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Attitude changes, modelling travel behaviour, and ex ante project evaluations

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ABSTRACT

The literature has increasingly recognized that people's attitudes can change for many reasons. This paper argues that attitude changes can have important implications for modelling travel behaviour and ex ante evaluations of candidate policy options. Limiting ourselves to the transport system and the built environment, we discuss why attitudes could change, how these changes are not addressed in current aggregate travel behaviour models, mainly the four step model, and how they could influence the assessment of candidate policy options. We suggest related avenues for future research. The core point we want to make is that attitude changes are not included in aggregate models, which leads to an underestimation of the impacts (often: benefits) of unconventional transport policy options.

Introduction

Before policy makers decide upon new policy measures, options for such measures are often ex ante evaluated. This applies to transport policy measures but also to other areas. For such evaluations several tools are available, such as Cost-Benefit Analysis (CBA), Multi Criteria Analysis (MCA) and Cost-effectiveness Analysis (CEA) (Mouter 2020). Several ex-ante evaluation methods, such as CBA and CEA, require the quantification of effects. Policy interventions have societally relevant effects because of the behavioural responses of people and other actors such as companies. For example, focusing on transport, the building of new roads or railroads, or the introduction of road pricing, impacts the environment, accessibility, health and safety as a result of the travel behaviour responses. Such responses are generally assessed in real world ex ante evaluations using transport models, either by consultants, or owned and operated by larger public bodies like larger municipalities, regional and national authorities. Such models, generally traditional four step models, but in some cases Land Use Transport Interaction (LUTI) models, are generally econometric models, assuming that homogeneous groups of people have constant behaviour under constant conditions (Ortúzar and Willumsen, 2011). Model runs show the quantitative changes in travel behaviour for future years with and without implementation of the candidate policy interventions.

In this paper we argue that the behavioural assumption referred to above can easily be violated if such interventions lead to attitude changes. Changes in attitudes are especially problematic if some of the policy interventions influence attitudes more than other interventions that policy makers consider to be alternatives. More specifically, attitude changes can lead to an underestimation of the impacts (often: benefits) of unconventional transport policy options.

Following Ajzen (1991: 188) we define attitude toward behaviour as 'the degree to which a person has a favorable or unfavourable evaluation or appraisal of the behaviour in question'. Attitude changes are often (but not exclusively) discussed in the context of the impact of land use on travel behaviour (Van Wee et al., 2019) because being exposed to changes in the built environment (land use, transport system) can easily lead to attitude changes (see next section). Attitudes changes are important because firstly travel behaviour might be affected, and thus many related societally relevant effects that depend on travel behaviour (emissions, congestion, safety, health, …), and secondly because the valuations of the given effects, such as the value of time and the value of reliability, could be influenced. We use the term 'attitudes' and not the related term 'preferences' because in the transport literature 'attitudes' are the most frequently used term. It is beyond the aims of this paper to debate the terminology, but it is defendable to use the term 'preferences' at places where we refer to 'attitudes'. Note that we focus on the use of aggregate models for real world ex ante evaluations, generally-four-step models, and in some cases LUTI-models, not on discrete choice models that are based on empirical data and published in academic literature, e.g. hybrid choice models (Abou-Zeid and Ben-Akiva, 2014). The core

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point we want to make is that attitude changes are not included in aggregate models, which leads to an underestimation of the impacts (often: benefits) of unconventional transport policy options.

We depart from the mainstream practice and theoretical underpinnings as made by conventional aggregate transport models (four step models, LUTI models). Such models assume that people make choices based on utility. We also depart from the evaluation practice of Social Cost-Benefit Analyses (SCBA, often reduced to CBA). With respect to our theoretical lens we depart from the Theory of Planned Behaviour and the theory on attitude changes as proposed by Van Wee et al. (2019), ignoring several other disciplines that can shed light on the topic of this paper, like sociology or philosophy. Next we focus on long-term effects of the built environment and the transport system, because these are most relevant from a policy and societal perspective. Long-term effects on behaviour could be larger than short-term effects because people (and other actors like companies) need time to adapt to changes in the transport and land-use system.

Section 2 discusses the role of attitudes and attitude changes in mainstream approaches for modelling travel behaviour. Section 3 explains why policy interventions could induce attitude changes, followed by Section 4 which elaborates on the relevance of attitude changes for ex ante evaluations of policy interventions. Some final comments are presented in Section 5.

Attitude changes in transport models and theory

Conventional aggregate transport models, founded in econometrics and utility theory, generally do not explicitly include attitudes, but these are implicitly incorporated in the model parameters (estimated via revealed or stated preferences).

But attitudes are important for the behaviour of people. A very influential theory conceptualizing this, also often used in travel behaviour research, is the Theory of Planned Behaviour (TPB) (Ajzen, 1991). While the theory acknowledges that attitudes, social norms, and perceived behavioural control may mutually influence each other (as captured by the correlations between these constructs), it is generally assumed that the effects of the psychological constructs on behaviour indeed run in this direction and not vice versa.

Although in social psychology attitude changes have received attention already many years ago (e.g. Gärling et al., 2003), the topic received increasing attention in the transport literature in the last few years. See De Vos (2022) for an overview the position of attitudes in travel behaviour research. Recent empirical research in transportation has shown that attitudes may be directly influenced by behaviours and other factors such as the built environment and can therefore change over time. For an overview of studies we refer to Van Wee et al. (2019). Regarding the relationship with behaviour, recent panel studies have consistently shown that bidirectional effects exist between behaviours and attitudes (Kroesen et al., 2017; Olde Kalter et al, 2021). In fact, both studies showed that past behaviours (mode use) were found to be more predictive of later attitudes than vice versa. In addition, attitudes are also not only endogenous to behaviours but also to the built environment. For example, Kroesen and Chorus (2018) argue that the effect of the built environment on travel behaviour could be underestimated if these attitude changes are ignored. Indeed, in a later panel study Kroesen (2019) found that residential preferences are affected by the built environment. For example, those living near a train station were found to report (one year later) a higher desire to also live near a train station. De Vos et al. (2021a) conclude that the built environment influences mode choice partly via attitudes changes.

An important question is: via which mechanisms do attitudes change, both in general as well as as a result of policy interventions? Or in other words: how can we theoretically understand why attitudes can change? Building upon earlier work by Eagly and Chaiken (1993), Van Wee et al. (2019) proposed a conceptual model for attitude changes (Fig. 1). The point of departure for their model is Eagly and Chaiken, who argue that attitudes can change due to cognitive processes: "people know things they did not know before", because of behavioural processes "people do things they did not do before", and because of affective processes "people develop new feelings". In Eagly and Chaiken's original model all three processes lead to attitude changes directly. In Van Wee et al.'s model the triggers that lead to any of these three processes are added first. In addition, the causal structure of this model is more complex. For example, new information might lead to cognitive processes (arrow 1a) and these cognitive processes might lead to behavioural changes (arrow 2a). These behavioural processes might subsequently influence people's feelings (arrow 3b) and subsequently their attitudes (arrow 4b).

Coming back to the point of departure of this paper, ex ante evaluations of candidate policy interventions, these interventions can be interpreted as triggers. In line with the example above, if a new metro line is built, people might become aware of it due to a search for travel information, a cognitive process. Next they might decide to use that metro line (behavioural process), enjoy the trip and feel more positive about travelling by metro than they had expected (affective process), which may result in them finally changing their attitudes, probably both via the affective processes, as well as the behavioural processes directly. To the best of our knowledge this model is the most complete and detailed model conceptualizing attitude changes.

Now that we have explained why attitudes could change, we conceptualize the impact of travel behaviour and the built environment related attitude changes on ex ante evaluations. Fig. 2 shows this

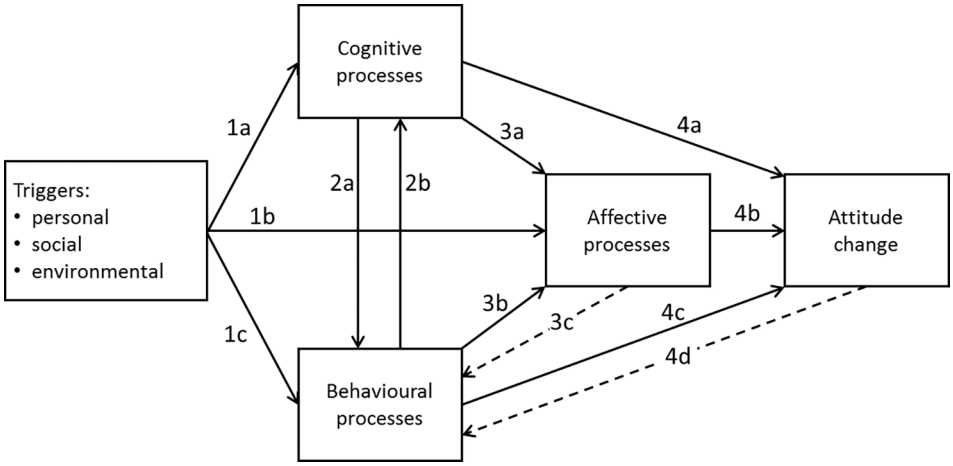

Fig. 1. A conceptual model for attitude changes (Van Wee et al., 2019).

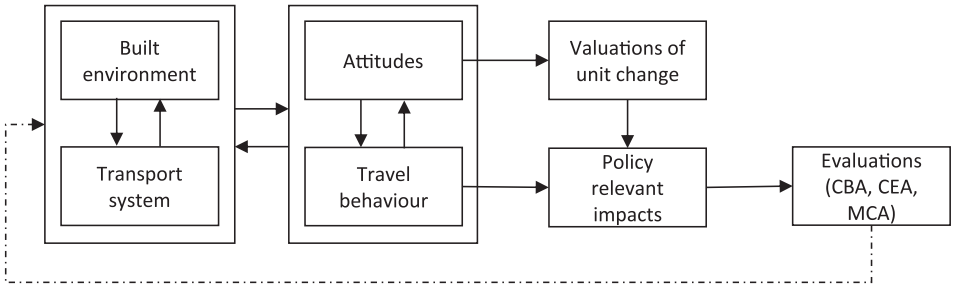

Fig. 2. Conceptualisation attitude changes and impacts on evaluations of candidate policy options.

conceptualization.

Fig. 2 shows that attitudes can change due to changes in the built environment, the transport system and travel behaviour. Attitude changes influence travel behaviour and the valuation of unit change, and both changes influence policy relevant impacts. Note that Fig. 2 does not distinguish between the disaggregate level of individuals (or households) and the aggregate level. Although this is very common in the land use, transport and travel behaviour literature (e.g. Cao et al., 2009; Heinen et al., 2018) this distinction can matter, as what happens on the macro level is not necessarily the sum of what happens on the micro level of the individual. For example, macro level changes in the transport system and the built environment can induce debates in (social) media, as a result of which attitudes and next travel behaviour can change. The feedback from the transport system and the built environment to attitudes and travel behaviour is included in Fig. 2, but this interaction between micro and macro level is not explicit. Because the point of departure of our paper is what happens on the macro level (because that is the aim of transport modelling and evaluations of candidate policy options), we do not further discuss this topic.

Finally these impacts are input for evaluation methods such as CBA, CEA or MCA, and thus the final outcomes of the evaluation of candidate policy interventions can change due to attitude changes. Note that, in an ideal world, policy evaluations would influence the changes made to the built environment and transport system (e.g. new infrastructure), yet, empirically, this link has not been found to be very strong (hence the dotted arrow) (Eliasson and Lundberg, 2010; Annema et al., 2017).

Effects of policy interventions on attitudes, and policy relevant impacts

Based on Figs. 1 and 2 we now briefly discuss policy interventions that could lead to attitude changes. A first cluster of interventions are those with respect to (changes in) the built environment (BE) (Van de Coevering et al., 2016). Such changes could be options for new residential, work or other areas, but also the reshaping of existing areas (urban renewal). The core is that the interventions influence the built environment to which people are exposed. This applies to built environment interventions in general, but certainly specifically to unconventional interventions, such as New Urbanism and Transit Oriented Development (TOD), or other European or Asian concepts (higher densities, mixed use, close proximity to public transport infrastructure – see Ewing and Cervero, 2010). If people are exposed to (for them) new types of urban environments, this exposure could influence their attitudes, via the cognitive, behavioural and affective processes as conceptualized in Fig. 1.

A second cluster of interventions are those that affect the characteristics of the transport system, i.e. the provision of new infrastructure (for example new light and heavy rail lines, charging infrastructure for electric vehicles), the introduction of new vehicle types (for example, shared vehicles, autonomous vehicles, micro mobility vehicles), and new services (for example, Mobility as a Service, sharing concepts, 24/7 timetables). In addition, changes could relate to the prices of vehicles and services, new designs of stations, airports, bus stops, vehicles, etc., new forms of information provision, factors changing the experienced social and road safety, and probably more. A very obvious example of a policy intervention in the transport system that could change attitudes is policies that influence automated driving. There is a lot of literature on automated driving, the societal implications, travel behaviour changes, and the value of time (Milakis et al., 2017; Milakis et al, 2020; Pudāne et al., 2018). There are also many examples, such as better public transport services, and certainly new travel options, such as maglev trains and the hyperloop. Also the introduction of new services such as Mobility as a Service could influence attitudes, as do car and bike sharing services.

The main point from the perspective of this paper is that changes in the built environment and the transport system can lead to attitude changes via multiple routes as conceptualized in Fig. 2. These changes in attitudes can lead to behavioural changes. A first category of

Table 1
Dimensions of travel behaviour, impact of attitude changes on those dimensions, and impacts on societally relevant impacts due to behavioural changes.

Dimension of Travel behaviour	Possible impacts of attitude changes on the dimension of travel behaviour	Societal relevant impacts
Number of trips, total and by mode	Changing preferences for travel in general, and by specific modes	Emissions, noise, safety, well-being, health
Number of kilometres travelled, total and by mode	,,	Emissions, noise, safety, well-being, health
Residential location choices	Changing preferences for types of residential areas	Additional to overall levels of emissions, noise, safety, well-being: local environmental impacts (noise, concentrations of pollutants, nuisance of driving and parked vehicles)
Destination choices	Changing preferences for activities at certain places, changing travel preferences	Additional to overall levels of emissions, noise, safety, well-being: local environmental impacts (noise, concentrations of pollutants, nuisance of driving and parked vehicles)
Route choice	A changing preference for more attractive or safer routes	Noise nuisance, concentrations of pollutants, health
Total travel time	Changing (dis)like for spending time on travel	Emissions, noise, safety, well-being
Time of day of travel	Changing attitudes towards congestion	Congestion levels, travel times, travel time reliability
Way of using vehicles	Changing preferences for driving styles	Emissions, noise, safety
Vehicle type choice	Changing preferences for specific vehicle types	Emissions, noise, safety of vehicle users and other road users
Interactions between dimensions above	Many combinations of the above changes are possible	All impacts listed above

behavioural changes are changes in travel behaviour. Table 1 summarizes the core dimensions of travel behaviour and why attitude changes could have an impact on those dimensions, and consequently on the societally relevant impacts, as a result of travel behaviour changes.

Attitude changes can first of all lead to travel behaviour changes, expressed in the number of trips and kilometres travelled by mode. Secondly people might change their residential location and their destinations because, due to their attitude changes, they developed other preferences for living, working, or doing other activities in specific environments. Third, the overall (dis)like for spending time on travel might change due to attitude changes. For example, a person who experienced cycling after moving to a cycling friendly environment might enjoy it, and prefer to cycle for half an hour to work, whereas she did not like to drive for half an hour. Fourth, the time of day of travel could change, for example due to a change in attitude due to experiencing changes in the discomfort of congestion or crowded public transport during the rush hours. Fifth, attitudes could change the way people drive vehicles (driving speed, aggressive driving or not). Sixth, attitudes towards specific vehicle types can change. For example, a person moving from a low density suburb to a high density compact residential area might shift preferences towards smaller cars because of the fact that that area might have more narrow streets, or smaller parking places. Finally, the dimensions can interact in multiple ways. For example, a person might prefer a smaller car after moving to a high density area, and subsequently might dislike long distance trips or driving under congestion conditions because the car is less comfortable, or might prefer to drive slower.

As Table 1 makes clear, several societally relevant effects could be influenced by travel behaviour changes. Emission levels (CO_2, pollutants, noise) could change, and therefore local concentrations of pollutants and noise levels, depending on local traffic. Also safety levels could change depending on transport volumes, the spatial and temporal distribution of travel, and the way of using vehicles. The well-being and travel satisfaction of people can change depending on modes used and the spatial distribution of travel and the conditions under which people use modes (see, for example, De Vos et al., 2013). Also the nuisance of driving and parked vehicles will be influenced by travel behaviour, as does congestion and travel time reliability. Finally health can be influenced by travel behaviour, first because cycling and walking are forms of exercise, also because travellers and others are exposed to pollutants, and because of accidents, and well-being changes (see Van Wee and Ettema, 2016, for a conceptualization of the links between travel behaviour and health). The quantitative magnitude of all such effects influence the results of ex ante evaluations of candidate policy interventions.

In addition to these quantitative effects for such ex ante evaluations the value attached of each unit also matters, examples being the value of time, the value of travel time reliability, and health indicators. Attitude changes could lead to other valuations. For example, people could be willing to pay less for travel time savings because they switched to a more comfortable car and that change could influence their attitudes towards spending time in their car. Or after starting to cycle or walk (more) they might experience improved health and well-being and realize how important such improvements are for them, and then value improvements more highly than before.

Implications for quantitative ex ante evaluations

Changes in travel behaviour and unit valuations are by definition relevant for any quantitative ex ante evaluation because the quantitative assessment of the pros and cons of policy options might be influenced. However, as long as the valuation of alternatives under consideration is changed equally the risk that the outcomes in terms of the order of preference of options for policy interventions will be influenced is not very large. For example, an overall increase or decrease in the value of travel time savings influences options for new road infrastructure roughly equally as long as all these options have roughly the same effect on travel times. It is then still possible that the difference between the reference scenario (the future without any of the policy interventions under study) and the intervention scenarios could be influenced. To give an extreme example: if in the future people did not care about congestion at all anymore, any policy to reduce congestion will have less benefits.

Changes in attitudes are more problematic, however, if some of the policy interventions influence attitudes more than other interventions that policy makers consider to be alternatives. If, for example, for new residential areas two scenario options are evaluated, one being the business as usual development of new residential areas at the outskirts of cities and towns, and the other option being infill locations near public transport nodes (stations, shops), with high densities and high levels of mixed use, it is quite likely that attitude changes would work out differently in both scenarios, and consequently the quantitative effects due to these attitude changes will be different. To give another example, if a city or region considers two scenarios for a future transport system, one being business as usual, the other being a shift towards walking and cycling, at the cost of the car, attitude changes that influence the pros and cons of that second scenario are likely. More specifically, for both examples we hypothesize that the attitude changes in the second scenario lead to more 'positive' effects than estimated using mainstream models, not only in absolute terms, but also relative to the first scenario. In more general terms we hypothesize that the positive effects of more sustainable and less conventional policies could easily be underestimated, in absolute terms, and relative to conventional policies. Formulated the other way around, more traditional policies (e.g. those focused on the car) may be unduly favoured.

A first message for ex ante evaluations is that it is important to explore whether attitude changes could be at stake, especially attitude changes that work out differently for the candidate policy interventions under consideration. It would also be relevant to explore the likely magnitude of the attitude changes, followed by the implications for travel behaviour, unit valuations, and the final results of ex ante evaluations.

Research implications

Empirical research

We realize that it is way easier to put the topic of attitude change on the agenda, than to suggest easy 'solutions'. There is a long way to go before attitude changes can adequately be addressed (quantitatively) in models that are used for ex ante evaluations of candidate policies. It will take many years before we are at that stage; the literature on attitude changes and the transport and built environment has only recently been evolving.

We first of all need to understand the role of attitudes on travel behaviour in general better, as a first step to understanding the importance of attitude changes: how should attitudes be measured, which attitudes play a role for which people, under which circumstances, and to what extent do attitudes influence travel behaviour? Note that mainstream transport models do include (heterogeneity in) sociodemographic characteristics of people and households, but not attitudes. In case of attitudes, also the heterogeneity in attitudes and attitude changes should preferably be included.

So the question of significance is not the only question to be answered, but also the question of the magnitude of the impact of attitudes on travel behaviour. In addition, not all attitudes are equally important from the perspective of the ex-ante evaluation of candidate policy interventions. Let us give two examples. First, if people have a positive attitude towards traveling by train, then it is more likely that they (ceteris paribus) will use the train more often, assuming train services are provided. And models including such attitudes will have more exploratory power than if such attitudes were not included. But what

does it tell, and how useful is it? And which evaluations of candidate policy interventions would be influenced by including attitudes or not? In this example we think the added value of including attitudes is limited, and could even be misleading because of the strong correlation between attitudes and behaviour. Another example could be attitudes based residential self-selection: if people with a positive attitude towards travelling by train self-selected into neighbourhoods near train stations, that impacts the influence of (policy induced changes in) built environment variables on travel behaviour. There are fierce debates on the interpretation of the relevance of such effects (Cao et al., 2009; Næss, 2014), one of the points made being that not all people are able to self-select in the desired way. It is beyond the aim of this paper to discuss that debate, but the point we want to make is that in this second example the inclusion or not of attitudes could have an impact on the evaluation of built environment policies and the interpretation of the findings.

A next topic for research is the better understanding of the 'right' causal structure. Do attitudes directly influence travel behaviour, or are they mediators or moderators? See for debates on causalities in the context of residential self-selection Cao et al. (2009) and Heinen et al. (2018).

Now that we have discussed the importance of research in the area of attitudes and travel behaviour in general, we next proceed with ideas in the area of attitude changes. To better understand the occurrence of attitude changes (who changes attitudes, under which conditions, and preferably also: why?) there is a strong case for longitudinal studies (see van de Coevering et al., 2015) focussing on changes in attitudes, behaviour, and explanatory variables such as changes in the built environment, live events, and societal trends (e.g. growing awareness of climate change) and possible impacts on attitudes. Cross-lagged panel models may then be used to assess the effects of attitudes on other relevant variables (and vice versa) over time (see e.g. Kroesen et al., 2017; Olde Kalter et al., 2021). Another option is to use latent class transition models which would be able to show which (groups of) people are more prone to attitude changes, and under which conditions (Kroesen, 2014; De Haas et al., 2018).

Empirical research in the area of attitude changes could distinguish users (of a policy intervention) from non-users. It is plausible to assume that the attitude changes of non-users will be weaker than those of users, although we cannot exclude attitude changes of non-users, assuming the causal model of Fig. 2. And users could be both those who already used the 'object changed by the intervention' (such as a specific transport mode, or a specific type of neighbourhood) before an intervention or project, and users who started using the object after the intervention.

But such studies need 'before and after' research, and real world cases, and take a long time. A 'faster' option could be empirical research into attitude change related to transport and the built environment based on retrospective questioning. Relatively simple questionnaires asking people about their attitudes after being exposed to new built environments or transport options are a first option. But it is not clear how reliable this methodology is, we do not know yet how well people are able to answer questions about attitude changes, so we should be careful with respect to this method. So this type of research might add value in the early explorative stages of research, rather than in later more mature stages aiming to come to quantifications of attitude changes, to be used in models for applying ex ante evaluations of candidate policy options (mainly: four step models). We refer to De Vos et al. (2021b) who give an overview of studies that have applied the methodology of retrospective questioning and debate this methodology.

A next option could be to rely on expert judgement. Expert judgment could be used to correct model outcomes. But first of all it will be very difficult to find the 'right' experts, because the topic of attitude change is underexplored, and secondly for several reasons expert judgements could be biased.

Finally, attitude changes could also be explored in stated preference studies by providing particular contexts. For example, in a straightforward mode choice experiment participants could be asked to consider the scenario that they live either in a car-free neighbourhood or a traditional neighbourhood. Given similar variations in travel costs and travel times for various travel alternatives, it would be interesting to assess whether the context independently alters the parameter estimates of travel costs and travel times of the various modes. Should this be the case, it could be concluded that the value people ascribe to travel costs and times is context dependent and that consequently attitudes can be influenced by residential environments. But such experiments do not in themselves reveal attitude changes.

Theory development

In parallel to empirical research, more theoretical work would be helpful to understand why attitudes change. A validation of the model presented in Fig. 2 could be a first example. Secondly, if in the future several such studies became available, that literature might allow for quantitative estimations of attitude changes and their impact on travel behaviour and unit valuations. Regression-based meta analyses could be a methodology to use empirical results for the estimation of attitude changes in other contexts. Finally, it would be interesting to explore the hypothesis that traditional policies that have been adopted in the past lead to less attitude changes than innovative policies. Should this be the case, a general implication would be that ex-ante evaluations unduly favour more traditional policies, e.g. policies focused on the car, at the cost of policies focused on innovative policies, that are generally focused on more sustainable modes.

Aggregate transport modelling

Finally, there is a cluster of challenges for transport models. In the previous section we already explained that some attitude changes are less important for ex ante evaluations than others, depending on the impact of those changes on the ranking or alternatives, or the comparison of alternatives and the reference scenario. The same line of reasoning also applies to models: it is important to distinguish different categories of attitude changes and implications for models. A first category is attitude changes that do not influence model parameters. Transport models are based on stated or revealed preference data, and at the time of data collection some people might have recently changed their attitudes as a result of the exposure to new built environment characteristics or transport system changes. And these attitude changes may have resulted in travel behaviour changes. The impact of such attitude and resulting travel behaviour changes is captured in the model parameters. As long as future attitude changes cancel each other out in terms of model parameter impacts, this is not a problem. The second category of attitude and behavioural changes are those that have general impacts on modelling travel behaviour, regardless of the policy intervention at stake. If, for example, people gradually changed their attitudes towards spending time in a car while driving because cars become more comfortable or self-driving, this might have an impact on the overall level of car use, but if models are used to compare different options for the extension of the motorway system such changes in attitudes will have roughly the same impact on the ex-ante forecasted effects of the policy options. Thirdly, it is possible that the attitude changes work out differently for alternative policy options, for example, public transport versus cars. Then the ex-ante evaluation of options to improve the motorway system or the train network might be significantly influenced by ignoring attitude and related travel behaviour changes. If in the future more quantitative results of empirical research in the area of attitude changes become available, both new empirical (case)studies on attitude changes, as well as meta analyses, the results could be integrated in transport models, such as the traditional four step transport model (including modifications of the original four step models), and land-use transport interaction (LUTI) models.

Concluding remarks

The implicit assumption of this paper is that it makes sense to conduct ex ante evaluations of candidate interventions. Zooming in on CBA and, as already briefly referred to above, the correlation between the quantitative overall outcomes and final policy decisions, is quite limited (Eliasson and Lundberg, 2010; Annema et al., 2017). This does not mean such evaluations do not make sense. They aim to inform decision makers and others, rather than determine which policy is the 'best' choice. It is possible that decision makers, mainly politicians, have other societal preferences than those assumed in a CBA. For example, a green party might weigh CO_2 emissions higher than assumed in a CBA. In addition, ex ante evaluations can lead to well-informed decision makers and other societal actors, such as interest groups, and they discipline the debate because they provide a point of departure to discuss candidate solutions for a problem or challenges, and societally relevant effects.

That being said, the argument made in this paper could be added to the critiques of ex-ante evaluation methods and interpreted as a caution regarding their use. Because these methods implicitly assume constant preferences, they neglect the idea that policies also shape our preferences. Ideally, innovative "out-of-the-box" policies should not be evaluated based on the current preferences, but instead be evaluated from the perspective of a hypothetical world in which preferences already might have changed in directions that can be expected by the policy in question. Indeed, this also points to a way to improve ex-ante evaluations, by performing sensitivity analyses that try to capture the expected shift in preferences (informed by research efforts formulated above).

The relevance of attitude changes goes beyond the ex-ante evaluation of the pros and cons of candidate policy interventions in the area of the built environment and travel behaviour. Attitude changes probably play a role in several other domains, such as energy, housing, ICT, food and education. And the relevance of attitude changes is not only for ex ante evaluations of policy interventions, but also for other topics, such as the understanding of success or failure of candidate innovations, and forecasting market shares of new products and services.

Author statement

Bert van Wee: study conception and design, manuscript writing.
Maarten Kroesen: manuscript writing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

References

Abou-Zeid, M., Ben-Akiva, M., 2014. Hybrid choice models. In: Hess, S., Daly, A. (Eds.), Handbook of Choice Modelling. Edward Elgar Publishing.
Ajzen, I., 1991. The theory of planned behavior. Org. Behav. Hum. Decis. Process. 50 (2), 179–211.
Annema, J.A., Frenken, K., Koopmans, C., Kroesen, M., 2017. Relating cost-benefit analysis results with transport project decisions in the Netherlands. Lett. Spat. Resour. Sci. 10 (1), 109–127.
Cao, X., Mokhtarian, P.L., Handy, S.L., 2009a. Examining the impacts of residential self-selection on travel behaviour: A focus on empirical findings. Transp. Rev. 29 (3), 359–395.
De Haas, M.C., Scheepers, C.E., Harms, L.W.J., Kroesen, M., 2018. Travel pattern transitions: applying latent transition analysis within the mobility biographies framework. Transp. Res. Part A: Policy Pract. 107, 140–151.
De Vos, J., 2022. The shifting role of attitudes in travel behaviour research. Transp. Rev. 42 (5), 573–579.
De Vos, J., Schwanen, T., van Acker, V., Witlox, F., 2013. Travel and subjective well-being: A focus on findings, methods and future research needs. Transp. Rev. 33 (4), 421–442.
De Vos, J., Cheng, L., Kamruzzaman, M.d., Witlox, F., 2021a. The indirect effect of the built environment on travel mode choice: A focus on recent movers. J. Transp. Geogr. 91, 102983.
De Vos, J., Cheng, L., Witlox, F., 2021b. Do changes in the residential location lead to changes in travel attitudes? A structural equation modeling approach. Transportation 48 (4), 2011–2034.
Eagly, A., Chaiken, S., 1993. The Psychology of Attitude. Harcourt, Brace & Jovanovich, Fort Worth, TX.
Eliasson, J., Lundberg, M., 2010. Do cost-benefit analyses influence transport investment decisions? Experiences from the – transport investment plan. Transp. Rev. 32 (1), 29–48.
Ewing, R., Cervero, R., 2010. Travel and the built environment. A meta-analysis. J. Am. Plann. Assoc. 76 (3), 265–294.
Heinen, E., van Wee, B., Panter, J., Mackett, R., Ogilvie, D., 2018. Residential self-selection in quasi-experimental and natural experimental studies: an extended conceptualisation of the relationship between the built environment and travel behaviour. J. Transp. Land Use 11 (1), 939–959.
Kroesen, M., 2014. Modeling the behavioral determinants of travel behavior: An application of latent transition analysis. Transp. Res. Part A: Policy Pract. 65, 56–67.
Kroesen, M., 2019. Residential self-selection and the reverse causation hypothesis: Assessing the endogeneity of stated reasons for residential choice. Travel Behav. Soc. 16, 108–117.
Kroesen, M., Chorus, C., 2018. The role of general and specific attitudes in predicting travel behavior – A fatal dilemma? Travel Behav. Soc. 10, 33–41.
Kroesen, M., Handy, S., Chorus, C., 2017. Do attitudes cause behavior or vice versa? An alternative conceptualization of the attitude-behavior relationship in travel behavior modeling. Transp. Res. Part A: Policy Pract. 101, 190–202.
Milakis, D., van Arem, B., van Wee, B., 2017. Policy and society related implications of automated driving: A review of literature and directions for future research. J. Intell. Transp. Syst. 21 (4), 324–348.
Milakis, D., Thomopoulos, N., van Wee, B. (Eds.), 2020. Policy Implications of Autonomous Vehicles. Elsevier Series Advances in Transport Policy and Planning, vol. 5. Elsevier, Cambridge/San Diego/Oxford/London.
Mouter, N. (Ed.), 2020. Standard Transport Appraisal Methods. Elsevier Series Advances in Transport Policy and Planning, vol. 6. Elsevier, Cambridge/San Diego/Oxford/London.
Næss, P., 2014. Tempest in a teapot: The exaggerated problem of transport-related residential self-selection as a source of error in empirical studies. J. Transp. Land Use 7 (3).
Olde Kalter, M.J., Puello, L.L.P., Geurs, K.T., 2021. Exploring the relationship between life events, mode preferences and mode use of young adults: A 3-year cross-lagged panel analysis in the Netherlands. Travel Behav. Soc. 24, 195–204.
Ortúzar, J.d.D., Willumsen, L.G. (Eds.), 2011. Modelling Transport. Wiley.
Pudāne, B., Molin, E.J.E., Arentze, T.A., Maknoon, Y., Chorus, C.G., 2018. A time-use model for the automated vehicle-era. Transp. Res. Part C: Emerg. Technol. 93, 102–114.
van de Coevering, P., Maat, K., van Wee, B., 2015. Multi-period research designs for identifying causal effects of built environment characteristics on travel behaviour. Transp. Rev. 35 (4), 512–532.
Van de Coevering, P., Maat, K., Kroesen, M., van Wee, B., 2016. Causal effects of built environment characteristics on travel behavior: A longitudinal approach. EJTIR 16, 674–697.
Van Wee, B., Ettema, D., 2016. Travel behaviour and health: A conceptual model and research agenda. J. Transport Health 3 (3), 240–248.
van Wee, B., De Vos, J., Maat, K., 2019. Impacts of the built environment and travel behaviour on attitudes: theories underpinning the reverse causality hypothesis. J. Transp. Geogr. 80, 102540.