Chapter 7
Cost-Benefit Analysis and Evaluating Transport Safety Effects: A Discussion from the Perspective of Ethics

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7.1 Introduction

Transport is crucial for society: Societies cannot function without the transport of people and goods. It enables us to participate in many activities at different locations, such as living, working, education, shopping and visiting relatives and friends. In addition, it allows us to transport goods, from the locations of mining of raw materials, via several production stages, culminating in the shops where people buy products, or even up to the final locations of use, such as houses or offices. The transport system is heavily influenced by public policies. For example, governments decide where and when to build new infrastructure, even in countries that have privately owned infrastructure, such as France and Portugal. Governments set regulations for safety (examples include vehicles, crash worthiness; infrastructure, design; speed limits; persons, alcohol; age of being allowed to drive a car), emission of pollutants (CO_2 and noise) and decide on levies on vehicles and fuels. Governments make dedicated public transport policies.

Policy making in general, and therefore also transport policy making, implies making choices, in case of infrastructure-related policies, examples being budget allocations for infrastructure in general and choices between alternatives for a new road or railway line. Because of all the choices to be made, there is a huge need for

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ex ante evaluations of choice options. An important question therefore is how to evaluate potential options for future transport projects and policies. (Social) Cost-benefit analysis (CBA) nowadays is a very popular ex ante evaluation method in many countries (Hayashi and Morisugi 2000; Bristow and Nellthorp 2000; Grant-Muller et al. 2001).

One of the important effect categories is safety effects. Although since the early 1970s in most western countries the numbers of fatalities have decreased, despite a huge increase in transport volumes, per 10 million inhabitants, hundreds of people get killed each year in crashes. Consequently, safety effects are important, both from a general policy perspective and from the perspective of the ex ante evaluation of candidate policy options. These options can be transport options in general (such as options for new infrastructure) or specifically related to safety. In CBA, the ex ante evaluation of safety effects is generally based on the so-called willingness to pay of consumers: How much money are consumers prepared to pay for a reduction in risks? This chapter aims to discuss this practice from an ethical perspective.

The remaining part of this chapter is organised as follows: Sect. 7.2 introduces the reader to the current state of the art with respect to CBAs for transport. Section 7.3 explains in more detail how CBA deals with safety effects. Section 7.4 is the core of this chapter and discusses the way safety effects are included in transport CBAs. Section 7.5 discusses the implications of the findings for (spatial) policies. Section 7.6 finally summarises the main conclusions of this chapter and briefly discusses the implications for decision making.

7.2 CBA for Transport: An Introduction

Basically a CBA is an overview of all the pros (benefits) and cons (costs) of a project. These costs and benefits are as much as possible quantified and expressed in monetary terms. Benefits are in general based on consumer preferences.[1] Costs and benefits occur in different years within the time horizon of the CBA. To deal with this, they are presented as so-called net present values, implying that taking into account interest and inflation, it is better to have 1 euro or dollar nowadays than in, for example, 2030. The discount rate is used to express this valuation. Final results are often presented in summary indicators. The main indicators that are presented are the difference between costs and benefits, the return on investment and the benefit to cost ratio. Almost every handbook on transport economics pays attention to CBA in transport (see e.g. Blauwens et al. 2008; Button 2010).

There are three major explanations for the popularity of CBA in the ex ante evaluation of infrastructure projects and its role in decision making – these reasons are the main strengths of the method. The first explanation is that most costs and benefits are well known, the second is that models to forecast demand are generally available and the third is that CBA is a relatively "neutral" evaluation method. We will discuss both explanations in more detail below.

In case of possible future transport policy options, certainly in case of infrastructure options, costs and benefits are quite well known. Investment, maintenance and operation costs can be derived from data from projects constructed in the past, or from tenders. The most important benefits are travel-time savings, both for travellers and freight transport. Models are generally used to estimate the demand of passengers or volumes of goods transport that will benefit from a new project, as well as time savings. Next, the so-called value of time (VOT) is used to express shorter travel times in monetary terms. VOT is higher for business travel and goods transport than for commuting, and leisure travel has the lowest value of time. VOT differs between modes, income classes and some other characteristics of travel and travellers (e.g. Gunn 2001). Note that the travel-time savings, often being the most important benefits of infrastructure projects, are not fully expressed in GDP. Travel-time savings for business trips and goods transport lead to higher productivity and lower costs and have an impact on GDP, but if a commuter can leave home later because commuting times are reduced, or because it takes less time to travel to a relative, GDP is not affected. In CBA, it is common to have a broad approach for welfare, implying that all benefits for consumers are included, even if they are not incorporated in GDP.

The second reason for the popularity of CBA is the general availability of models for demand forecasts. The overview of CBA relevant impacts is generally based on state-of-the-art methods, modelling being the method of preference in most cases. In general two categories of models are used, the first one being transport models and the second being impact models (emissions, safety). Many western regions and countries have state-of-the-art models available, at least transport models, but often also impact models, though impact models, especially safety models, are often quite simple – they multiply travel volumes (in general or per mode, or car use only) with risk factors.

The third reason for the popularity of CBA is its often-assumed "neutral" characteristic as opposed to its main competitor: multi-criteria analysis (MCA). In MCA, effects are presented and weighed using weights per effect. Setting the weights is not at all value free. It is therefore much easier to manipulate the final outcomes of an MCA compared to a CBA.

Despite these strengths, several weaknesses exist. It is beyond the scope to give a full overview. Briefly summarising important weaknesses relate to the quality of cost estimates, in some case, the quality of travel demand forecasts; the difficulty to estimate wider economic effects; the difficulty to monetise some categories of effects, such as effects on nature or the quality of the urban environment; the general ignorance of distribution effects (who gains, who loses?); and the poor way of communication of results to nonexperts.

CBA is aimed to allow for a welfare evaluation. The focus on welfare implies a utilitarian perspective. Utilitarianism is the most popular theory of a family of ethical theories called consequentialism. Utilitarianism is a theory within the wider family of consequentialism. Consequentialism "is the view that normative properties depend only on consequences" (*Stanford Encyclopedia of Philosophy*). Utilitarianism, more specifically act consequentialism, "is the claim that an act is

morally right if, and only if, that act maximizes the good, that is if, and only if, the total amount of good for all, minus the total amount of bad for all, is greater than this net amount for any incompatible act available to the agent on that occasion" (*Stanford Encyclopedia of Philosophy*). Utilitarianism provides an ethical foundation of CBA: A CBA compares policy options from the perspective of utility. The utility of distinguished effect categories is mainly based on the willingness to pay (WTP) of consumers.

7.3 Safety in CBAs

Also monetary valuation of changes in safety levels is based on the willingness to pay (WTP) of consumers for lower risk levels. A concept that can often be found in monetary valuations of safety effects is the value of a statistical life (VOSL). In economics and in the transport and safety community, monetary valuation of risk changes is much more common than in some other areas, such as in the health sector. An often used "solution" to (potential) moral criticism to express safety in monetary terms is to not price lives directly, but to use what is called a "statistical life". The result is the VOSL, also abbreviated in literature as VSL. The VOSL is an "anonymous indicator" that is used to place a monetary value upon a change in the estimated number of fatalities in traffic over a certain period of time under given circumstances. In fact, a value is put on risk, and this risk is multiplied by traffic or travel volumes. Proponents argue that people may not be able to say how much their life is worth, but they are able to say how much they are prepared to pay for lower risks. And if we know the WTP for lower risks, we have an indication of the VOSL. Examples of choices that people make that give an indication of the WTP could be the safety features in cars (such as additional airbags) or preferences with respect to driving speed (and related travel times).

This implies that the term VOSL is actually somewhat misleading. Its essence is that it represents the valuation of people exposed to travel risks in terms of an amount of euros and dollars (or other currency) per unit of risk reduction. Hence, the use of the VOSL concept is nothing more than a handy way to represent consumer's preferences for risk reductions. The standardisation to the willingness to pay per 1 statistical life saved is, strictly speaking, superfluous. An obvious advantage of the concept of the VOSL is that it is easy to use for communication purposes. The essence of the economical approach is not "pricing human lives", but "pricing human risks".

7.4 Discussion on Current Practice of Including Safety in CBA

Despite its popularity, CBA is often criticised. van Wee (2012) gives an overview of the criticisms as found in literature. Here, we limit the discussion to the inclusion of safety effects in CBA. van Wee and Rietveld (2013b) discuss the current practice of including safety effects in CBA. More specifically, they discuss the following questions:

1. Is it morally acceptable to express (prevention of acceptance of) fatalities or risks in monetary terms?
2. How useful is the concept of the value of a statistical life (VOSL) for ex ante evaluations of transport policy options?
3. What are the pros and cons of expressing (prevention or acceptance of) fatalities or risks in monetary terms in ex ante evaluations?
4. Which methods are available for expressing (protection of) human lives in monetary terms, and what are the main related methodological discussions?
5. Are all safety-related costs generally included in ex ante evaluations of the safety impacts of transport policy options, and if not, what is the relevance of excluded costs categories from an ethical perspective?
6. How important is the distribution of safety effects from an ethical perspective?

They discuss these questions from the perspective of transport safety but state that the discussion might also be relevant for other areas of application, such as risks in industry – see, for example, Evans (2009) who reflects on this topic. Here, we present a summary of the discussions.

7.4.1 Is Pricing Risk Changes Acceptable?

Within the community of persons involved in ex ante evaluations of transport plans and policies, the subject of pricing human lives is one of the most controversial. Some think intuitively that it is immoral to price human beings, others highly support doing this. We will not give a clear and indisputable answer to the question in the heading of this subsection: There is no clear answer. The answer depends on the ethical theory one uses as a basis. The two most extreme positions probably follow from the Kantian perspective, an influential perspective in a category of ethical theories called "deontology" and the utilitarian perspective, an influential perspective in a category of ethical theories called "consequentialism".

Deontology is a category of ethical theories regarding which choices are morally required, forbidden or permitted. In other words, deontology falls within the domain of moral theories that "guide and assess our choices of what we ought to do" (*Stanford Encyclopedia of Philosophy*). Deontologists hold that at least some fundamental moral principles, rules or ideas are to be followed, regardless of the outcomes. The most well-known deontologist is Immanuel Kant. In this chapter, we firstly discuss the Kantian perspective because of its "extreme" position. Kant developed the so-called principle of the categorical imperative. We cite Audi's (2007) formulation because it is much simpler than the original formulation by Kant: "Act in such a way that you always treat humanity, whether in your own person or in the person of any other, never simply as a means, but always at the same time as an end". This applies to oneself as well as to others. Everyone matters and matters equally. Although a Kantian perspective does not directly relate to risks, one could argue such a perspective could lead to the conclusion that pricing the value of a human life is immoral.

People should not be considered as a means to something else. It would then follow, for example, that shorter travel times cannot compensate for a reduction in safety: Travel-time savings should not come at the cost of additional risks for others. This perspective can, but does not necessarily have to, be derived from a Kantian perspective. When considering transport projects and policies, a potential problem with the Kantian perspective is that the ex ante evaluation of transport projects and policies relates to *statistical* lives; there are no clearly defined people who will lose their lives. We consider probabilities, not specific individuals.

7.4.2 The Utilitarian Perspective

We have introduced utilitarianism above. A utilitarian perspective on valuing safety holds that people may not necessarily price their own life or the life of others, but they do value risks. For example, a person buying a new car considers the safety level (at least the perceived level of passive safety, the crash worthiness of a car, as expressed in the Euro NCAP ratings) but also many other characteristics of a car, such as price, size, performance and emotional values. And people know that driving 120 km/h is less safe than driving 100 km/h, but they trade-off travel time, and maybe the fun of driving, and safety (and fuel costs). So maximising any form of utility should include safety. And this can be done, based on the preferences of humans as consumers or – more generally – persons making choices.

Some have even claimed that striving for maximum safety levels is unethical. An example is provided by the discussion on the Swedish Vision Zero (for road traffic). One of the architects behind the vision, Claes Tingvall, stated that the requirements of the vision were so strong that "whenever someone is killed or seriously injured, necessary steps must be taken to avoid a similar event" (Tingvall and Haworth 1999).[2] This position is claimed to be naïve, overly ambitious and even unethical (Fahlquist 2006). Elvik (1999) asserts that the aim to eliminate road traffic deaths would demand such substantial resources that other areas where people's lives are also at risk would suffer.[3]

7.4.3 Deontology: The Doctrine of Double Effect

In addition to the two most extreme positions with respect to pricing changes in safety levels, we now discuss one of several "in-between positions". The position is based on the deontological principle of the "doctrine of double effect", according to which there is a moral difference between causing harm or evil as an unintended side effect of an intended action or policy, and intending the harm of evil directly, either as an end or as a means to an end. From this perspective, it would at least make a difference if a fatality resulted from immorally risky driving behaviour by someone who deliberately endangers the life of others or from "normal" driving behaviour. People who drive riskily do not intend to harm others (or themselves), but they accept endangering others. Examples

include drunk driving and speeding. In general, a follower of deontological principles would be reluctant to price accident risks, although the introduction of the distinction between intended and unintended effects according to the "doctrine of double effect" might lead to a refinement of this position. This refinement could be relevant if the position is linked to policy because the two kinds of effects may well differ in their preventability by policy interventions. One could argue, however, that from the perspective of consequentialism, no difference should be made between a fatality resulting from immoral driving behaviour and a fatality resulting from a "normal" accident.

To summarise, there is no clear answer to the question of whether pricing human lives is right. One could wonder: Why discuss the question at all? Our answer would be that we should respect the positions of people who support both sides of the argument.

7.4.4 How Useful Is the Concept of the Value of a Statistical Life (VOSL) for Ex Ante Evaluations of Transport Policy Options?

Above we have introduced the VOSL. This is a seemingly simple concept: Ask for peoples' WTP and derive monetary values for risk reductions from their answers. However, applying the concept is not completely straightforward, a first reason being that the concept of the VOSL (and certainly how it is used in practice) assumes no relationship between the VOSL and risk levels. However, the level of risk can have an impact on the VOSL because it has an impact on choices and WTP. Generally speaking, the higher the risk, the higher the monetary value people put to a constant unit of output (Morton 1991; Hammitt 2007). For example, people might be willing to accept a risk of 1/10,000 for 200 dollars (resulting in a VOSL of two million dollars), but only very few people will accept a risk of 50 % for 4 million dollars. Therefore, the risk level can cause variations in the outcomes of choices, leading to other VOSLs. In other words, the patterns of choice, and thus also the VOSLs, are *risk level dependent*. Due to the increase in VOSL with increasing risk levels (the VOSL could approach infinity for risks nearing the value of 1), it can even be argued that the VOSL is not the same as the value of an unidentifiable person's life (Hammitt 2007).

Secondly, if the VOSL is based on people's choices, it assumes a "correct" perception of the risks. The usefulness of VOSL could be questioned if it is based on a misperception of the risks by people. For example, from research, it is known that people are not very able to deal with very small risks and to translate a small risk reduction into a monetary benefit (Kahneman and Tversky 2000; Kahneman et al. 1982, 1999; Kahneman and Knetsch 1992; De Blaeij 2003). VOSL based on WTP for lower risks may be primarily useful if risk levels in a particular ex ante evaluation matches those of the cases of the stated or revealed preference research. Below we further discuss the problem of discrepancies between objective and subjective safety levels.

Thirdly, the VOSL generally includes a valuation of the statistical lives of the people involved, but not their descendants, though there could be a good point in doing so (see Broome 2005; the explanation is quite complicated and is beyond the

scope of this chapter). This point refers to the conventional way of doing WTP research in this area – questions do not explicitly relate to descendants that could be born in the future but are not due to fatalities. A well-designed research could nevertheless include related questions.

Fourth, if one argues that each person is equally important and thus the VOSL (at least within one country) should not depend on income levels, an inconsistency can occur between the VOSL and the value of time (VOT), or more specifically the marginal value of travel-time savings (MVTTS). Below we will use the term VOT. This is because the VOT is income dependent: VOT for higher income groups is higher than for low income groups. The inconsistency only occurs in case an income-dependent VOT would be used. As a result, high income groups score better in a CBA than lower income groups (e.g. Mackie et al. 2003). As a reaction, the so-called "equity value of time" was introduced in virtually all CBAs carried out in the USA and abroad. The equity value of time is based on an average income level (Morisugi and Hayashi 2000).[4] Note that our discussion relates to evaluations, not to forecasting behaviour. In the latter case, person-dependent VOTs and risk acceptance levels should be used.

7.4.5 What Are the Pros and Cons of Pricing (Prevention or Acceptance of) Lives or Risks in Case of Ex Ante Evaluations?

The consideration that pricing of risks is unethical is an extremely powerful argument, probably strong enough to overrule all other arguments for those who accept it. On the other hand, there may be good reasons to value human lives. One reason is that people trade-off safety levels and other impacts of their choices anyway, so using a monetary value for the changes in risks (and, multiplied with volume indicators, resulting in the number of fatalities) based on peoples preferences contributes to a balanced way of including peoples preferences in ex ante evaluations.

A second, and related, reason could be that if a CBA is carried out anyway, outcomes of interest that are not expressed in monetary terms probably have less impact on decision making. Many researchers and policy makers have the impression that decision makers, certainly in the case of a CBA, primarily look at financial indicators such as benefits minus costs, the benefit to cost ratio or the return on investment. If safety is not included, its impact on decision making could be less compared to including safety in monetary terms. Hills and Jones-Lee (1983, p. 355) reflect on the risks of inconsistency and allocative efficiency: "If inconsistency and allocative inefficiency are to be avoided, then explicit monetary costs of accidents and values of accident prevention are required". An equal amount of discussion can also be found in the literature on intergenerational justice: Risk reductions come at a cost. The price of risk reductions to zero can easily be too high (Davidson 2009).

7.4.6 Which Methods Are Available for Expressing (Protection of) Human Lives in Monetary Terms, and What Are the Main Related Methodological Discussions? An Overview of Methods

The current state of the art in valuing changes in safety levels is that both material and nonmaterial costs should be included (De Blaeij et al. 2003). Material costs include damage to vehicles and in some cases also infrastructure, loss of production of people and costs of medical treatment. Immaterial costs include loss of the quality of lives of the victims and the people who care about them (family, friends, others).

Several methods are available to express protection of human lives in monetary terms. A first distinction can be made between consumer-based and other methods. In the CBA community, the impression is that consumer-based preferences are generally to be preferred: Who else is better able to value the importance for consumers than the consumers themselves? We will discuss related methods below. Nevertheless, it is good to realise that other methods also exist. Such methods are labelled as "costs per life saved methods" (De Blaeij 2003). Such methods mainly look at choices of policy makers in the past: One can look at the implicit VOSL that results from policy measures taken in the past. This could be done within or outside the transport system. Examples in the transport system could be safety regulations to reduce the risks of car or rail accidents; examples outside the transport system could be regulations for safety standards in industry.

In the category of consumer-based methods, a distinction can be made between willingness to pay (WTP) and willingness to accept (WTA) methods. WTP relates to the willingness to pay for any improvement, such as a reduction in risk levels. WTA relates to the willingness to accept any losses, such as an increase in risk levels, for example, due to other car drivers driving faster. For several reasons, WTP values are of more use than WTA values. One of the reasons is that WTA values that follow from questionnaires could be biased because of strategic behaviour of respondents. In addition, WTA can more easily be nonrealistic: People might (implicitly or explicitly) suggest that they have a much higher WTA measures that will yield risk reductions than they are really prepared to pay for given the choice (see e.g. Hanemann 1991; Perman et al. 2003).

7.4.6.1 A Discussion of Methods

Below we will discuss these methods using ethical theory. An important issue in the valuation of safety is the question: Does each fatality have an equal value or not? If one answers this question with "yes", the conclusion would be that it is as bad if a 90-year-old blind and deaf person dies 2 weeks earlier than he or she would otherwise have done due to high concentrations of ozone, as when a 15-year-old school child gets killed in a road accident. Only a few people would agree. If the answer is negative, the question is: which method to use? There are at least two options: the

WTP as discussed above and the concept of QALYs (quality adjusted life years). We first discuss this concept, followed by a discussion on the inconsistencies between QALY and the WTP-based VOSL.

The concept of QALY is introduced to express the combination of quality and quantity of lost life years. The concept is widely applied in health-care decision making (Loomes and McKenzie 1989). The QALY concept firstly has the advantage that the quantity and quality of lost life years do count. A second advantage is that it can also be used to include injuries causing permanent negative health impacts: Even if the quantity of life years of an injured person remains the same, the loss of quality can be expressed. A major point of discussion is that it is disputable whether very young persons should be compared with others. To quote Morton (1991, p. 112), "for very few people would think that, for example, one should sacrifice more for the safety of a newborn baby than for that of a fifteen-year-old child".

We now continue the discussion comparing QALYs and the WTP. It is important to realise that an inconsistency can occur between WTP and the concept of QALYs. A good overview of the discussion on WTP versus QALYs can be found in Hammitt (2002). He states that although both methods are based on individual preferences, the underlying assumptions differ. The different bases yield systematically different conclusions about the relative value of reducing health and mortality risks to individuals that differ in age, health conditions, income and other factors. The choice of which method to use depends on judgments about what constraints should be placed on individual preferences and what factors should be considered in aggregating preferences across people. Estimates of QALYs are likely to be less variable across people and studies than estimates of WTP because the QALY framework imposes greater constraints. To quote Hammitt (2002, p. 998), "QALYs impose substantial and somewhat unrealistic constraints on the form of individual preferences and combine preferences across people on a relatively egalitarian basis. In contrast, WTP imposes few constraints on individual preferences and gives relatively greater weight to more affluent sectors of society".

The inconsistency between QALYs and WTP firstly relates to the relationships between age and both concepts. Researchers have explored the relationship between the WTP for a statistical life and age. For example, Shepard and Zeckhauser (1984) found that VOSL peaks near age 40 and is less than half as large at ages 20 and 65. The increasing VOSL between the age of 20 and 40 contradicts the QALY concept. An explanation may be that between the age of 20 and 40 income increases. But probably even a person having an increased WTP between the age of 20 and 40 might prefer to get killed in a road accident at the age of 40 rather than at the age of 20. So the inconsistency is notable. De Blaeij (2003) found another example of such an inconsistency between the QALY approach and the VOSL approach, stating that the VOSL peaks between 50 and 65, and hence only starts to decline beyond 65 years. In De Blaeij's analysis, a correction was applied for income levels; hence, the age pattern was not distorted by age-income interrelationships.

The inconsistency between QALYs and WTP next relates to travel mode. For the concept of QALYs, it does not matter how people are killed in a road accident, but for WTP, it may matter. This is illustrated by Johansson-Stenman and Martinsson

(2008) who did research on people's general *ethical preferences* and the value of life. They combine age and mode. The results reveal not only a strongly decreasing "ethical preference value" of a life with age (giving support for the concept of QALYs over WTP); in addition, it shows that pedestrian fatalities are valued higher than fatalities of an equivalent driver.

A third potential inconsistency between QALYs and WPT arises with respect to children. Children hardly have any money, so their WTP for reduced risks will be very low. One can seriously debate if even doing research into the WTP of children for risks is morally acceptable. One could argue that what then matters is the WTP of their parents (Leung and Guria 2006). But suppose a 10-year-old child lost her parents. Would that mean that the WTP for risk reduction of that child is hardly more than zero? Would it make the life of the orphan child of less value than the life of her friend that still has both parents? And if the parents still live, the WTP for reduced risks of children may very well depend on income as well as on the number of children they have. Would this really matter? Many people would feel uncomfortable answering these questions with "yes".

The fourth inconsistency between QALYs and WTP results from the distinction between risky behaviour and people in general. Again this distinction is not relevant for the QALY concept, but it may be for WPT. In literature, a distinction is made between people who utilise substances that are bad for their health, such as smokers and users of illicit drugs, versus people in general. Researchers have found several differences (Johansson-Stenman and Martinsson 2008). People think that persons responsible for their own bad health should be given lower priority (e.g. Anand and Wailoo 2000, Cookson and Dolan 2000). Accordingly it could be that the public's opinion on WTP for risk reductions is lower in case of people with risky behaviour, compared to the wider public.

The fifth inconsistency between both concepts follows from a distinction between involuntary risks versus voluntary risk. This distinction is not relevant for QALYs, but it is for people's ethical preferences and related WTP. People think involuntary risks are to be valued higher (e.g. Slovic et al. 1985; Mandeloff and Kaplan 1989).

Sixth, people think that risks that are difficult to avoid should be valued higher than those that are not (e.g. Subramanian and Cropper 2000), a distinction that is not relevant from a QALY perspective.

Note that several of the differences in ethical preferences do not match the utilitarian perspective taken in a CBA; from a utilitarian perspective, it would not matter whether, for example, a person gets killed in an accident that was easily avoidable or not. But CBA would favour spending on effective measures to prevent avoidable accidents overspending on vain attempts to prevent unavoidable ones.

It has to be added that the above discussion on the valuation of life risks of different categories of people is somewhat theoretical if it is compared with real-world applications of the VOSL in the cost-benefit analysis of transport policies. Real-world applications tend to avoid the use of differentiation values for different types of people at risk and just apply an average value. There are probably two reasons for this. First, the overall quality of estimates of VOSL is probably not strong enough to allow specific values for various subgroups. Second, the researchers responsible for

the cost-benefit calculations may fear debates about "unethical" assumptions on which the calculations are based. They prefer therefore to stay on the safe side by using just the average VOSL. A similar reason would be that researchers doing CBA would anticipate that the application of strongly differentiated VOSL levels might lead to conclusions that decision makers might find difficult to swallow, like a low priority for traffic safety themes that would in particular benefit children. Thus, by using an average value for the VOSL, analysts responsible for CBA make sure that the potential gap between market-oriented economics-based policy support on the one hand and the domain of policy convictions and equity concerns on the other hand can be kept to a manageable size.

A second subject for methodological discussion is discounting future safety effects. Discounting reduces the value attributed to long-term benefits. Applying usual discount rates to protection of human lives would reflect a preference for preventing a person's death now over preventing the death of an equivalent person in the future. This makes perfect sense in the context of CBA. Consider, for example, the case that an investment has safety benefits now compared with an equally expensive investment that has identical safety benefits in the future. Then it makes sense to prefer the investment with immediate effect over the one with delayed effect. Along similar lines, not discounting the benefits of investments in terms of lower probabilities of death (or higher QALYs), while at the same time discounting the costs of such measures, leads to the implausible result that postponing this investment is always to be preferred (e.g. Keeler and Cretin 1983; Hammitt 2002). The reason is that postponement would lead to lower costs given the discounting, whereas the benefits would remain unaffected. Thus, the case for discounting VOSL or QALYs is stronger than one might think. Johannesson et al. (1994) indicate that a limited change in definition – and measurement – of QALYs would suffice to allow discounting within this concept.

A third subject of methodological discussion is related to the fact that objective safety and perceived safety do not always match. Traffic situations can be unsafe, but people do not always perceive that to be so. Alternatively, objective numbers show that risk levels are low, but people might feel unsafe. Research has shown that the correlation between objective and subjective safety is often poor, not only in the area of road safety (Vlakveld et al. 2008) but also elsewhere in society (Nilsen et al. 2004). Does this matter? From a CBA (utilitarian) perspective, the answer could be that it matters if people are willing to pay (WTP) for an increase in perceived safety *even if the objective safety does not change by an equal amount*. This subject can be seriously debated. People might be prepared to pay for increased safety but only if objective safety increases. If they initially thought that a traffic situation would become safer, but they find out – or are informed – later that it does not, one can seriously doubt the WTP for increase perceived safety. In fact, one can doubt if perceived safety will increase at all if people know the real safety levels.

A fourth subject for methodological discussion is the interaction between risk influencing factors. In the case of road safety, risk levels result from (at least) driving speed, the use or otherwise of protective devices of cars (active and passive safety levels), infrastructure characteristics and the quality of the health-care system.

In addition, some of these determinants interact, and this interaction has an impact on the final risk levels. For example, if cars become safer, drivers may drive faster. But the combined impact on risk levels may be infrastructure dependent. Understanding such interactions is primarily a challenge for researchers. But an important ethical question is whether changes in determinants and their interactions should firstly have design consequences and secondly consequences for evaluating designed options. Should, for example, safer cars lead to higher maximum speeds at motorways? Calculations based on the "optimal" design of speed on motorways from a utilitarian perspective would argue so. On the other hand, higher speeds can lead to changes in the distribution of risks. For example, low income people may have smaller, less safe cars and drive at lower speeds compared to high income people with big, new, safer cars. Would that matter? Egalitarian theories would argue that it does; consequentialism would probably conclude that it does not.

Finally, a methodological discussion is the transferability of results over time and space. To start with the transferability over space, it can be highly ethically problematic to transfer the outcomes of one country to another country. For example, the VOSL based on WTP in the USA will not be of value for evaluating the lives of people in Bangladesh, and vice versa. For a discussion of the impact of the world region under consideration on the ethics of fatalities, see Lorenzo et al. (2010). In addition, the transferability of VOSLs over time deserves attention. If people get richer, their WTP for risk reductions is likely to increase. But are the lives of rich people of more value than those of poor people? In other words, is the WTP the best method for valuing a statistical life? On the other hand, an ageing population would – ceteris paribus – lead to a decrease in the VOSL if it was based on the concept of QALYs.

7.4.6.2 Are All Safety-Related Costs Generally Included in Ex Ante Evaluations of the Safety Impacts of Transport Policy Options, and if Not, What Is the Relevance of Excluded Costs Categories from an Ethical Perspective?

We argue that a certain category of avoidance costs is missing in CBA. We firstly introduce the concept of avoidance costs, followed by a discussion of a specific category of avoidance costs that is generally missing in the societal ex ante evaluation of policy options.

Avoidance costs are costs made to improve safety and can be split into several categories:

1. Infrastructure-related costs
2. Vehicle-related costs
3. Costs related to the health system
4. Costs related to changes in human behaviour

The first three categories are usually included in CBA and will not be discussed here. The fourth category of avoidance costs is the costs of changes in human behaviour

due to (perceived) changes in safety. People can adapt their behaviour because they perceive safety levels to be low. For example, older persons may prefer to stay at home because they think travelling is too risky. Or they may travel by taxi because they perceive cycling to be too risky. Or a person may prefer to cycle but travels by car because of a perceived low safety level of cycling. In addition, parents may not allow their children to travel to school independently because of a certain (perceived) risk and therefore bring their children to school themselves. Or they may want them to use the school bus instead of cycling to school. Such adaptations come at a cost. In addition, if adaptations result in a decrease in the use of slow modes, there are losses related to health. For example, the health benefits of cycling are substantial. In a Norwegian study on costs and benefits of cycling infrastructure in cities, these benefits count for more than half (55–75 %) of all benefits of cycling (Saelensminde 2004).

So at least theoretically, avoidance costs are relevant for ex ante evaluations. But are they in practice? We think in many cases the *changes* in perceived risks due to candidate policy options are very low, and consequently, the impact of ignoring avoidance costs may be small. But in some cases, they could matter, examples being changes in maximum speeds on distinguished road classes or the planning of schools and related routes between homes of school children and schools. In addition, they are relevant when an estimation of the total costs of safety needs to be made.

7.4.6.3 How Important Is the Distribution of Safety Effects from an Ethical Perspective?

It is very possible that the pros and cons of policy options related to safety in the transport system are not equally distributed across the population. This distribution is relevant from an ethical perspective. Trade-offs may exist between car users and others (e.g. children, elderly who do not drive). Such trade-offs exist in both directions. It is the non-car user who benefits from restrictions with respect to car use at the cost of car users. If priority is given to car users, the latter benefit, at the cost of the non-car users. If and how distribution-related impacts should be evaluated depends on the ethical perspective. CBA and a related utilitarian perspective would allow for a straightforward calculation of utilities, either simply summarised in the value of a single indicator or accompanied by an estimated distribution of benefits and disbenefits over various categories of affected (groups of) people. However, egalitarian theories would specifically address distribution effects. A focus on, for example, the 20 % of people who are "worse off" in the transport system would probably result in a shift to policies that favour the safety of the non-car user. Distribution effects also matter from the perspective of sufficientarianism, which holds the view that what primarily matters is that everybody is well-enough off, that is, has well-being above a certain given threshold which is considered "sufficient". For "weak sufficientarianism", the improvement of well-being matters if people's well-being is below a threshold. The lower the level of well-being, the higher the moral value of benefiting a person. For " strong sufficientarianism", absolute priority should be

given to the improvement of well-being of those whose level of well-being is below the threshold. And the lower their welfare, the more important it is to improve their well-being (Meyer and Roser 2009; see also Wolf 2009). The perspective of strong sufficientarianism could even imply that absolute priority should be given to improving safety if safety levels are below the minimum level. A problem then exists that a sufficientarianism approach relates to persons, not to (segments of) infrastructure or vehicles, whereas safety policies often do not focus on individuals, although traffic education, driving lessons and obligations like wearing helmets and not drinking are exceptions. Safety policies often try to make infrastructure or transport modes safer. In such cases, benefits are distributed in a rather diffuse manner which makes it difficult to link them to specific individuals, so that overall safety levels at the individual level cannot be estimated. The sufficientarianism approach implies "personalising" safety, and therefore, bringing this approach into practice is not at all straightforward and needs to create stronger links between people and safety relevant policy options. To conclude, in ex ante evaluations of the safety impacts of policy options, the indicator chosen can easily lead to overlooking such ethically relevant impacts on distribution, but need not do so.

7.5 Implications for Spatial Policies

Spatial policies relate to land-use policies and (often related) infrastructure policies. Such policies in general can have safety impacts. Firstly, land-use policies may have safety implications. For example, planning a school at a cheap location, but at the "wrong side" of a risky road (from the perspective of the residential area where most children live), results in cost savings, but in higher risks. And densification and mixing land-use categories reduce passenger transport in general (less passenger kilometres) and increase the share of slow modes, and such travel behaviour changes may have safety implications. Infrastructure policies relate to which infrastructure is decided upon, at which locations, and with which design characteristics, and which regulations (e.g. speed, overtaking) apply. Such policies may have important safety implications.

In addition to spatial policies in general, these can also be applied to design the built environment in such a way that safety effects are reduced. Infrastructure examples include safe pedestrian crossing, separate lanes for cyclists and speed bumps to reduce speed of motorised traffic. Examples of land-use policies include planning mixed use at the neighbourhood level to avoid pedestrians and cyclists having to use risky roads and the planning of offices near stations to increase the share of the relatively safe train, at the cost of the more risky car. Land-use policies may also be tailored to reduce non-transport-related risks such as third-party risks of manufacturing industry, for example, by creating buffer zones between those industries and residential areas – such policies are quite common in many countries.

So, the evaluation of such policies, and next the use of the evaluations for policy making and decision making, may need careful consideration of how to include

safety effects. Based on the discussions of this chapter, we argue that the use of the WTP for risk reductions could provide a first way to evaluate effects. But we think a careful consideration from both a methodological and an ethical perspective according to the lines of this chapter is recommended.

7.6 Conclusions: The Link Between Ex Ante Evaluations and Policy

In our opinion, it is important, if ex ante evaluations are used as input for decision making, that the research is of the highest quality. A practical rule of thumb could be that the quality of this research is higher if as a result of it, the decision makers make the choice they would have made (i) if they had all the potential choice options available, (ii) if they were fully informed and (iii) if they were able to evaluate different choice options. Giving more information on the value of risk improves the information base of decisions and hence would increase the quality of decision making according to the above rule of thumb. We can therefore carefully conclude that expressing safety in monetary terms more often increases the usefulness of research for decision making than that it decreases. A possible exception may be that information overload may undermine the quality of decision making (see Knockaert et al. 2010). However, when cost-benefit information is presented in a proper way with different options in terms of details on certain cost and benefit items, this is probably not a real problem. Another exception might occur when the additional information provided – although being correct as such – is misleadingly presented and thus not well understood by the user. This is indeed a point of interest, implying that the information provided must minimise the risk of misinterpretation.

Notes

1. In some cases, benefits are not based on consumer preferences. Examples include the valuation of CO_2 emission; current consumer preferences are generally much lower than estimates based on policy and political choices.
2. Cited in Elvebakk and Steiro (2009).
3. Cited in Fahlquist (2006).
4. Cited in Martens (2006).

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