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Contrasting the recommendations of participatory value evaluation and cost-benefit analysis in the context of urban mobility investments

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ABSTRACT

Participatory Value Evaluation (PVE) is a new method to assess the desirability of government projects. In a PVE, individuals select their preferred portfolio of government projects given a constrained public budget. Individuals' preferences for (the impacts of) government projects can be determined based on these choices. The obtained preferences can be used to rank government projects in terms of their desirability. Cost-Benefit Analysis (CBA) is an alternative appraisal method used to assess the desirability of government projects. CBA establishes the desirability of public projects through analyzing people's trade-offs between their private income and impacts of public projects. The primary objective of this paper is to investigate whether CBA and PVE lead to different policy recommendations in the context of urban mobility investments. We conducted CBAs and a PVE for 16 urban mobility investment projects and find indicative evidence that projects which focus on improving traffic safety and improvements for cyclists/pedestrians rank higher in the PVE, whereas car projects rank higher in the CBA analysis.

1. Introduction

Participatory Value Evaluation (PVE) is a new method which can be used to assess the desirability of government projects. In a PVE, participants are offered several possible public projects, information about the impacts of these projects and a constrained public budget in an (online) experiment. Participants are asked to choose the public projects they like to see implemented while respecting the public budget constraint. The trade-offs made in selecting their preferred portfolio can be used to establish individuals' preferences for (the impacts of) the public projects and to rank these projects in terms of their desirability (Dekker et al., 2020; Mouter et al., 2020).

Cost-Benefit Analysis (CBA) is an economic appraisal method which is also used to assess the desirability of public governments and this method is widely applied in the transport domain (e.g. Asplund and Eliasson, 2016; Thomopoulos et al., 2009). The main difference between the two methods is that PVE establishes the desirability of government projects based on people's advises regarding the allocation of the public budget toward (impacts of) government projects, whereas CBA establishes the desirability of government

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projects through analyzing people's trade-offs between their private income and impacts of government projects. In a CBA, positive and negative impacts of government projects are quantified and where possible converted into monetary units using the notion of the amount of money that individuals are willing to pay from their private income for project impacts. Revealed and stated preference methods like hedonic pricing studies and stated choice surveys are often used to obtain estimates of individuals' private marginal willingness to pay (WTP). For instance, the standard empirical approach that is used to infer the value of travel time savings from government projects relies on (hypothetical) route choice experiments. In these experiments respondents are asked to make a series of private choices between routes which differ in terms of travel time and travel costs (e.g. Batley et al., 2019; Börjesson and Eliasson, 2014; Jara-Díaz, 2007). Similarly, impacts of government projects on landscape, nature and noise pollution are evaluated through investigating the private decisions people make when buying a house (e.g. Allen et al., 2015; Seo et al., 2014).

To illustrate the difference between the two methods in the context of the appraisal of transport projects with a fictive example, suppose that the government of country Y considers five projects (A, B, C, D and E) all costing 10 million euro. Each of the projects results in a certain amount of travel time savings and reduction in noise pollution. The government considers spending 20 million on the projects which implies that they can implement two or less projects. In a CBA, the travel time savings are valued based on trade-offs that people make between private income and time in hypothetical route choices and changes in noise pollution are valued through decisions of consumers in the housing market. Subsequently, the aggregated monetary benefits are compared with the costs to define the project's desirability. In a PVE, these impacts are not valued based on private choices but through surveying citizens regarding the specific decision situation of the government of country Y. More specifically, participants in a PVE are asked to provide a recommendation to the government on choosing their most preferred portfolio of projects whilst receiving information about the overall impacts of the projects they can select. Participants need to respect the public budget constraint of 20 million euro. They also have the option to advise the government against implementing any of the projects that are considered in the PVE and thereby shift the budget to the next year to ensure that preferences of individuals who believe that it is better to do nothing are respected (Mouter et al., 2020). In a so-called flexible budget PVE, individuals additionally have the opportunity to advise the government to increase the public budget by levying a collective tax – which allows them to recommend more projects – or to decrease the public budget which leads to a tax reduction. These choices of participants in the PVE can, amongst other things, be used to establish individuals' preferences for (the social impacts of) the projects A, B, C, D and E (e.g. travel time savings and noise pollution) and to rank these projects in terms of their desirability.

Mouter et al. (2020) presented an application of a PVE in the context of a flood protection scheme for the Dutch Ministry of Infrastructure and Water Management. In their PVE, 2900 citizens were asked to allocate a budget of 700 million euros to flood protection projects in the Netherlands and other projects that fall within the remit of the Ministry. From this application of PVE no conclusions could be drawn whether PVE provides different policy recommendations than a traditional CBA. CBAs were not available for many of the projects considered in their PVE experiment. For the projects for which CBAs were available, the studies were incomplete as some of the main impacts of the flood protection projects such as biodiversity and recreational opportunities were not monetized or monetized in a very rudimentary way. This was also the main reason why the Dutch Ministry of Infrastructure and Waterworks commissioned a PVE (Mouter et al., 2020).

The primary objective of the present paper is to investigate whether CBA and PVE lead to different policy recommendations regarding the rankings of transport projects in terms of their desirability. We conducted CBAs and a PVE for 16 transport projects considered by the Transport Authority Amsterdam (henceforth: TAA) and investigated whether the two approaches provide different results in terms of the ranking of these 16 projects. In the PVE, 2498 citizens were presented with the 16 transport projects and related societal impacts. The total costs of the 16 projects was 386.5 million euros but with only 100 million euros to spend, it was not possible for the respondents to include all projects in their portfolio.[1] A transport case study lends itself well for comparative purposes due to the wealth of guidance and experience of CBA-based project appraisal in this domain. Both in the Netherlands and in other western countries, transport is the domain in which CBA has the strongest tradition in terms of guidelines and knowledge available to transfer impacts of government projects into monetary terms (Mackie et al., 2014; Romijn and Renes, 2013).

Although the literature provides various potential explanations for why CBA and PVE might produce different policy recommendations (e.g. Ackerman and Heinzerling, 2004, but see for a review Section 2) it is important to gain empirical insight into the extent to which these proposed explanations materialize in practice. Hence, a second objective is to obtain empirical insights into potential reasons why PVE and CBA might provide different rankings in the context of the urban mobility investment projects considered in the case study of the TAA. Such empirical insights, although in a specific context (in this case urban mobility investment projects), might be relevant for policy makers, but they also provide input for academic discussions about (explanations of differences in recommendations produced by) the two appraisal methods. To achieve this second objective of our paper, we asked participants in the PVE to provide written motivations for each selected project after they submitted their preferred portfolio.

As this journal is intended for readers more interested in policy and practice, we refer to the supplementary material for mathematical derivations and technical details. Readers that are interested in detailed micro-economic underpinnings of PVE are referred to Dekker et al. (2020). The present paper does not provide a normative discussion about the pros and cons of CBA and PVE and it therefore does not provide insights on whether PVE is a better or worse method than CBA normatively speaking. We think that this is an important topic for further research yet believe that it would be premature to provide a conclusive answer to these normative questions based on a single application of PVE in the transport domain. For reasons of space limitations, this paper also does not provide an

[1] A demo version of the PVE can be found online: www.burger-begroting.nl (in Dutch) and http://burgerbegroting.tbm.tudelft.nl/participatory-value-evaluation-transport-authority-amsterdam (the English translation).

exhaustive discussion of how PVE relates to various (political/philosophical) theories such as the notion of the General Will (Rousseau, 1762), Harsanyi's (1976) account of ethical preferences and right-based approaches (Neuburger and Fraser, 1993). A clear difference between these approaches and PVE is that they concern the evaluation of social states from a specific normative perspective. For instance, the approach of Harsanyi (1976) requires that an individual *should* assume that he has the same probability to be put in place of any one of the members of society to elicit his ethical preferences. Instead, the PVE conducted in this study adopts a non-paternalistic approach in the sense that individuals are not urged to take a certain perspective or standpoint when selecting their preferred portfolio. They are free to take a purely self-interested perspective, to identify themselves with each member of society, the members worst off in society etc. How PVE exactly relates to these theories and to which extent PVE can (and should) be amended to provide an operationalization of these theories is, in our view, an interesting avenue for further research.

The remainder of this paper is organized as follows: Section 2 lists potential reasons for why CBA and PVE might produce different results when evaluating urban mobility projects based on a literature review. Section 3 describes the 16 transport projects of the TAA that were analyzed using both the CBA and PVE methodology and Section 4 compares the results of the appraisal of these 16 projects using both methods. Section 5 analyzes the written motivations of participants in the PVE to generate empirical insights into potential reasons why PVE and CBA might provide different rankings. Finally, Section 6 concludes and provides a discussion.

2. Potential reasons for differences in results of a CBA and a PVE in the context of urban mobility investments

This section reviews the literature on potential reasons for differences in policy recommendations between CBA and PVE. Section 2.1 discusses potential reasons that we extracted from the general literature on the evaluation of government projects. Section 2.2 addresses potential reasons discussed in the planning literature that focus specifically on the appraisal of urban mobility investments. The potential reasons we distill from this literature review will be used to structure our empirical analysis in Section 5.

2.1. Potential reasons identified in the general literature on project evaluation

The values that are used in a CBA to monetize the impacts of transport projects are generally inferred from (hypothetical) private decisions such as hypothetical route choice experiments and people's decisions in the real estate market. In contrast, a PVE infers preferences from people's recommendations regarding the allocation of public budget toward (impacts of) government projects. The literature offers various hypotheses for why these two preference elicitation contexts (henceforth: 'private WTP-based elicitation' and 'PVE-based elicitation') may provide different values and thereby different policy recommendations. First, various scholars argue that private WTP-based elicitation studies impacts of government projects in another context than the one in which these impacts will actually occur (e.g. Ackerman and Heinzerling, 2004; Sen, 1995, 2000). More specifically, impacts that will materialize in the context of a government decision are inferred from the value individuals attach to these impacts in the context of a (hypothetical) private decision such as a route choice (Mouter et al., 2019). On the other hand, PVE-based elicitation studies impacts of government projects in the context in which they will eventually occur: a government decision. This only results in different outcomes when individuals value impacts differently in different contexts. Sunstein (1994) and Anderson (1993) argue that individuals might value the same impact differently in the private sphere compared to the public sphere. Specifically, Sunstein (1993, p. 784) states: "distinctions among kinds of valuation are highly sensitive to the particular setting in which they operate. People do not value goods acontextually. In one setting – say, the workplace – the prevailing kinds of valuation might be quite different from what they are elsewhere – say, the home or the ballot box." Weimer (2017) argues that valuing impacts of a government project through observing individuals' consumer choices overlooks that people may place a value on the way collective decisions should be made. Ackerman and Heinzerling (2004) and Sagoff (1988) assert that the two preference elicitation approaches differ in the way they allow individuals to express altruistic and/or moral considerations. Private WTP-based elicitation allows individuals to express moral considerations through their consumption decisions (i.e. ethical consumerism). However, PVE-based elicitation enables participants to express (altruistic and moral) considerations regarding the way that the government should trade-off burdens and benefits of public policies (Posner and Sunstein, 2017). Another difference between the two approaches is that private WTP-based elicitation estimates preferences for (impacts of) government projects from individuals' spending of their private income, whereas PVE-based elicitation estimates preferences for government projects and related impacts from individuals' preferences regarding the expenditure of public budget. This can result in different outcomes as research shows that individuals value impacts of transport projects such as travel time savings and accident risk differently when they trade these impacts against their own budget or the public budget (Mouter et al., 2017, 2018). Finally, PVE-based elicitation allows individuals to express their preferences toward positive and negative synergies between projects and potential (spatial) equality concerns as they are asked to advise the government on the allocation of a public budget to a portfolio of projects. Such considerations are not captured in preference elicitation contexts in which individuals value a single private or public good.

2.2. Potential reasons identified in the urban planning literature

This section reviews studies in the urban planning literature which can provide potential reasons for differences between outcomes of private WTP-based elicitation studies and PVE-based elicitation studies for the evaluation of urban mobility investments. Due to the novelty of PVE, the planning literature does not explicitly discuss potential reasons for differences in recommendations of the two elicitation techniques. However, this branch of the academic literature highlights limitations of using CBA for the evaluation of urban transport projects which can be identified as potential reasons for why the two elicitation approaches might provide different recommendations. We want to emphasize again that throughout this paper we adopt an *agnostic* standpoint. We do not intend to make any

value judgments regarding the extent to which we agree or disagree with *normative* comments made by planning scholars.

The first limitation of assessing urban transport projects through a CBA brought forward by planners is that the instrument corrodes and degrades the *forward-looking nature* of the planning proficiency (e.g. Banister, 2008; Hajer and Pelzer, 2018; Handy, 2008). Planners argue that CBAs have difficulty with considering normative ideas regarding a preferred future urban mobility system (Hickman and Dean, 2018; Nicolaisen et al., 2017). For instance, Nicolaisen et al. (2017) observe that policy makers' normative aspiration to reduce car traffic in the urban core through discouraging car use is not sufficiently reflected in a CBA even though this is their key rationale for championing projects such as Light Rapid Transit (LRT), removing roads/car lanes and lowering travel speed. Banister (2008) asserts that transport planning requires clear, innovative and strategic thinking about city futures in terms of desirability, and the role that transport can (and should) play in achieving these objectives. Handy (2008) states that the central goal of transport planning is defining the desired future for a place and then think about policies which help to move a place towards that future. Hajer and Pelzer (2018) assert that planning and evaluation need to refocus from a tradition of 'expected futures' to an approach centering on 'desirable futures' and ways to get there. The notion of anticipating the (uncertain) future by setting goals goes beyond the conventional private WTP-based elicitation approach which determines the value of impacts of (future) government projects through observing people's (hypothetical) consumer choices (e.g. hypothetical route choices and behavior in the housing market). Implicitly, these planners argue that individuals' *past* consumer choices are not necessarily a good reflection of their normative ideas concerning a *future* mobility system. They argue that the importance of this issue is amplified due to the broadening of goals of transportation planning in the last decades. Manaugh et al. (2015), for instance, observe that throughout most of the 20th century the goals of transportation were almost entirely mobility-based, with a focus on congestion reduction, travel time savings and safety improvements for motorists. All effects which are relatively easy to value through observing people's (hypothetical) private consumer choices. Manaugh et al. (2015) state that in this era CBA captured all the important goals of transportation planning. However, prompted by concerns regarding climate change, social inequality and the scarcity of public space in urban areas, the focus of transportation planning shifted more and more to other (more normative and/or future-oriented) goals, such as long-run sustainability, quality of life, social equity, resilience and promotion of green transportation in urban regions (e.g. Banister, 2008; Ferreira et al., 2012; Handy, 2008; Manaugh et al., 2015). Banister (2008), for instance, argues that in urban areas a much wider notion of the street has been created, as it is no longer only being considered as a road but also as a space where people meet. Therefore, nowadays, urban transport projects pursue both traditional effects (e.g. costs, travel time savings, safety and reduction of noise pollution) as well as a diverse set of non-traditional effects such as long-run sustainability, townscape, social inclusion, city image and improving the quality of urban spaces (e.g. De Bruijn and Veeneman, 2009; Hickman and Dean, 2018; Nicolaisen et al., 2017). However, several authors argue that CBA does not sufficiently appreciate many of these non-traditional effects as they are generally not included in the CBA, or are given marginal importance because they are not quantified or monetized (Beukers, 2015; Handy, 2008; Hickman and Dean, 2018; Nicolaisen et al., 2017). For instance, various scholars argue that CBAs for cycling projects have difficulty with including the impacts of a modal shift from car to bicycle such as the positive health impacts of increased physical activity and a reduction of road congestion and emissions, even though realizing these impacts are often a key goal of cycling projects (de Hartog et al., 2010; Heinen et al., 2015; Adam et al., 2018; van Wee and Börjesson, 2015). Moreover, various planning scholars assert that goals of cycling policies such as improvement of urban quality, space efficiency, social inclusion, improved mobility for children and social interaction potential often have a minor role in CBA (de Hartog et al., 2010; te Brömmelstroet et al., 2017; van Wee and Börjesson, 2015). Planning scholars argue that the weak position for such impacts in CBA does not sufficiently acknowledge the multifaceted planning priorities in urban transport infrastructure investments (Handy, 2008; Nicolaisen et al., 2017). Because participants in a PVE consider the impacts of a proposed government project in the context of a future government decision (and not in the context of a consumer choice) this elicitation context potentially allows them to express preferences that line up with their preferred future perspectives regarding the (local) urban mobility system, broader goals of transport planning as well as their ethical considerations.

Another potential reason why CBAs and PVEs can produce different recommendations for the evaluation of urban mobility investments stems from the fact that CBAs generally use standardized transport models to establish the impacts of a transport project and transfer these impacts into monetary terms using generic price tags such as the 'Value of Time' and the 'Value of a Statistical Life'. Planners argue that this approach might not sufficiently recognize the special (local) conditions of the problem which the urban mobility investment aspires to address (Beukers et al., 2012; Handy, 2008). This argument relates to the dichotomy between formal assessment and informal assessment (Pesch et al., 2017). Formal assessment methods include institutionally established methods, such as CBA. Apart from these formal assessment trajectories, transport projects are assessed by local citizens, local businesses and other actors that are not part of established institutions. This so-called informal assessment trajectory particularly focusses on the specific characteristics, needs and concerns of the local communities that are affected by the transport project and/or problem. In case the informal assessment provides new insights, this may lead to adaptations in the formal trajectory, which Pesch et al. (2017) refer to as 'backflowing'. In short, planners question CBA's 'backflowing capacity' as its generic approach does not properly account for the insights of citizens regarding the specific characteristics of the problem/project at hand. PVE potentially allows for 'backflowing' as participants are allowed to choose their own perspective when providing a recommendation. That is, individuals can assess the projects under scrutiny based on the impacts which are provided by the analyst (formal assessment) or the consequences of the projects that emerge from their personal experience (informal assessment).

3. Selecting transport projects which will be assessed through a CBA and PVE

Together with the program managers of the 'car', 'public transport', 'cycling' and 'safety' departments of the TAA, we selected 16 transport projects that were considered for inclusion in a transport investment scheme. Table 1 provides a brief verbal description of

the 16 projects. A more elaborate description of the projects is included in the demo versions of the PVE www.burger-begroting.nl (in Dutch) and http://burgerbegroting.tbm.tudelft.nl/participatory-value-evaluation-transport-authority-amsterdam (the English translation). Where available, we used the project descriptions of the TAA to compose the verbal descriptions. Table 1 (column 2) presents whether the projects were suggested by the car, public transport (PT), cycling or safety department. We also received documents to determine seven types of societal impacts of the projects: 1) costs; 2) number of travelers who experience travel time savings during an average working day; 3) average number of minutes of travel time savings per traveler; 4) change in traffic deaths per year; 5) change in severe traffic injuries per year; 6) additional households affected by noise pollution; 7) number of trees that have to be chopped. We asked civil servants of the TAA to provide information regarding the impacts in bandwidths because we needed to differentiate among the participants in the PVE in terms of the attribute levels of the impacts to estimate people's sensitivity for these impacts (see the

Table 1
Impacts of the 16 projects.

	Type	Costs (mln €)	Travellers affected (thousands)	Minutes time savings	Change traffic deaths	Change severe injuries	Households affected by noise pollution	Trees cut
1) Faster connection to the provincial road N516 (Zaandam) at the Poelenburg/ Achtersluispolder will decrease travel time for car/bus traffic	Car	40/60	50/70	2/4	0	0	20/100	0
2) Fly-over on the A10 at the junction Amsterdam Noord will decrease travel time for car and bus traffic.	Car	30/50	60/80	2/4	0	0	50/200	40 /200
3) Extending Mac Gillavrylaan to the Middenweg improves accessibility of the Science Park and reduces noise pollution for citizens living at the Middenweg.	Car	7/13	30/40	3/6	0	0	−50/−150	0
4) Extra lane on Bovenkerkerweg decreases travel time for car users.	Car	7/13	25/40	2/6	0/0.2	0/2	0/20	20/40
5) New bus connection IJburg – Bijlmer Arena will improve public transport between IJburg, Amstelveen and Schiphol Airport.	PT	40/60	3/6	4/11	0	0	0	0
6) Route of busses that run between Amsterdam CS and Zaandam will be shortened through the realization of an extra entrance and exit ramp.	PT	3/7	3/7	1/2	0	0	0	0
7) The tram connection between Diemen and the Linnaeusstraat will be accelerated through a more efficient allocation of stops and traffic lights.	PT	11/19	4/10	3/5	0	0	0	0
8) A comfortable cycling path (cycling highway) will be realized between Hoofddorp – Schiphol and Aalsmeer.	Bike	5/11	2.5/4	3/6	0	0	0	0
9) A cycling highway will be realized between the sports facilities at the Amstelveenseweg (Amsterdam)	Bike	4/8	8/15	2/4	0	0	0	20 /100
10) New bridge for cyclists/pedestrians at Hoornselaan (Purmerend).	Bike	3/6	6/10	2/4	0/−0.1	0/−2	0	0
11) Bike tunnel will be built at the Guisweg (Zaandam) where cyclists now cross the railroad.	Bike	30/50	5/8	1/3	0/−0.2	0/−3	0	0
12) A new bridge for cyclists will be built between Borneo−Eiland and Zeeburgereiland (Amsterdam).	Bike	25/45	6/8	5/8	0	0	0	0
13) Ilpendam pedestrian tunnel will diminishing travel time for car traffic and bus traffic and improve safety for pedestrians.	Safe	2/4	15/25	1/2	0/−0.1	0/−2	0	0
14) The Stadhouderskade will be tunnelled for car users at the entrance of the Vondelpark. Cyclists/pedestrians and car traffic will be separated.	Safe	30/50	35/40	1/2	0/−0.8	−2/−6	0	0
15) Traffic education for children in the age group 4 – 18 will prevent traffic accidents through improving awareness of children.	Safe	40/60	0	0	0/−1	−2/−15	0	0
16) Five additional police officers will be hired who will specifically focus on enforcing traffic laws.	Safe	15/25	0	0	0/−1	−3/−10	0	0

supplementary material for more detailed information). Table 1 describes the bandwidths of the impacts for each project.

We ensured that the projects were to some extent distributed between the six sub-regions (A: Zaanstad; B: Purmerend; C: Amsterdam West; D: Amsterdam Oost: E: Haarlemmermeer: F: Amsterdam Zuid-Oost). that fall under the jurisdiction of the TAA. Fig. 1 shows the locations of the projects. The projects 'traffic education' and 'five police officers' are not attached to a specific location.

For making the CBA calculations we translated the impacts of the projects into monetary terms using the values enumerated in Dutch CBA guidelines (Rijkswaterstaat, 2018). For these computations we used the averages for each of the impacts.

For conducting the PVE it was necessary to conduct an experiment. We developed a web-based environment (see the demo version) in which respondents received the following instruction:

> *"On the next page we present 16 transport projects that the Transport Authority Amsterdam could implement. The Transport Authority Amsterdam can only spend 100 million euro on these projects. Hence, there is not enough budget to finance all projects. The Transport Authority Amsterdam decided to consult a large number of citizens to provide an advice for this choice situation. You are one of the citizens that we selected. More specifically, we ask you to select the projects you advise to the Transport Authority through clicking on the 'selection button'. Please note that any remaining budget will be shifted forward to the next year which would imply that the Transport Authority Amsterdam will be able to spend more money on projects that fall within their remit in the next year."*

After reading this text, respondents saw an instruction video and then they were guided to a web-tool in which they could, amongst other things, sort and compare the projects by one of the impacts and find out more about the goals and the impacts of the projects through clicking on an information button. We communicated to the respondents that they could assume that the impacts will materialize in a period of 50 years. Participants were not forced to make a choice but had the option to delegate their choice to an expert. The delegates in turn also completed the experiment. We conducted the experiment in four waves (June 2017, October 2017, January 2018, March 2018). In two waves (flexible budget PVEs), respondents were also allowed to advise to adjust the governmental budget by increasing the tax per household or by selecting a rebate. The survey company Kantar Public was asked to draw four random samples from the population of the TAA of 18 years of age and older. The company was not explicitly requested to draw representative samples, but it was important that all relevant demographic segments (e.g. income, education, age and gender) were present. Respondents who completed the experiment received a monetary compensation. In case respondents delegated their choice, they received a lower financial compensation from the survey company. In total 9607 individuals were recruited and 2498 respondents completed the full PVE experiment (26%). Table 2 provides information about the socio-demographic characteristics of the respondents as well as their political affiliation. The sample is not representative for the population of the TAA in several respects. Males, older inhabitants and individuals with a higher income are overrepresented. In Section 4.2 we will show that this is not a problem as we can correct for this in the social welfare analysis.

After respondents made a single portfolio choice, they received some questions about how they experienced their participation in the PVE and they were asked to provide arguments for why they selected the projects. The primary reason to ask participants in the PVE to provide written motivations was to generate empirical insights into potential reasons why PVE and CBA might provide different results which is one of the objectives of this paper. In the next section, we explain that a secondary reason is that the written motivations provide a qualitative explanation of some of the quantitative outcomes of the PVE. The written motivations were manually coded using content analysis. Content analysis is a systematic, replicable technique for compressing many words of text into fewer content categories based on explicit rules of coding and categorizing (Weber, 1990). A content analysis starts with a theory or relevant insights from the literature as a starting point for initial categories of codes. In this study, we started our content analysis with a list of 29 initial codes that were associated with the impacts of the 16 projects that were explicitly described in the experiment as well as the goals of urban transport projects that emerged from the literature review discussed in Section 2. Next, we analyzed the data in two rounds. The goal of the first round was to identify new categories of motivations which added to the initial list of categories which resulted in 85 categories. In the second round, the 9920 motivations were divided across these categories.

4. Comparing the results of the CBAs and the PVE for the 16 projects

Section 4.1 describes the results of the CBAs that we conducted for the 16 projects. Section 4.2 presents the results of the PVE which includes all these 16 projects and compares the results of the CBAs and the PVE. Despite that the results of the CBAs and the PVE are expressed in different units (money vs utility), the ranking of the transport projects can easily be compared.

4.1. Results of the CBA

We conducted the CBAs for the 16 transport projects based on the average impacts presented in Table 1. For instance, to compute the costs and benefits of the first project – faster connection of bus and car traffic Zaandam – we used 50 million as the costs (average between 40 million and 60 million), 60,000 travelers who experience travel time savings during an average working day, 3 min of travel time savings per traveler and 60 additional households affected by noise pollution. Next, we converted these impacts into money metrics using the recommended values enumerated in Dutch CBA guidelines (Rijkswaterstaat, 2018): value of travel time savings: 9 euros per hour; value of a statistical life: 2.6 million; value of statistical severe traffic injury: 0.3 million; value of one additional household facing noise pollution: 250 euro per year. The Dutch Guidelines do not prescribe standard numbers for converting chopped trees into monetary terms. However, in a previous CBA a dedicated study was conducted to value replacing and/or replanting a similar number of trees that have to be chopped in the projects that are part of our study (Decisio, 2014). This study estimated the present value of these costs at 2 million euros in total, and we decided to use this figure in our study. Subsequently, we computed the costs and

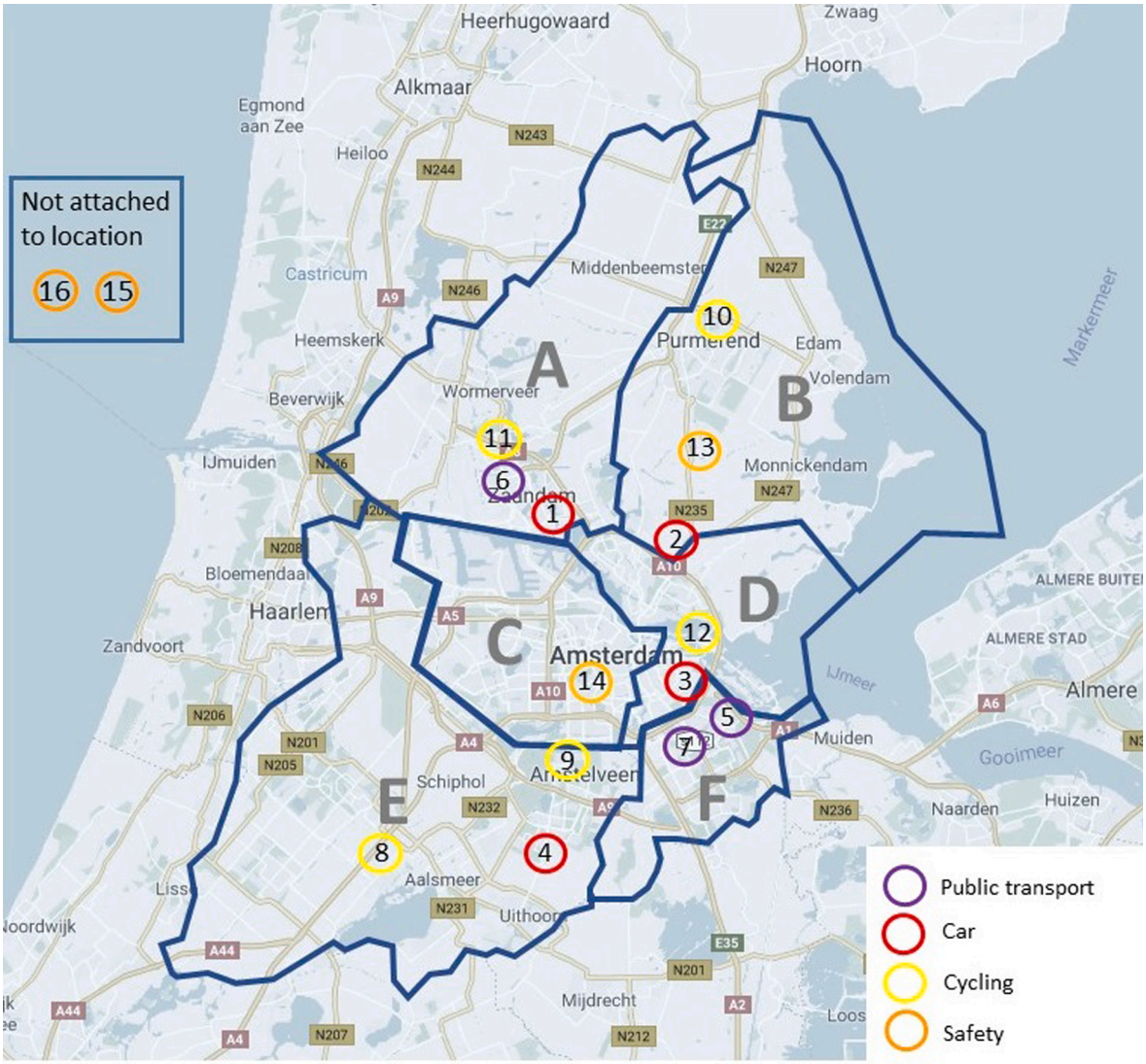

Fig. 1. Locations of the projects.

benefits of the projects using the prescribed discount rate in the Netherlands of 4.5% (Mouter, 2018) over a time horizon of 50 years. Table 3 presents the monetary values for the impacts of the 16 projects as well as the final indicators (net present value and benefit-cost ratio). The Dutch CBA Guideline (Romijn and Renes, 2013) prescribes the net present value as the final indicator that should be presented in a CBA because the benefit-cost ratio (BCR) can be easily manipulated. For this reason, we ranked the projects based on their net present value.

Table 3 shows that 13 projects have a positive CBA score (positive net present value). The main result of Table 3 is that projects which focus on improvements for car users rank highest in the CBA followed by the projects concerning safety improvements. Public transport projects rank lowest. The results can also be used to define the optimal portfolio when the investment budget of a government is limited. For instance, within a budget constraint of 100 million the optimal portfolio consists of three car projects: (Fly-over A10, extending MacGilavrylaan, extra lane Bovenkerkerweg), two safety projects (five extra policy officers, pedestrian tunnel Ilpendam), two cycling projects (cycling highway Amstelveenseweg, new bridge Purmerend) and a small public transport project (acceleration bus connection Amsterdam CS – Zaandam). This portfolio has a net present value of 419.3 million euros.

4.2. *Results of the PVE*

This section presents the results of the PVE and also provides a comparison with the results of the CBA presented in Section 4.1.

Table 2
Socio-demographic characteristics of participants in the PVEs.

	Wave 1	Wave 2	Wave 3	Wave 4
Number of respondents	742	803	381	301
Gender				
Female	44%	47%	53%	50%
Male	56%	53%	47%	50%
Age				
18 – 25	4%	5%	12%	11%
26 – 35	10%	11%	13%	20%
36 – 45	14%	16%	10%	16%
46 – 55	23%	23%	19%	18%
56 – 65	22%	22%	24%	16%
65 +	27%	23%	22%	18%
Education				
Lower education	35%	35%	30%	37%
Higher education	43%	43%	47%	42%
University (of applied sciences)	21%	22%	24%	21%
Household gross income				
Less than 15,000	6%	6%	15%	8%
15,000–30,000	15%	14%	28%	12%
30,000–60,000	40%	40%	41%	38%
More than 60,000	39%	40%	16%	42%
Voted previous election				
VVD (Conservative-Liberal)	20%	24%	13%	18%
PVV, Forum voor Democratie (Nationalist)	8%	7%	7%	6%
CDA, CU, SGP (Christian)	10%	8%	6%	9%
D66 (Social Liberal)	14%	14%	17%	15%
GL, PvdD (Green Parties)	22%	22%	23%	21%
SP (Socialist)	11%	10%	14%	10%
PvdA (Labor)	11%	12%	8%	8%
I did not vote	4%	3%	11%	11%

4.2.1. *Descriptive results*

In the PVE, citizens were asked to select transport projects within a budget constraint of 100 million euros. The total costs of the 16 projects was 386.5 million euros, so it was not possible for participants to include all projects in their portfolio. Table 4 presents the number of projects selected by the respondents and shows that most respondents selected 3 or 4 projects.[2]

Fig. 2 presents the percentage of respondents that selected each project. For each project the average costs (in million euros) are displayed between brackets.

The first observation is that all projects are chosen by at least 5% of respondents. Second, 12 out of 16 projects were selected by more than 20% of the participants in all experiments. Third, Fig. 2 shows that the differences in the shares of respondents who select a project between the four waves of the PVE are not very large. As the waves took place at different time instances this is an indication that citizens' preferences for the 16 transport projects are fairly stable over time. For reasons of readability we will not further distinguish between the four waves in the remainder of this section. Participants were also asked to evaluate the PVE on four items. Table 5 presents the results.

Although the answers that respondents gave to these questions are not required to achieve the two research objectives of our study, we think that it is relevant to report that individuals positively evaluated their participation in the PVE. Table 5 shows that 88% of the respondents were convinced about their choice. 94% of the respondents believed it is good that the TAA involves citizens in making choices between transport projects and 81% of the respondents agreed with the proposition: 'the experiment provides the government with relevant information in their decision-making process'. Only 10 respondents (1%) strongly disagreed with this proposition.

4.2.2. *Eliciting preferences for effects of individual transport projects*

To elicit the preferences for the impacts of the transport projects from the choices of the participants in the PVE, we estimated a Kuhn-Tucker type choice model. The model extends the work of Bhat (2008; 2018) and assumes that participants aim to select a portfolio of transport projects that in their view represents the portfolio which maximizes their 'utility' (i.e. they select the best portfolio) whilst satisfying private and public budget constraints. The technical details of the choice model can be found in the supplementary material and detailed micro-economic underpinnings of the random utility models can be found in Dekker et al. (2020). Below we only discuss the most important assumptions that are made in the analysis.

[2] Around 15% of the respondents delegated their choice to an expert.

Table 3
Cost-Benefit computations for the 16 transport projects (ranked by net present value in millions of euros).

	Project	Type	Costs (in millions of euros)	Travel time savings (in millions of euros)	Traffic deaths (in millions of euros)	Traffic injuries (in millions of euros)	Noise pollution (in millions of euros)	Chopped Trees (in millions of euros)	Net present value (in millions of euros)	BCR
1	Fly-over A10 at the junction Amsterdam Noord	Car	−40	149.4	0	0	−0.6	−2	106.9	3.67
2	Extending the MacGillavrylaan to the Middenweg	Car	−10	112	0	0	0.5	0	102.5	11.25
3	Faster connection Poelenburg/ provincial road Zaandam	Car	−50	128	0	0	−0.3	0	77.7	2.55
4	Extra lane on Bovenkerkerweg	Car	−10	92.5	−5.1	−5.9	−0.1	−2	75.3	7.94
5	Five police officers which sanction violation of traffic regulations	Safety	−20	0	51.4	38.5	0	0	69.9	4.5
6	Stadhouderskade car tunnel at the entrance of the Vondelpark	Safety	−40	42.7	20.5	23.7	0	0	46.9	2.17
7	Ilpendam pedestrian tunnel	Safety	−3	21.3	2.6	5.9	0	0	26.8	9.93
8	Traffic safety education for children in the age group 4–18	Safety	−50	0	25.7	50.4	0	0	26.1	1.52
9	New bridge for cyclists and pedestrians Purmerend (Hoornselaan)	Cycling	−4.5	17	2.6	5.9	0	0	21.1	5.67
10	Cycling highway Amstelveenseweg	Cycling	−6	24.5	0	0	0	−2	16.5	3.75
11	Improvement tram connection Diemen – Linnaeusstraat	PT	−15	20	0	0	0	0	5	1.33
12	Cycling highway Hoofddorp – Schiphol – Aalsmeer	Cycling	−8	10.4	0	0	0	0	2.4	1.30
13	Acceleration of the bus connection Amsterdam CS - Zaandam	PT	−5	5.3	0	0	0	0	0.3	1.06
14	New cycling bridge Zeeburgereiland and Borneo Eiland	Cycling	−35	32.4	0	0	0	0	−2.6	0.93
15	Guisweg bike tunnel	PT	−40	9.2	5.1	8.9	0	0	−16.7	0.58
16	New bus connection IJburg - Bijlmer Arena	PT	−50	24	0	0	0	0	−26	0.48

First, we assume that part of the desirability of an individual project is defined by the impacts that were explicitly presented to participants for each of the transport projects (henceforth: explicit impacts): reducing travel time, the number of traffic deaths, the number of severe traffic injuries, the number of households affected by noise pollution or the number of trees that need to be chopped.[3] We estimated so-called preference parameters in order to determine the importance of these explicit impacts on the individual's decision. This is comparable to stated choice surveys which estimate preference parameters for attributes of a public good. Although a

[3] Note that the value of project(impacts) can potentially include the private benefits of the project, but also other-regarding considerations related to the impacts of the project on other citizens or future generations. Because we cannot identify the extent to which participants themselves experience benefits/costs from the transport projects, we cannot draw conclusions regarding the extent to which the value of the projects can be attributed to private impacts or other-regarding impacts. We consider this to be a good avenue for future research.

Table 4
Number of projects selected by respondents.

Number of projects selected	Number of respondents
0	35 (2%)
1	42 (2%)
2	181 (8%)
3	475 (21%)
4	479 (21%)
5	362 (16%)
6	285 (13%)
7	216 (10%)
8	127 (6%)
9	23 (1%)
10	1 (0%)
11	1 (0%)

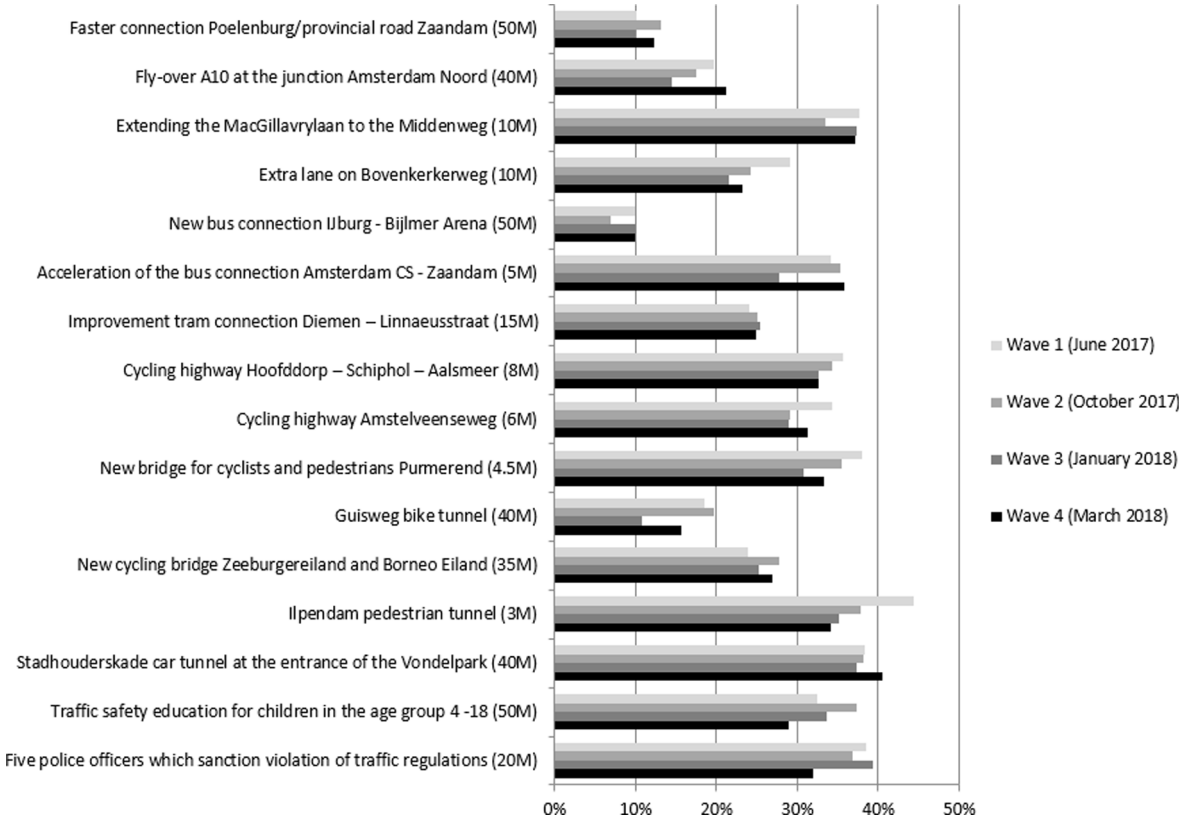

Fig. 2. Percentage of respondents which selected the different transport projects.

Table 5
Answers of respondents to the four items rated at the end of the PVE.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I was convinced of my choice	572 (32%)	991 (56%)	182 (10%)	22 (1%)	1 (0%)
I thought that the experiment was realistic	397 (22%)	907 (51%)	386 (22%)	87 (5%)	10 (1%)
I think that it is good that the government aims to involve citizens in making choices between transport projects	1024 (56%)	687 (38%)	85 (5%)	20 (1%)	2 (0%)
The experiment provides the government with relevant information for making choices between transport projects	561 (31%)	908 (50%)	290 (16%)	56 (3%)	10 (1%)

cost coefficient is not directly estimated, the Kuhn-Tucker model implicitly accounts for private and public budget constraints (Dekker et al., 2020). Therefore, the costs of the project affect its desirability (see for further details Section 4.2.3).

Second, we estimated so-called project specific parameters, because the (un)attractiveness of an individual project can also be defined by other considerations than the level of the five 'explicit impacts'. These parameters capture the benefits individuals derive from a project irrespective of the level of the impacts included explicitly in the PVE (comparable to alternative specific constants in stated choice surveys). These project specific parameters capture the value resulting from other considerations than the five explicit impacts (such as the normative views concerning the future urban mobility system as discussed in Section 2). Furthermore, when citizens derive value from the fact that a project influences one of the explicit impacts irrespective of *the extent to which* the impact is affected, this is also captured in the project specific parameter. To illustrate this: when a participant selects a project because (s)he thinks that reducing traffic deaths is an important priority, this is captured in the project specific parameters. When the participant values the *number of* traffic deaths that are prevented as a result of the project as well, this is captured in the preference parameter for traffic deaths. Both the preference parameters and the project specific parameters are presented in Table 6 in the column 'Estimate'. The column 't-value' depicts whether the parameter is significantly different from 0 at the 0.05 level (t-value higher than 1.96). All the project specific parameters and the preference parameters for traffic deaths and severe traffic injuries are significantly different from zero. The arguments that respondents gave to underpin their selection of the projects (which will be discussed in Section 5) provide qualitative insights in the interpretation of the project specific parameters. For instance, if respondents argue that they selected a project because it will lead to a certain impact and they did not receive explicit information about this impact in the PVE, then it is likely that this perceived impact contributes to the positive project specific parameter.

Table 6 shows that the level of these safety impacts is considered to be relevant when citizens choose their portfolio of projects. The preference parameter for reduction of travel time is not significantly different from zero. This means that *the level of* travel time savings does not significantly affect the utility of a project. However, *the fact that* a project reduces travel times can still impact a project's (un) attractiveness. In this case, this is captured in the project specific parameters. Using the preference parameters, it is also possible to establish the relative importance of the different impacts. For instance, we can infer from the results that citizens of the TAA think that a reduction of 1 traffic death and a reduction of 8.34 severe traffic injuries (1.5814 / 0.1896) are equally attractive (provide the same utility). This is very close to the relative importance of these impacts in a CBA which can be computed by dividing the value of a statistical life (2.6 million) and the value of statistical severe traffic injury (0.3 million) = 8.67. In the context of a PVE, the utility that individuals obtain from travel time savings is substantially lower than the value of traffic safety when compared with the standard numbers enumerated in CBA Guidelines. In a CBA, 1 million minutes of travel time per day will result in a yearly benefit of 36 million euros ((1 million / 60) * 9 euros value of time * 240 working days = 36 million) which is substantially higher than saving one statistical life (2.6 million euro). However, Table 6 reveals that respondents participating in the PVE obtain a higher utility from preventing a traffic death (1.5184) than from saving 1 million minutes of travel time on an average working day (0.4806[4]). The result that individuals attach more importance to safety in a PVE context than in a CBA context aligns with previous research which compares these two impacts in a willingness to pay and a willingness to allocate public budget context (Mouter et al., 2017).

4.2.3. *Computing the social welfare effect of individual projects and portfolios of projects*

The behavioral choice model allows for the derivation of the probability that a project improves social welfare compared to shifting the money to the next period, i.e. whether societal benefits are higher than the costs (see the supplementary material and Dekker et al. (2020) for a detailed discussion of how the notion of the social welfare function can be used to aggregate (and weigh) individual utility functions and thereby rank alternative policy portfolios). These probabilities are the final indicators of the evaluation of the individual projects which reflect the extent to which a project improves social welfare (probability higher than 50%). Computing the probabilities is a key step in the policy evaluation of a PVE since participants always have the fallback option of not spending any money in case they think that all the projects are undesirable. More specifically, in case all the participants in the PVE would have selected the null portfolio (a portfolio without any projects) thereby recommending to shift the entire public budget to the next year, the probability that one of the projects improves social welfare compared to shifting the money to the next period would be (very close to) 0%.

Table 7 ranks the projects in terms of their desirability probability. The final column shows the ranking of the projects in the CBA analysis. Table 7 shows that seven projects have a probability higher than 50% to improve social welfare, where in the social welfare function each citizen receives an equal weight (Dekker et al., 2020). The Stadhouderskade car tunnel has a 56% probability to improve social welfare compared to shifting budget to the next year. There are also some projects which are welfare decreasing. For instance, the new bus connection IJburg – Bijlmer Arena has a 31% probability to improve social welfare compared to shifting budget to the next year.

Another noteworthy result is that the project desirability of the majority of the projects is very close to 50%. This reflects the high uncertainty associated with the policy recommendations. The first cause for the high uncertainty is the tightness of the budget constraint in the experiment. For instance, many respondents included two very expensive projects in their portfolio ('Stadhouderskade car tunnel' and 'Traffic education for children') which together already take up about 90% of the budget. From this selection we can infer that these respondents think that these two projects are highly attractive, but at the same time it is hard to evaluate how they judge the attractiveness of the other 14 projects. A second explanation for the high uncertainty in the policy recommendations is that the large majority of projects is selected by a substantial part of the participants. More precisely, 12 out of 16 projects were selected by

[4] Note that Table 6 shows that the preference parameters for travel time savings is not significant at the 0.05 level.

Table 6
Estimation results behavioural choice model.

Log-likelihood	−20,170,52	
Estimation results	**Estimate**	**t-value**
Preference parameter		
Reduction of travel time (per 1,000,000 min)	0.4806	1.13
Additional traffic deaths	−1.5814	−2.76
Additional traffic injuries	−0.1896	−2.31
Additional households affected by noise pollution (per 100)	−0.0619	0.85
Additional trees cut (per 100)	−0.0882	−1.09
Project specific parameters		
Faster connection Poelenburg/provincial road Zaandam	6.5555	65.28
Fly-over A10 at the junction Amsterdam Noord	6.6974	38.09
Extending the MacGillavrylaan to the Middenweg	5.5604	53.77
Extra lane on Bovenkerkerweg	5.3741	71.39
New bus connection IJburg - Bijlmer Arena	6.3883	139.15
Acceleration of the bus connection Amsterdam CS - Zaandam	4.9451	118.33
Improvement tram connection Diemen – Linnaeusstraat	5.7723	134.40
Cycling highway Hoofddorp – Schiphol – Aalsmeer	5.3959	128.12
Cycling highway Amstelveenseweg	5.0542	74.96
New bridge for cyclists and pedestrians Purmerend (Hoornselaan)	4.8378	110.12
Guisweg bike tunnel	6.5271	149.09
New cycling bridge Zeeburgereiland and Borneo Eiland	6.6641	146.95
Ilpendam pedestrian tunnel	4.5549	101.35
Stadhouderskade car tunnel at the entrance of the Vondelpark	7.0658	108.88
Traffic safety education for children in the age group 4–18	7.1350	77.60
Five police officers which sanction violation of traffic regulations	6.1875	65.71

Table 7
Probability that a project improves societal value.

	Project	**Project type**	**Project desirability**		**Ranking in CBA**
1	Stadhouderskade car tunnel at the entrance of the Vondelpark (40 M)	Safety	56%	✓	6
2	Ilpendam pedestrian tunnel (3 M)	Safety	55%	✓	7
3	Traffic safety education for children in the age group 4 – 18 (50 M)	Safety	54%	✓	8
4	Five police officers which sanction violation of traffic regulations (20 M)	Safety	54%	✓	5
5	New bridge for cyclists and pedestrians Purmerend (4.5 M)	Cycling	52%	✓	9
6	Extending the MacGillavrylaan to the Middenweg (10 M)	Car	52%	✓	2
7	Acceleration of the bus connection Amsterdam CS - Zaandam (5 M)	PT	51%	✓	13
8	Cycling highway Hoofddorp – Schiphol – Aalsmeer (8 M)	Cycling	50%	?	12
9	Cycling highway Amstelveenseweg (6 M)	Cycling	48%	x	10
10	New cycling bridge Zeeburgereiland and Borneo Eiland (35 M)	Cycling	46%	x	14
11	Improvement tram connection Diemen – Linnaeusstraat (15 M)	PT	44%	x	11
12	Extra lane on Bovenkerkerweg (10 M)	Car	44%	x	4
13	Fly-over A10 at the junction Amsterdam Noord (40 M)	Car	41%	x	1
14	Guisweg bike tunnel (40 M)	Cycling	40%	x	15
15	Faster connection Poelenburg/provincial road Zaandam (50 M)	Car	35%	x	3
16	New bus connection IJburg - Bijlmer Arena (50 M)	PT	31%	x	16

more than 20% of the respondents in all experiments (see Fig. 2). Because of this substantial heterogeneity in preferences it is relatively difficult to determine which projects have a negative social welfare effect compared to a situation in which various projects were only selected by a few respondents.

When we compare the ranking of the projects presented in the PVE with the ranking of the projects in the CBA (last column of Table 7) we see that various projects that score negatively in the CBA (new cycling bridge Zeeburg, Guisweg bike tunnel and the new bus connection IJburg – Bijlmer) also score negatively in the PVE. Hence, in this case CBA and PVE provide rather similar recommendations. The most important difference between the rankings is that the 4 car projects represent the 'top 4' in the CBA analysis, but these projects rank relatively low in the PVE as 3 of these projects are among the bottom five projects and they are likely to generate a negative social welfare effect. It is also noteworthy that the five cycling projects and the four safety projects score better in the PVE than in the CBA in terms of their ranking. Section 6 provides potential reasons for this divergence.

A second output of the welfare analysis conducted in a PVE is the ranking of portfolios of projects in terms of social welfare. When the public budget is unlimited policy makers should implement all projects with a desirability probability of higher than 50%. However, policy makers are faced with limited budgets and PVE allows for determining the best selection of projects (i.e. the best portfolios) for a given budget. Table 8 shows the top 10 of portfolios within a budget constraint of 100 million euros. A '1' indicates that a project is included in the portfolio and a '0' indicates that a project is not included.

The first conclusion that we can draw based on Table 8 is that the portfolio with the most positive impact on social welfare consists of the Ilpendam pedestrian tunnel, the new cycling bridge in Purmerend, the Stadhouderskade car tunnel and the traffic education

Table 8
10 portfolios computed in the PVE which result in the highest expected social welfare within a budget constraint of 100 million.

	Top 10 portfolio's									
	1	2	3	4	5	6	7	8	9	10
Faster connection Poelenburg/provincial road Zaandam (50 M)	0	0	0	0	0	0	0	0	0	0
Fly-over A10 at the junction Amsterdam Noord (40 M)	0	0	0	0	0	0	0	0	0	0
Extending the MacGillavrylaan to the Middenweg (10 M)	0	1	0	0	0	0	0	0	0	0
Extra lane on Bovenkerkerweg (10 M)	0	0	0	0	0	0	0	0	0	0
New bus connection IJburg - Bijlmer Arena (50 M)	0	0	0	0	0	0	0	0	0	0
Acceleration of the bus connection Amsterdam CS - Zaandam (5 M)	0	0	1	0	1	0	1	0	0	0
Improvement tram connection Diemen – Linnaeusstraat (15 M)	0	0	0	0	0	0	0	0	0	0
Cycling highway Hoofddorp – Schiphol – Aalsmeer (8 M)	0	0	0	0	0	0	0	0	1	0
Cycling highway Amstelveenseweg (6 M)	0	0	0	0	0	0	0	1	0	0
New bridge for cyclists and pedestrians Purmerend (Hoornselaan) (4.5 M)	1	0	0	0	1	1	0	0	0	0
Guisweg bike tunnel (40 M)	0	0	0	0	0	0	0	0	0	0
New cycling bridge Zeeburgereiland and Borneo Eiland (35 M)	0	0	0	0	0	0	0	0	0	0
Ilpendam pedestrian tunnel (3 M)	1	0	1	1	0	0	0	1	0	0
Stadhouderskade car tunnel at the entrance of the Vondelpark (40 M)	1	1	1	1	1	1	1	1	1	1
Traffic safety education for children in the age group 4–18 (50 M)	1	1	1	1	1	1	1	1	1	1
Five police officers which sanction violation of traffic regulations (20 M)	0	0	0	0	0	0	0	0	0	0

Note: '1' ('0') indicates a project is included in (excluded from) the portfolio.

program. These are all projects that focus on safety and improvements for cyclists and pedestrians. Car projects and public transport projects are not included in the best portfolio. Finally, the Stadhouderskade car tunnel and the Traffic education program received high support by citizens and are included in all the top 10 portfolios within a budget constraint of 100 million euros. Notwithstanding the high total cost of these projects (90 million) citizens seem unwilling to sacrifice these projects for alternative projects.

Section 3 revealed that the sample is not representative for the population of the TAA. One of the strengths of PVE is that it is possible to control for this in the evaluation step. In a parallel research project Volberda (2020) analysed the choices of the participants in the TAA using latent class cluster analysis and found that the living area of the participant was the most important variable explaining heterogeneity among the clusters. That is, participants disproportionally selected projects close to where they live. This does not mean, however, that all participants in the PVE only select projects in their own region. For instance, 8% of the participants living in Region F (Amsterdam Zuid-Oost) only select projects in their own region and 37% of the participants living in this area do not select any of the projects in their region. For Region B (Purmerend) it was found that a relatively high percentage of participants (28%) only select projects in their own region (Volberda, 2020). Because some regions were underrepresented in our sample, we conducted a new welfare analysis applying corrective weights for their living area. It is beyond the scope of this paper to report the full analysis, but the most important insight was that the portfolio's 1 and 2 changed position. Other than that, the welfare analysis correcting for this location effect did not substantially affected the ranking of portfolios. For instance, the Stadhouderskade car tunnel and the Traffic education program are still included in all the top 10 portfolios.

To summarize, CBA and PVE produce different results when assessing the 16 projects of the TAA. The most important difference is that car projects are ranked at the top in the CBA analysis. However, car projects are found at the bottom of the ranking in the PVE. On the other hand, projects focusing at improvement of safety rank highest in the PVE. The four projects recommended by the safety department even represent the 'top 4' in the PVE analysis and two expensive safety projects are included in all the top 10 portfolios within a budget constraint of 100 million euros. Finally, on the project level, projects resulting in improvements for cyclists and pedestrians are ranked higher in a PVE than in a CBA.

5. Empirical insights concerning potential reasons why urban mobility investments rank differently in CBA and PVE

The goal of this section is to generate empirical insights into potential reasons why projects rank differently in a CBA study and a PVE study. To achieve this goal, we analysed the written motivations respondents gave after they submitted their preferred portfolio. As discussed in Section 3 we grouped the 9920 written motivations provided by respondents in 85 categories. Fig. 3 provides for each project an overview of the motivations put forward by participants. For reasons of readability, various small categories are excluded from Fig. 3.[5]

The analysis of the data revealed that most of the qualitative motivations of the respondents could be linked to the potential reasons for differences in policy recommendations between CBA and PVE discussed in the planning literature that focus specifically on the appraisal of urban transport investments (Section 2.2). However, we also identified a few categories of written motivations provided by respondents that could be linked to potential reasons for difference in recommendations between the two preference elicitation contexts proposed in the general literature on the evaluation of government projects (Section 2.1). One example of such a category was 'spatial equality' which indicates that respondents had chosen a project because infrastructure should be improved across the region and not only in Amsterdam itself. These respondents therefore assign a value to a fair distribution amongst communities. Respondents

[5] Examples of such categories are: 'trees should not be chopped' (mentioned 30 times) and 'this project perfectly aligns with other policies' (mentioned 5 times).

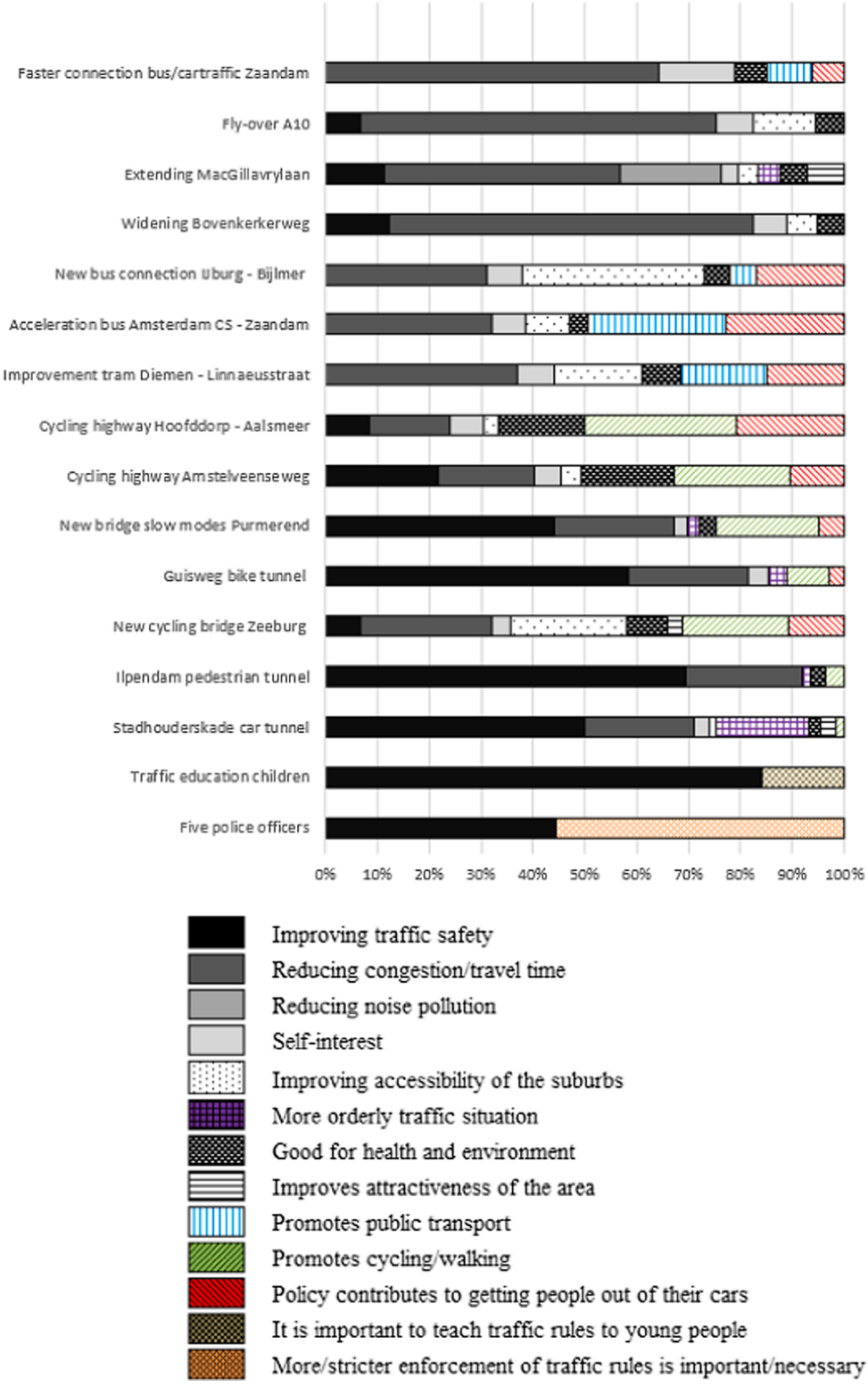

Fig. 3. Overview of qualitative motivations for each project.

can only express this preference in valuation studies such as PVE in which they make a portfolio choice, but not in preference elicitation contexts in which individuals value a single private or public good. Below two illustrative statements of respondents are given.

> *"As a resident of Amsterdam, I wanted to do something for the regions outside Amsterdam with the funds I had left over."*
> *"Spread the investments across the region and across the different modes."*

The written motivations of respondents particularly provide potential explanations for why safety projects and cycling projects rank higher in a PVE analysis than in a CBA analysis and why car projects rank higher in a CBA analysis. Section 6.1 discusses potential explanations for why safety projects rank higher in a PVE analysis. Section 6.2 presents potential reasons for why cycling projects rank higher in a PVE analysis, whereas car projects rank higher in a CBA analysis. Note that it was relatively difficult to identify potential reasons why respondents ranked car projects lower in a PVE because participants in the PVE were only asked to provide arguments for the projects they selected and not for projects they didn't select.

5.1. Empirical insights concerning potential reasons why safety projects rank higher in a PVE than in a CBA

Improvement of traffic safety was mentioned 2502 times to underpin the selection of a project which makes this the most frequently cited motivation for choosing projects. In the analysis of the written motivations of all the four projects which aimed to improve traffic safety (Ilpendam pedestrian tunnel, Stadhouderskade car tunnel, Traffic education, Additional policy officers) we found potential explanations for why safety projects ranked higher in a PVE analysis than in a CBA analysis.

5.1.1. Stadhouderskade car tunnel: Individuals do not only value objective safety

Traditional CBAs generally operationalize traffic safety as the reduction in traffic deaths, serious injuries and slight injuries (Mackie et al., 2014). However, based on the statements of respondents who selected the Stadhouderskade car tunnel project we established that citizens' conceptualisations of traffic safety turn out to be broader than the reduction of injuries and deaths and this might explain why this project is ranked higher in the PVE than in the CBA. Respondents argued that they also valued the reduction of small accidents, 'near misses' and the subjective experience of safety. The fact that travellers value both 'objective safety' and 'perceived safety' is endorsed in the literature (Adam et al., 2018). Moreover, many respondents who selected this project (18%) indicated that they did so because they believed it would make the traffic situation more orderly. Respondents characterized the present traffic situation as chaotic or stressful and hoped that the project would alleviate these issues thereby creating a calm, relaxed or pleasant travel experience. The importance of including these impacts into the appraisal of transport projects is emphasized in Gössling et al. (2019). Below, we present some illustrative statements provided by respondents who selected the Stadhouderskade car tunnel.

> *"I use this intersection on a frequent basis, and I think it is very dangerous. The fact that various traffic flows cross each other results in near misses on a frequent basis."*
> *"Many small accidents occur at this intersection which are not registered."*
> *"I bike across this intersection quite often and pretty much always end up ringing my bell at someone. The bike path running along the Vondelpark is narrow, and there is an enormous number of tourists in this section who don't watch where they're going. If this ceases to be an intersection, and instead becomes two roads above/below each other, then cycling will become a lot more relaxed."*
> *"Because this is such a chaotic scene the speed is very low and there are not a lot of traffic deaths and injuries. But still a tunnel is crucial to enhance travellers' sense of safety."*

The final statement is particularly interesting because the respondent seems to believe that an improvement of subjective safety (preventing near misses) is important even though objective safety (reduction number of injuries and traffic deaths) is not affected that much.

5.1.2. Ilpendam pedestrian tunnel: Solving a specific safety issue for vulnerable travellers

The analysis of the written motivations uncovered two potential reasons why participants in the PVE assigned a particularly high

Fig. 4. Image retrieved from Google maps to illustrate the safety situation at Ilpendam.

value to this project. First, respondents referred to a specific characteristic of the safety issue being that pedestrians need to cross a busy road when they wish to access the bus stop. Currently, some pedestrians decide to disrespect the red traffic lights when they see that the only way to catch their bus is running through the red light. According to some respondents this results in very dangerous situations. Policy makers of the TAA were unaware of the details of this traffic safety issue prior to the completion of the PVE. Fig. 4 shows the traffic situation in more detail.

Particularly the following statements clearly illustrate the specific safety issue in Ilpendam.

> *"The situation in Ilpendam is quite dangerous at present (certainly in the morning- and evening rush hours). Many pedestrians rush across even when the light is red – to catch the bus, for instance. A pedestrian tunnel would improve this dangerous situation."*
> *"Pedestrians just cross the street there right now, not at the crosswalk, not at a green light. They could get killed."*

A second reason why respondents particularly value this project is that it will improve safety for 'vulnerable travellers' such as pedestrians and children. The fact that citizens assign a higher value to traffic safety of pedestrians compared to car drivers was also found in the study of Johansson-Stenman and Martinssen (2008). Conventional CBA does not account for the two motivations that are discussed above as the standard numbers which are used for valuing a reduction of traffic deaths and traffic injuries do not differentiate between different groups (e.g. safety improvement for children or adults; pedestrians and car drivers) and between different causes of a safety issue (e.g. pedestrians negating a red light or drink and drive). Instead, participants in the PVE experiment were able to consider the local conditions of this specific traffic safety issue when valuing the safety impacts of the pedestrian tunnel which might explain why this safety project is ranked higher in a PVE analysis than in a CBA analysis.

5.1.3. Traffic safety education for children: Individuals value education as a matter of principle

Policy makers of the TAA expected a priori that respondents would only choose this project to improve traffic safety, but 71 respondents indicated that they supported such an investment because they saw it as important to impart the rules of the road to young road users. This normative belief was not included in the CBA and therefore potentially explains why it was ranked higher in the PVE.

> *"Education is a matter of principle. You should always be investing in it."*
> *"The education, guidance, and shaping of our youth contributes to a more intelligent, engaged, and respectful society in the years to come."*

5.1.4. Five additional police officers: Enforcement of traffic laws is valuable in its own right

Although policy makers of the TAA proposed the project to add five additional police officers which sanction violation of traffic regulations solely to improve traffic safety, 281 respondents indicated that they had chosen it because stricter enforcement of traffic laws is desirable in and of itself. In fact, the number of respondents choosing this project for reasons of safety is lower than the number who chose it because they thought enforcement of traffic laws was valuable in its own right. This normative goal was not included in the CBA which might explain that this project was ranked lower in the CBA than in the PVE.

> *"Always good to show the traffic jackasses that they can't get away with everything. Most importantly: fines on the spot!!! No sneaky photos with payment after the fact…"*
> *"When you make rules you are obliged to enforce them."*
> *"It is about time to enforce the rules we made. Sometimes it feels that no one is obeying the rules. I know a lot of elderly people who do not cycle anymore because they are too afraid. This is madness of course."*
> *"I would not be surprized if better enforcement in traffic also results in positive impacts outside mobility because the essence is that people's inappropriate behaviour is reprimanded."*

The two final statements also suggest that participants in the PVE considered impacts which were not included in the CBA (e.g. increase in number of elderly people who are now afraid to cycle).

5.2. Empirical insights concerning potential reasons why cycling projects rank higher in a PVE and car projects rank higher in a CBA

This section presents potential reasons for why, on a project level, cycling projects rank higher in a PVE analysis, whereas car projects rank higher in a CBA analysis.

5.2.1. Respondents think that the TAA should promote cycling and discourage car use

Fig. 3 reveals that participants in the PVE clearly include a broader set of reasons than the traditional goals of transport planning which were included in the CBAs presented in Section 4 (improving safety, reducing travel time, preventing noise pollution) in their selection of cycling projects. For instance, for the cycling highway Hoofddorp – Schiphol – Aalsmeer only 25% of the motivations can be clustered in traditional transport goals and 71% of the motivations can be attributed to broader goals of transport (18% positive impact on health and the environment; 31% promoting cycling; 22% trying to get people out of their car). The fact that more than 50% of the respondents selected the cycling highway Hoofddorp – Schiphol – Aalsmeer because they think that the TAA should promote cycling and reduce car use is quite surprising as these goals were not discussed in the project description that was included in the PVE. These motivations exemplify that a group of inhabitants of the TAA has a negative attitude towards car use and these individuals positively evaluate government projects which result in a reduction of car use. Below we provide two illustrative quotes:

> *"Amsterdam is a cycling city. I believe it should always be made easier for cyclists to move throughout the city so that people are less likely to drive to where they need to be."*

"Perhaps if you make a fast cycling route, you'll be able to get a few people out of their cars. A few is already enough for me. If you don't do anything, absolutely nothing will happen."

The first quote expresses that respondents clearly have a normative idea regarding the urban mobility system of Amsterdam: cycling friendly, less place for the car. The fact that such preferences are not reflected in private WTP-based preference elicitation studies that are currently used in (Dutch) CBAs potentially explains why car projects rank higher in a CBA than in a PVE. The second quote suggests that simply getting a few drivers to opt for alternate means of transportation is enough to make the project worthwhile for this respondent.

Respondents also mention other normative reasons for why they think that the TAA should invest in projects which promote cycling that might explain why cycling projects rank relatively high in a PVE. First, there are respondents who feel that cycling is a part of the identity of Amsterdam itself.

"My choices are based on the idea that Amsterdam is a cyclists city par excellence. This idea should be further developed and therefore we should encourage cycling by expanding cycling infrastructure."

Moreover, there are respondents who seem to believe that cycling is a desirable behaviour that should be stimulated by the government:

"This is an additional incentive to take the bicycle and it is also a reward for cyclists."
"Those who bike deserve a comfortable route."

One unique comment comes from a respondent who feels that cycling infrastructure should be improved in order to ensure that children learn to bike independently (to the sports club):

"Since more and more families today see both parents working, it is important that their children can get to the sports club by themselves during their "free" time. It is often the case that parents have to avoid making any commitments so they can get their kids to their sporting activities. If these children can safely bike along their "protected" routes, that reduces pressure on the parents and makes it less likely that someone has to "rush" home."

Moreover, there are respondents who feel that there should now be more investment in cycling infrastructure for reasons of fairness. For instance, this could be because respondents feel that historically much more money has been spent on the road network, or because proportionally less is done for cyclists and pedestrians as compared to drivers.

"There has been a lot of investment for drivers on the road network around Amsterdam. It's now time to consider the interests of cyclists and pedestrians."
"It's nice that they're thinking about cyclists for once. This is why one would value this project more highly."

Finally, a number of respondents emphasize the importance of high-quality cycling infrastructure because it is an inexpensive mode of transportation that is important to those who cannot afford to buy/use a car or use public transport.

"This is important for the cyclists who do not want to use public transport and can therefore save a bit of money by using their own bike to get around."

5.2.2. Respondents use personal judgment to assess safety impacts

Several respondents stated that they selected a cycling project for safety reasons even though we communicated to them in the experiment that the project would not have any safety impacts. This was particularly the case for the cycling highway Amstelveenseweg project. The civil servants of the TAA that were involved in the design of the PVE were of the view that this project would not have any safety impacts. However, 23% of the motivations provided by the respondents related to safety improvements. For instance, one respondent made the following statement:

"I know this situation and think it is unsafe. Hence, I think that this problem should be tackled immediately."

Hence, we can conclude that respondents base their choices both on information that is offered to them in the experiment (formal assessment) and personal experience (informal assessment). These perceived safety impacts were not included in the CBA because they were not known by policy makers. This might explain why this project is ranked higher in a PVE analysis than in a CBA analysis.

6. Conclusions and discussion

Participatory Value Evaluation (PVE) is a new method which asks participants to select their preferred portfolio of government projects given a constrained public budget. Individuals' preferences for (the impacts of) government projects can be determined based on these choices and the obtained preferences can be used to rank government projects.

The primary objective of the present study is to investigate whether CBA and PVE lead to different policy recommendations regarding the rankings of urban mobility investments. More specifically, we conducted CBAs and a PVE for 16 urban mobility investments (car projects, public transport projects, cycling projects and safety projects). We find that projects rank differently in a CBA and PVE in the sense that projects which focus on improving traffic safety and improvements for cyclists and pedestrians rank higher in a PVE than in a CBA, whereas car projects rank higher in a CBA. Especially for the car projects the difference in terms of ranking is substantial as they represent the 'top 4' in the CBA, whereas three car projects are found in the bottom five of the PVE ranking (number 12, 13 and 15).

The second objective of the paper is generating empirical insights into potential reasons why PVE and CBA provide different rankings in the context of the urban mobility investment projects considered in the case study of the TAA. We find two kinds of

potential reasons for why safety projects and cycling projects rank higher in a PVE than in a CBA: 1) conventional CBAs value impacts of government projects through observing people's past consumer choices (e.g. hypothetical route choices and behavior in the housing market). Instead, PVE allows individuals to include normative ideas regarding their preferred *future* urban mobility system. Many of these forward-looking normative statements referred to the importance of fostering cycling and traffic safety (e.g. individuals value traffic education as a matter of principle, the normative belief of citizens that the mobility system of Amsterdam should be cycling friendly with less place for the car); 2) a conventional CBA uses standardized approaches to estimate and value impacts of an urban mobility investment, whereas a PVE experiment allows participants to include specific (local) characteristics of a project that are not on the radar of policy makers when valuing the impacts of a project. Especially for the safety projects participants grounded their judgments in personal experiences that policy makers were unaware of prior to the completion of the PVE. This might explain why these projects ranked relatively high in the PVE-analysis. For instance, the policy to add five additional police officers is a good example of a selected project by citizens based on other motivations than the policy makers of the TAA expected a priori. Although the policy makers expected that citizens would only choose this project to improve traffic safety, the most mentioned argument by respondents was that they thought that a stricter enforcement of the traffic laws is desirable in and of itself. Because policy makers were a priori unaware of these motivations it is highly likely that these would be omitted into a conventional CBA.

Our study finds that PVE and CBA produce different rankings in a case study concerning urban mobility investment projects of the TAA. However, we recognize that there are multiple ways to conduct CBAs (and PVEs) and a clear limitation of our study is that we only compared the rankings of a PVE with the rankings produced by CBA studies that were conducted in the way that the TAA conducts them in the *status quo*. For instance, impacts such as travel time savings and accident risk reduction were valued using generic price tags such as 'the Value of Time' and the 'Value of a Statistical Life' as prescribed by the Dutch CBA Guidelines (Romijn and Renes, 2013). An alternative approach would be to compare rankings produced by a PVE with rankings produced by CBAs that use *dedicated valuation studies* as input. Because we only adopted one approach toward comparing PVE and CBA recommendations in our study it should be seen as a first attempt to compare rankings produced by the two methods. Our study finds indicative evidence that the two methods produce different rankings and we recommend further research that investigates the extent to which the differences that were observed in our study would disappear (or further increase) when the CBAs are based on valuation studies that are specifically conducted for the occasion. Only when such a study is conducted, we can draw more conclusive conclusions.

One potential limitation that stems from the realism of the PVE case study that we conducted is that some projects might have been selected relatively frequently because they are more known than others through, for example, attention in the media or the political debate.[6] First of all, it might be interesting to explore the magnitude of this bias in further research through asking respondents about their awareness of projects or problems at a location prior to their participation in the PVE and explore the extent to which this is correlated with their choices. When further research shows that this source of bias exists and when one establishes that this is undesirable we believe that it is interesting to study whether this can be alleviated by raising participants' awareness of the projects that are part of the PVE through including videos which visualize the problems at each location in the PVE and/or through including the option that respondents can deliberate with citizens that face the problem at a certain location.

Another limitation of our study is that we cannot capture the extent to which each project's (un)attractiveness is affected by other considerations than the level of the impacts that were explicitly presented to participants. For instance, we did not explicitly state the extent to which projects will increase cycling, reduce car use or improve safety for 'vulnerable travellers' such as cyclists and children. Any such effects are thus captured by the project specific parameters. This does not allow for isolating the extent to which these considerations influence the desirability of the projects. We think that an important avenue for further research concerns conducting more refined PVEs which aspire to isolate the extent to which these separate considerations affect the desirability of urban mobility projects. Moreover, we think that it is worthwhile to explore the extent to which asking respondents to complete multiple PVE choice tasks increases the role of preference parameters and diminishes the role of the project specific parameters in the evaluation of transport projects through a PVE.

Further research may also investigate the generalizability of our results to different contexts. First, it is questionable whether CBA and PVE provide alternative policy recommendations when these methods are deployed for the assessment of transport projects in which normative considerations regarding the future mobility system and local characteristics play a less important role (possibly the evaluation of motorway extensions in non-urban areas). In addition, normative considerations regarding the importance of city cycling might be a specific empirical result for countries with an omnipresent cycling culture such as Denmark and the Netherlands, making these results less generalizable to car-oriented countries/cities.

PVE also facilitates the participation of large groups of citizens in the design of public policies. The importance of the active involvement of citizens in the decision-making process on transport schemes to secure high-quality implementation is also recognized in the transport literature (Banister, 2008; Handy, 2008). As said before, PVE mobilizes the local knowledge of a large group of citizens to express their values and concerns regarding the specific characteristics of transport projects in an efficient way. In essence, PVE can be conceived as a method which combines formal assessment and informal assessment (Pesch et al., 2017). The standardized models and metrics that are used to quantify and monetize impacts of transport projects comprise the formal part of the assessment. The informal part of the assessment refers to the fact that PVE leaves room – and can be adapted to – citizens' values and concerns that are not on the radar of policy makers and experts. Apart from mobilizing local knowledge, Table 5 confirms that participants valued the fact that participating in the PVE made them feel involved in the decision-making process. PVE may also overcome issues that result

[6] One reviewer made this remark and labelled this type of selection bias as 'knowing bias'.

from the fact that conventional approaches to citizen participation (e.g. public hearings) generally require a substantial time commitment which many citizens would prefer to avoid. This has the potential to lead to a poor representation of the general population, insofar as those with a high motivation to participate will be those that have the most to gain by influencing decisions, but also have the free time and economic resources to do so (e.g. Irvin and Stansbury, 2004; Day, 1997). Various studies find that in conventional participation approaches white, middle aged well-educated males are overrepresented (e.g. Huitema et al., 2007; Public Agenda, 2016; Wittmayer and Rach, 2016). A key benefit of PVE is that the entry barrier for participating is relatively low. Participants generally spend 20 min to submit their choice(s), and the respondents can choose themselves when and where they conduct the PVE. Hence, the probability is relatively high that a more representative part of the population participates. However, our study finds that the same group of people is overrepresented as in conventional participation approaches but such concerns can be addressed by setting representative sampling targets. In Section 4.2.3, we discussed that a key strength of PVE is that the welfare analysis can correct for underrepresentation when all segments of the population are to some extent represented in a PVE. Because our study revealed that participants disproportionally selected projects close to where they live it is important to set representative sampling targets on different districts (and not only on age, gender and education) to ensure that citizens from all districts are represented to some extent. Corrective weights can, only to a limited extent, be applied in the welfare analysis to account for some under sampling as long as all relevant population segments are sufficiently represented in the sample. Further research may provide a comprehensive comparison of PVE with other approaches to citizen participation (e.g. citizen juries and focus groups).

It should be noted that the introduction of PVE does not disregard the role of experts in urban mobility planning. First of all, experts have an important role in the design of the PVE experiments. Second, citizens can delegate their choice to an expert. Moreover, in a graduation project (Darteé, 2018) citizens were asked which value should be assigned to the results of the PVE in the decision-making process. More than half of the respondents argued that the results of the PVE should not be decisive as the opinion of experts, civil servants and politicians should also count in the final decision. Hence, it can be argued that experts also have a third role on top of the design role and being an expert to whom participants can delegate.

Finally, we believe that the present paper warrants further research into the advantages and disadvantages of PVE and CBA for different types of transport projects and policies. A systematic survey of the merits of both methods can facilitate a discussion among policy makers about whether a CBA and/or a PVE should be commissioned to evaluate (a certain class of) transport policies. It is also important to study the (financial) costs of applying the methods. Indeed, conducting a PVE requires more time and money than a standard CBA because the analyst needs to collect new data and, possibly provide a financial compensation to the participants. On the other hand, conducting one PVE substitutes conducting multiple CBA studies for different projects. A study regarding the costs and benefits of PVE and CBA may also compare the two methods with other appraisal methods such as (participatory) multi-criteria analysis (Beria et al., 2012; Cornet et al., 2018; Dean et al., 2019; Hickman and Dean, 2018).

CRediT authorship contribution statement

Niek Mouter: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing - original draft, Writing - review & editing. **Paul Koster:** Conceptualization, Investigation, Formal analysis, Methodology, Writing - original draft, Writing - review & editing. **Thijs Dekker:** Conceptualization, Investigation, Formal analysis, Data curation, Methodology, Writing - original draft, Writing - review & editing.

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Appendix A. Supplementary data

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