van drempels of problemen die u zou kunnen ervaren bij eenbewonersavond?

***23. Ik ervaar geen drempels of problemen om deel te nemen aan de online omgeving**

Volledig mee oneens 1 2 3 4 Volledig mee eens 5

24. Indien van toepassing, kunt u een voorbeeld geven van drempels of problemen die u zou kunnen ervaren bij deonline omgeving?

Nut van de participatiemethode

***25. Op een schaal van 1 tot 5, hoeveel waarde hecht u aan de volgende punten?**

	Helemaal geen waarde 1	2	3	4	Heel veel waarde 5
Het vergaren van kennis over gemeentelijke plannen	○	○	○	○	○
Betrokkenheid in het planproces	○	○	○	○	○
Efficiënte aanpak van participatie in het planproces	○	○	○	○	○
Mogelijkheid om uw standpunt te laten blijken	○	○	○	○	○

Welk van de volgende punten zijn van toepassing op de participatiemethoden?
Vul afwisselend de opties 'bewonersavond' en 'online omgeving' in op de plaats van (...)

***26. De (...) draagt bij aan het vergaren van kennis over gemeentelijke plannen**

	Volledig mee oneens 1	2	3	4	Volledig mee eens 5
Bewonersavond	○	○	○	○	○
Online omgeving	○	○	○	○	○

***27. De (...) draagt bij aan het gevoel van betrokkenheid in het planproces**

	Volledig mee oneens 1	2	3	4	Volledig mee eens 5
Bewonersavond	○	○	○	○	○
Online omgeving	○	○	○	○	○

***28. De (...) draagt bij aan efficiënte participatie in het planproces**

	Volledig mee oneens 1	2	3	4	Volledig mee eens 5
Bewonersavond	○	○	○	○	○
Online omgeving	○	○	○	○	○

***29. De (...) biedt een mogelijkheid om uw standpunt te laten blijken**

	Volledig mee oneens 1	2	3	4	Volledig mee eens 5
Bewonersavond	○	○	○	○	○
Online omgeving	○	○	○	○	○

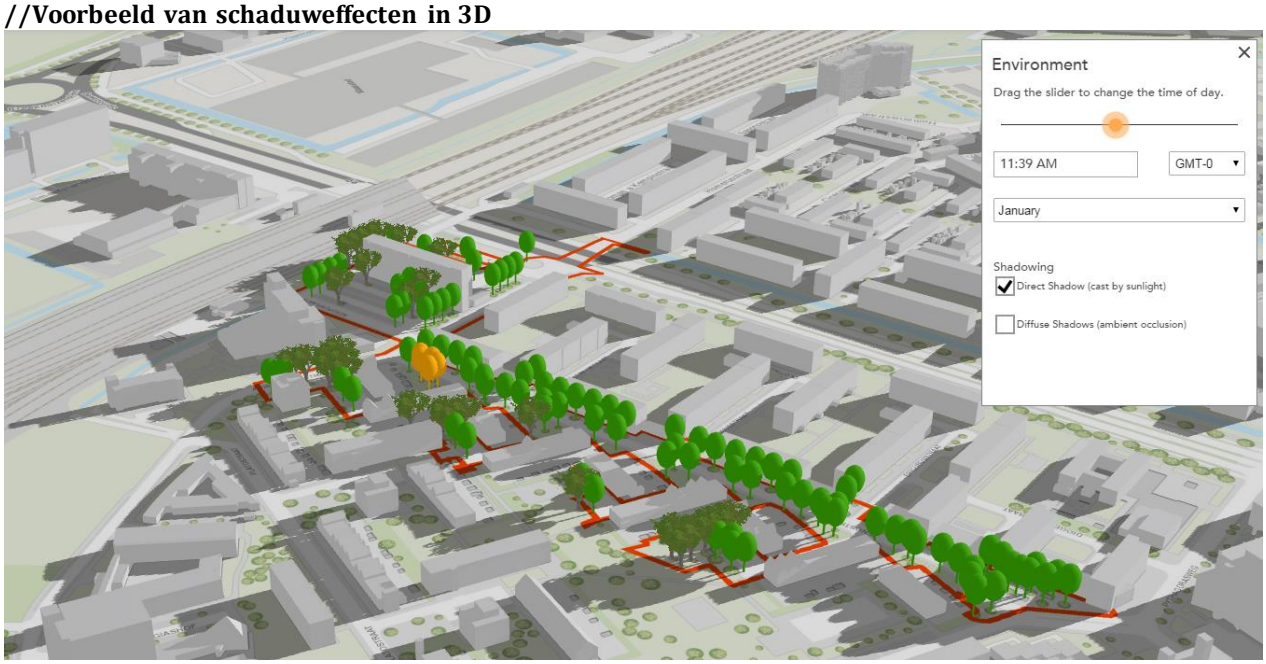
Toegepaste vragen op de online omgeving

***30. De plannen in een 3 dimensionale omgeving (3D; kaart met hoogte) zijn van toegevoegde waarde**

Volledig mee oneens	2	3	4	Volledig mee eens
1				5

31. Waarom vindt u een 3 dimensionale omgeving wel of niet van toegevoegde waarde?

//Voorbeeld van schaduweffecten in 3D



32. Het kunnen bekijken van schaduweffecten is van toegevoegde waarde

Volledig mee oneens	2	3	4	Volledig mee eens
1				5

33. Een hoger detail niveau van de 3D weergave is van toegevoegde waarde

Volledig mee oneens	2	3	4	Volledig mee eens
1				5

***34. Het kunnen plaatsen van opmerkingen of wensen op een kaart is van toegevoegde waarde**

Volledig mee oneens	2	3	4	Volledig mee eens
1				5

35. Waarom vindt u het plaatsen van opmerkingen op een kaart wel of niet van toegevoegde waarde?

***36. Hoe ziet u het gebruik van de participatiemethodes in het planproces voor zich?**

- De bewonersavond als de enige methode
- De bewonersavond en online participatiemethode als aanvulling op elkaar
- De online participatieomgeving als enige methode
- Anders, namelijk:

Appendix IV: The results of collected opinions, remarks and ideas from the online PPGIS environment for project Zenostraat

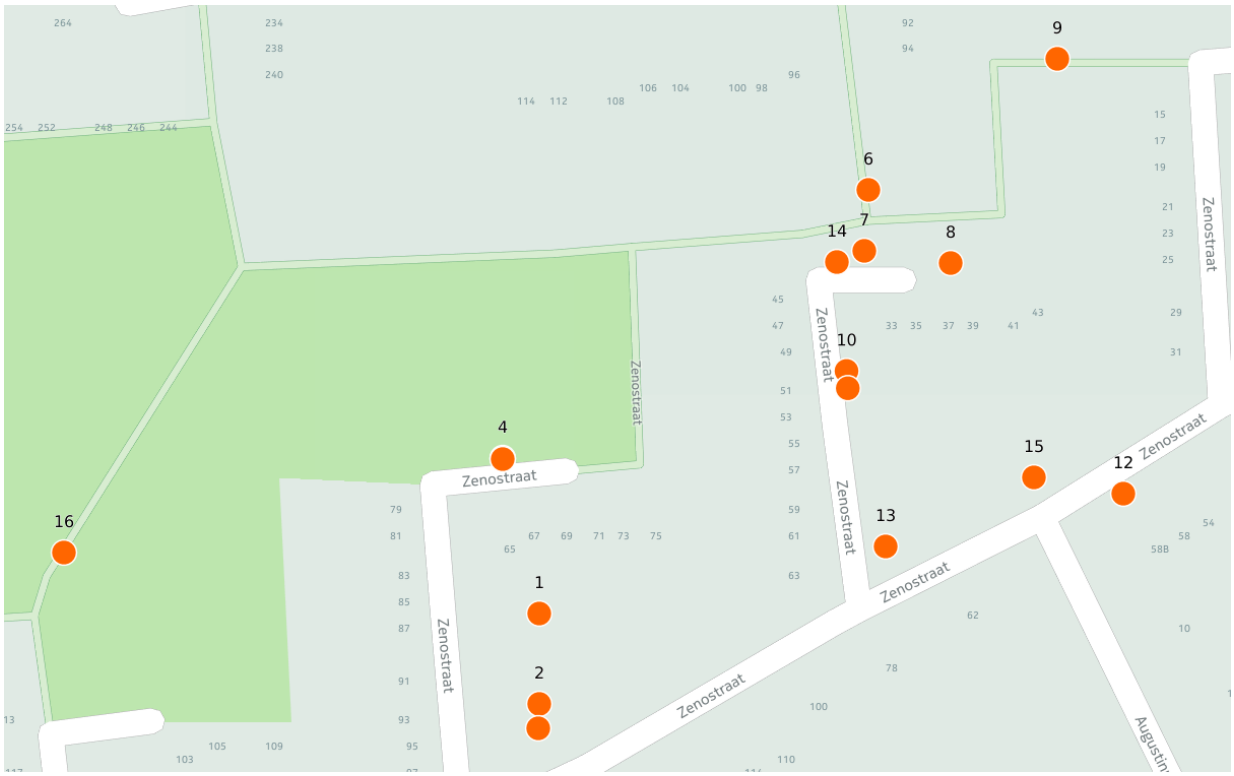


Figure 72: Map of the collected opinions, remarks and ideas of the citizens.

cartodb_id	name	description	item
1	JdM	Hier kom je vanaf een achterpad op de rijweg. Hier mag dus geen parkeerplek komen. Doe een holletje voor een fiets of brommer motor. Dit betreft alle hofjes!!	remark
2	E.B.	Hier staat ook nog een boom, wat gebeurd hier mee?	remark
3	JdM	Hier lopen voetpaden die echt meegenomen moeten woorden in de ophoging.	remark
4	E.B	Ik krijg mijn andere opmerking niet weg maar hier staat de boom	remark
5	E.B.	Hier ligt nog een voetpad, aangelegd door de gemeente maar staat niet op de kaart	remark
6	JdM	Met weghalen van de stoeprand en de put, zal de heg loskomen van de grond. Wie betaald een nieuwe haag?? Dit is in alle hofjes het geval!!	remark
7	E.B.	Hier staat nog een haag	remark
8	PW	Dit pad moet meegenomen worden met op ophoging. (of kaplaarzen verstrekken aan de bewoners)	remark
9	JdM	Met weghalen van de stoeprand en de put, zal de heg loskomen van de grond. Wie betaald een nieuwe haag?? Dit is in alle hofjes het geval!!	remark
10	JdM	Hier staat een boom, die het voetpad omhoog drukt. Boom moet weg, vind ik.	remark

11	JdM	Deze 2 bomen zijn jaren geleden al weggehaald.	remark
12	JdM	De ondergrondse container met de omringende stoepranden zakken weg door de zware vuilniswagen. Is hier een stevige fundering voor te bedenken	remark
13	JdM	Deze 3 bomen zijn weg,en in goed overleg met stadsbeheer op een andere plek kleinere bomen geplaatst	remark
14	JdM	Hier moet een verzamelplek komen voor kliko bakken. Vuilnis en papier. Steltonplaten en een hekwerkje eromheen?? Dit geld voor alle hofjes	remark
15	JdM	Ook op het hofje een belijning aangeven, waar te parkeren!! Maak een slim voorstel? Vaak wordt er rommelig geparkeerd!!	remark

Figure 73: Legend to the map of the collected opinions, remarks and ideas.

Appendix V: The results of collected opinions, remarks and ideas from the online PPGIS environment and preferences for the traffic access scenarios for project NNO

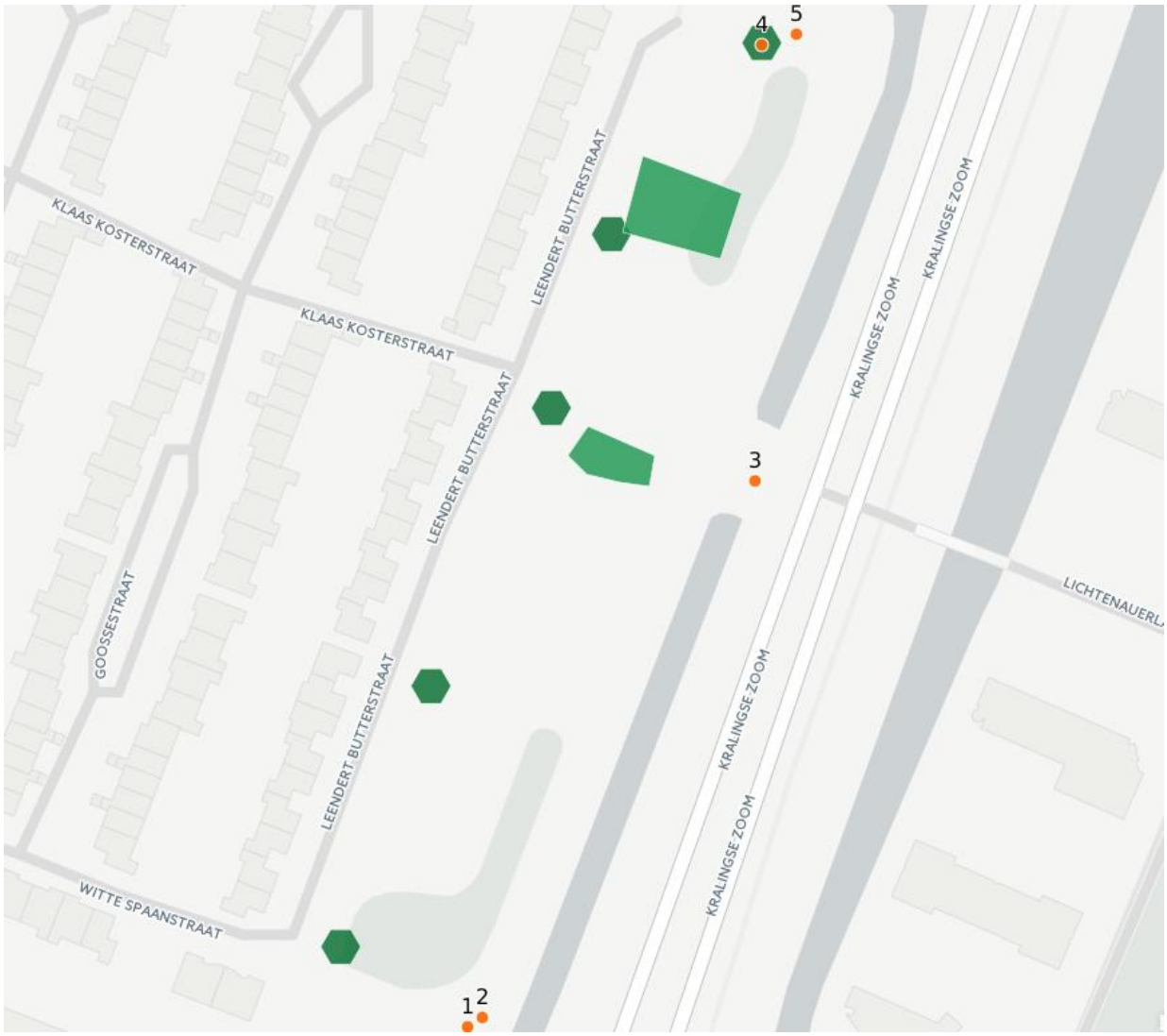


Figure 74: Map of the collected remarks, green areas and tree locations.

cartodb_id	name	description	item
1	FH	Voetgangersdoorgang naar bruggetje moet blijven bestaan.	remark
2	FH	Voetgangersdoorgang naar bruggetje moet blijven	remark
3	WK	Dit is de beste plek voor ontsluiting van de nieuwe wijk.	remark
4	WK	Door in het projectplan uit te gaan van een significant kleiner aantal woningen in een hore prijssegment zal de buitenruimte (zowel publiek als privaat) een veel groener karakter hebben en op die manier maximaal bijdragen aan de ervaren leefkwaliteit van de bewoners van de wijk. Dit dient uitgangspunt te zijn van de plannen. Een dergelijk plan kan gemakkelijk in de huidige markt worden uitgezet.	remark
5	WK	hore ==> hoger	remark
6	FH	-	greenarea
7	M	geen voorkeur	greenarea
8	-	-	tree
9	FH	Abeel	tree
10	FH	abeel	tree
11	M	kastanje	tree
12	m	geen voorkeur	tree

Table 22: Legend to the map of remarks, green areas and green locations.

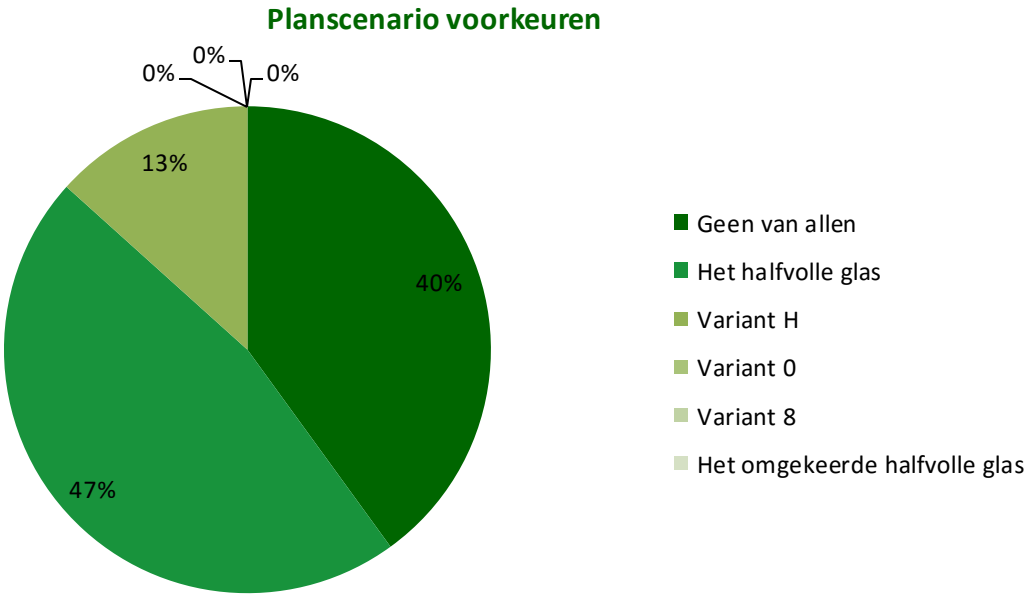


Figure 75: Preferences for the presented traffic access scenarios. Only two scenarios have got votes of the citizens. Others preferred none of the presented scenarios.

ID	Initialen	Geslacht (1=man; 2=vrouw)	Betrokkenheid bij project
1	c.j.m. S	2	Wij wonen hier al ruim 20 jaar.
2	J.E.	1	Het gaat om mijn wijk
3	J.E.	1	Betrokken bij wat er in mijn wijk gebeurt
4	M	2	Ons huis grenst - met de wetering als natuurlijke grens - aan het plangebied
5	L.F.E.	2	OMDAT IK ER WOON
6	JDP	1	Bewoner
7	M	2	Omdat het plan zonder participatie van bewoners wordt gerealiseerd.
8	WK	1	Ik wil de bestaande woonkwaliteit in de wijk zo veel mogelijk behouden. Ik heb het idee dat de gemeente niet primair maximaliseert op ervaren woonkwaliteit van de bewoners, maar op financieel gewin. Daar wordt niet open over gecommuniceerd.
9	RWF	1	wijkbewoner
10	X	1	Bewoner
11	BL	1	Omdat de ontsluiting niet geschikt is via dit bestaande wijk door het alsmaar toenemende verkeer op de slappe onderliggende veen grond, ons huis staat nu al te dreunen bij het passerende verkeer en abnormale afmetingen van passerende vrachtwagens o.a. container, verhuiswagens, shuffles, vracht wagens met zand die nauwelijks door bocht kunnen en wel drie maal moeten steken, en als dit niet lukt in de achteruit versnelling terug komen rijden. Ons huis vertonen nu reeds al scheuren in de binnen muren. Kort geleden is zelfs door de verzakking van de straat, een buis van de stadsverwarming gebroken, waardoor wij in de kou moesten zitten.
12	d.j.h.	1	buurt bewoner
13	E.S.	1	Wij wonen in de Leendert Butterstraat; de eventuele nieuwbouw gaat de kwaliteit van wonen beïnvloeden;
14	FH	1	Ik woon ik de Leendert Butterstraat
15	RS	1	Bewoner van de Leendert Butterstraat

Figure 76: Table which shows what citizens have participated to the traffic access preferences question, showing their connection to the planning project.

ID	Voorkeur planscenario's	Uitleg
1	7 – Geen van allen	Meest logische lijkt mij een ontsluiting vanaf de Kralingse zoom.
2	4 – Het halfvolle glas	Sluit beter aan op bestaande situatie
3	4 – Het halfvolle glas	Sluit best aan op bestaande situatie
4	1 – Variant H	meest logische oplossing; bovendien voor onze situatie de meest aantrekkelijke
5	7 – Geen van allen	het onderzoek is onzorgvuldig gedaan. Als je een foto neemt op het toevallige moment dat er weinig auto's staan en dan gaat zeggen dat het helemaal geen probleem is !!!!!! die verkeersman is niet capabel
6	4 – Het halfvolle glas	De verkeersontsluiting dient in samenhang met de algehele ontwikkeling bekeken te worden.
7	4 – Het halfvolle glas	De Leendert Butterstraat moet zeker doodlopend blijven zoals alle straten in de wijk!
8	1 – Variant H	mijn voorkeur is ontsluiting via Kralingse zoom, zoals ook al is toegezegd door wethouder deelraad. Van de gepresenteerde varianten vind ik de H versie het beste, omdat de klaas koster straat het beste verkeer kan afvoeren (geen aanliggende woningen)
9	4 – Het halfvolle glas	geeft toegang via twee bestaande wegen; ontziet ringvaartoever
10	4 – Het halfvolle glas	De verkeersontsluiting zal in zijn geheel bekeken moeten worden.
11	7 – Geen van allen	Geen onsluiting via Noordelijk Niertje West
12	7 – Geen van allen	ontsluiting moet komen op Kralingse Zoom
13	7 – Geen van allen	zoals op de bewonersavond aan de orde is geweest hangt dit af van de eventuiele bouwplannen
14	4 – Het halfvolle glas	-
15	7 – Geen van allen	Situaties gaan er allemaal vanuit dat er krampachtig twee rijen huizen gebouwd moeten worden. Daar zijn we het niet mee eens.

Figure 77: Legend to the diagram of the preferences for the presented traffic access scenarios. The table shows the explanation given by each participant what their motives were for the given preference.