

**Summary:**

# **Cost-benefit analysis of injury prevention measures**

This report presents an inventory of cost-effective measures designed to prevent accidents and injuries. The term cost-effective denotes measures whose benefits (in monetary terms) are greater than their costs. In total, 74 measures are listed, 26 of which are road safety measures. All measures have been evaluated by means of cost-benefit analysis (CBA). These analyses are based on estimates of

- the costs of the measures,
- effects of the measures, and
- the economic value of the effects of the measures.

A CBA adopting a societal perspective includes all costs and effects of a measure for society, regardless of who pays the costs and who benefits from the measure. Measures were not included in they were not cost-effective from a societal perspective or if no CBA was available. A number of measures in the report have been evaluated by means of analyses adopting different perspectives, e.g. a commercial perspective. Such measures are likely to be cost effective from a societal perspective as well. The benefits are likely to be greater from a societal perspective, while the costs are not likely to be greater.

All measures have been assigned one to three stars (\*, \*\*, \*\*\*), which indicate the quality of the CBA. Measures obtaining three stars have been evaluated by means of a CBA which is methodologically good, which includes all relevant costs and realistic estimates of the benefits. Measure obtaining less than three stars do not fulfil all of the criteria for three stars. The assessment of the quality of the CBA is independent of the size of the cost-benefit (CB) ratios. A measure obtaining one or two stars can be as cost effective as one obtaining three stars. However, the results are less reliable.

## ***Measures protecting from natural hazards and floods***

Only few measures protecting from natural hazards have been found. Most measures are larger projects, and most of them are complex and closely linked to local conditions. Costs benefit analyses in this area are based on a number of assumptions, e.g. about future changes of climate, water levels etc. Project costs can also be difficult to estimate. Existence values and bequest values are highly uncertain.

Two measures protecting from natural hazards have been given three stars.

\*\*\* Skjern-å project (Denmark): Wetlands were created in a coherent area which had earlier been drained and used as farmland. The risk of floods and water pollution was reduced, and favourable effects for biodiversity were found.

\*\*\* Acid rain program (USA): The program has reduced emissions of SO<sub>2</sub> and NO<sub>x</sub> from power plants and adverse health impacts of these emissions. There are no coal-fired power plants in Norway, but there are emissions of SO<sub>2</sub> and NO<sub>x</sub> from other sources.

Many of the measures protecting against natural hazards involve redistribution of land: farmland, residential areas and industrial areas are converted to woodlands, meadows, wetlands, lakes or sea. Despite the large costs of land redistribution, a number of studies have shown that the benefits of reduced floods and water pollution, preservation of biodiversity, storage of CO<sub>2</sub>, and benefits for the population can exceed the costs. Investments can lead to measurable financial benefits because large proportions of the benefits are direct savings or trade-in values. The benefits of many of the measures will however extend over very long periods of time. Such measures will be less cost-effective when the time perspective of a CBA is short. Larger projects may additionally involve “hidden” costs, e.g. for planning and for publicity and support of acceptance.

The lack of measures protecting from floods or storms is probably not due to a lack of CBA, but rather to a lack of published CBA. Such measures are mostly very specific (e.g. “reinforcement of a wall around a filling station in north-west Germany”) and would be difficult or impossible to transfer to other areas or countries. Two examples have been found from Norway (flood prevention and sustainable maintenance of the water distribution system). These analyses show that cost-benefit considerations in themselves and a high-level planning which takes into account all relevant costs and benefits can be economically beneficial.

No CBA of measures against structural damages have been found, although there is much room for improvement on this area (SINTEF Byggforsk, 2006). There is however not enough information available (e.g. statistics of loss expenses, use of building materials) for an assessment of the cost-effectiveness of specific measures.

### ***Measures designed to reduce occupational accidents and injuries***

Most measures designed to reduce occupational accidents and injuries have been evaluated by means of CBA adopting a business perspective. These measures can be expected to be cost-effective according to a societal perspective as well. The benefits according to a societal perspective are greater, because reduced welfare losses attributable to personal injuries are included in the societal perspective, but not the business perspective. According to the business perspective, the only benefit is usually increased productivity, sometimes also reduced medical costs. Costs arise mostly only for the company.

Different types of measures have been found in this area:

- ergonomic measures which reduce back injuries and other types of musculoskeletal injuries,
- regulations for handling of dangerous substances for the prevention of fires and explosions,
- general health-related measures,
- one measure against alcohol and narcotics at the work place.

Two of these measures have been assigned three stars:

\*\*\* PeerCare, program against alcohol and narcotics at the work place (USA): The program encourages support among co-workers and provides a certain degree of anonymity. At the same time it does not leave any possibility for employees to get away with problems related to alcohol or narcotics. It reduces acceptance for drugs and has reduced workplace accidents where alcohol or narcotics is involved.

\*\*\* No-lift policy, ergonomic lifting and moving of patients (USA): Whenever possible, manual lifting/moving is assisted by special equipment; standardized procedures for risk assessment have been implemented and the employees are trained in ergonomics. The policy has reduced injury risk among nurses.

The effects of measures designed to reduce occupational accidents and injuries are often difficult to evaluate. The safety measures are not always the only change and control groups are mostly not available. Evaluating effects of regulation for handling dangerous substances involves many assumptions, e.g. about compliance with the rules, which not always seem realistic and which are impossible to validate. General health-related measures affect injuries only to a relatively small degree.

Measures that are implemented within companies are related to organizational culture and the working environment, and their effects depend strongly on the way they are implemented. It is therefore not always possible to transfer results from one company to another. Implementation of measures should be preceded by a systematic assessment of tasks and work organization and the measures have to be adjusted accordingly. A lack of involvement of the employees and a lack of commitment and among managers are often barriers to the implementation and effectiveness of measures. The effectiveness is also likely to be reduced when measures increase work pressure and consequently reduce acceptance, for example when new equipment is provided (and has to be used) without providing training and sufficient time to get used to it.

The implementation of measures should therefore be evaluated on a broader basis and focus also on other criteria than injury prevention. The analyses of ergonomic measures that have been conducted in the UK have shown that acceptance and commitment for work safety measures can be high among employees and management when working processes and productivity, in addition to safety, are improved.

### **Road safety measures**

Most road safety measures included in this report have been evaluated with CBA in Norway. The effect estimates are based on meta-analyses, which combine results from several studies. The cost-effectiveness and the reduction of accident costs that can be achieved when the measures are implemented at an optimal level have been estimated for each measure. An optimal level of implementation means that the measures are implemented in all cases where or when a marginal CB ratio greater than one is expected, and that measures are not implemented in situations in which a marginal CB smaller than one is expected.

The road safety measures include vehicle safety measures, infrastructure measures and enforcement. Campaigns and education are not included because such measures only have small and uncertain effects on safety. In principle, an optimal use of infrastructure measures and enforcement is possible. In practice however, decisions regarding the use of road safety measures are based on more criteria than cost-effectiveness. It is therefore not likely that the greatest possible benefit will be achieved. Vehicle safety measures are regulated by international law. Incentives for voluntary installation is, however, possible (e.g. reduced insurance premiums for vehicles with ESC).

The following list shows all road safety measures that are included in the report in descending order of greatest possible accident cost reduction:

- \*\*\* Electronic Stability Control, ESC
- \*\*\* Intelligent Speed Adaptation (ISA)
- \*\*\* Seat belt reminder
- \*\*\* Event data recorder
- \*\*\* Whiplash prevention
- \*\*\* Improved pedestrian protection in passenger cars
- \*\*\* Road lighting
- \*\*\* Upgrading of pedestrian crossings
- \*\*\* Roundabouts (4-leg junctions)
- \*\*\* Grade separated crossings for pedestrians and cyclists
- \*\*\* Roundabouts (3-leg junctions)
- \*\*\* Guardrail along roadside
- \*\*\* Shoulder rumble strips
- \*\*\* Minor improvements following road safety inspections
- \*\*\* Median guardrail and 3 (instead of 2) lanes
- \*\*\* Roadside safety treatments
- \*\*\* Curve improvements
- \*\*\* Marked median with rumble strips
- \*\*\* Alcolock

- \*\*\* Drink-driving enforcement
- \*\*\* Speed cameras, section control
- \*\*\* Speed cameras
- \*\*\* Feedback signs for speed
- \*\*\* Stationary speed enforcement
- \*\*\* Seat belt enforcement
- \*\*\* Mandatory use of reflective materials for pedestrians
- \*\*\* Drink-driving enforcement and media campaign (New Zealand)

### **Fire prevention and fire safety measures**

A number of fire prevention measures were identified that are assigned three stars, several of which have been evaluated in Norway or Sweden:

\*\*\* Fire sprinkling system in nursing homes (Norway): Sprinkler systems prevent or delay spreading of fire and increase the time available for evacuation. Residents in nursing homes need relatively long time for evacuation and many need assistance. Additionally, fire risk is higher in nursing homes than in average private homes.

\*\*\* Fire sprinkling system in homes for older people, children or handicapped persons, in flats above the 10<sup>th</sup> floor and in buildings with more than 3 floors (UK): In these types of buildings evacuation times are longer than in average private homes.

\*\*\* Fire cells for the prevention of fire spreading in a cardboard factory (Sweden): The risk of fire spreading is large when large amounts of highly inflammable materials are present, even if fire extinguishers are available and when the personnel is qualified in fire fighting.

\*\*\* Measures against fire spreading and installation of a gas based fire extinguishing system (Sweden): The fire protection measures are installed in a factory where large amounts of inflammable substances are stored. The gas based fire protection system is installed in a part of the factory which is essential for all production processes in the factory, which takes very long time to repair if it gets damaged in a fire, and to which access is limited for safety reasons.

\*\*\* Systematic fire protection and sprinkler system in old wooden houses (Sweden): The risk of fire spreading is high in old wooden houses, and none of the buildings fulfills current fire protection standards.

None of these measures reduce the risk of fire, but prevent or delay the spreading of fire. This increases the time that is available for evacuation and fire extinguishing, and reduces the size of losses. The results can be transferred to other areas of application where fire can spread quickly and cause great material damages or where there is need for extended evacuation times.

The results of evaluation studies of safe distances around storages or routes of transport are uncertain and depend on property prices and estimates of the risk of accidents with major consequences. The transfer of the results is therefore

problematic, but they show that such measures can be cost-effective when they are based on realistic risk assessments.

Fire detectors and fire-extinguishers in private homes may be cost-effective, but it is uncertain to what extent they reduce the amount of property damage. Several measures that aim at reducing the risk of fire, such as fire standards for furniture foams, childproof lighters, self-extinguishing cigarettes, do not seem to be cost-effective. No evaluation studies have been found of measures against injuries from fireworks, such as safety glasses or a prohibition of private fireworks.

### **Measures for the prevention of accidents and injuries among older people**

All measures for the prevention of accidents and injuries among older people are directly or indirectly related to hip fractures. There is large scope for improvement in this area in Norway. There are ca. 9,000 hip fractures annually, ca. 789 fatalities related to falling accidents among people over the age of 64 (of which 63% above the age of 79), and there are only few measures for the prevention of hip fractures. The most frequent type of hip fracture is a fracture of the femoral neck. All measures on this area have been assigned three stars.

\*\*\* Rehabilitation after hip operations (USA): The program consists of strength training and supports the patients' own initiative to improve the life situation and health. It has reduced medical costs and increased the patients' mobility.

\*\*\* 'Stay on your feet', prevention of falls (Australia): The program is composed of several measures, such as increased physical activity, improved medication and glasses. It has reduced falls among older people.

\*\*\* Hip protectors for residents of nursing homes (USA): Hip protectors reduce the risk of hip fractures and medical costs. Mobility is improved. Acceptance may be a problem.

\*\*\* Accessibility of private homes, reconstruction or new buildings (Sweden): Improved accessibility of private homes reduces the risk of falls among older people and delays moving into nursing homes. This also improves quality of life.

### **Other measures**

A number of measures have been found in other areas which are cost-effective and which have been assigned three stars.

\*\*\* Ski helmets (Switzerland): Ski helmets reduce the risk of serious head injury among skiers and snowboarders.

\*\*\* Campaign for the use of ski helmets (Switzerland): The campaign has increased the use of ski helmets and reduced the number of serious head injuries.

\*\*\* Poison control center (USA): A poison control center provides information about poisoning and treatment of poisoning to the public and to hospitals, and reduces the numbers of consultations with doctors or hospitals, and treatment of poisonings becomes more effective. There is a poison control center also in Norway.

\*\*\* Reduction of noise from road and rail traffic. Noise is reduced with technical measures, such as low-noise brakes and asphalt, which do not directly affect traffic volumes. Reduced noise reduces health impairments.

Two measures have been found that reduce road accidents, but that primarily aim at reducing other types of accidents and injuries. A coherent network of pedestrian and cyclist paths would lead to improved mobility and reduced health problems. Moose management of migrant moose in winter habitats aims primarily at reducing damage to trees. In addition game accidents can be reduced.

No measures for the prevention of accidents in kindergarten or schools have been found.

### ***Use of the report and assessment of the cost-effectiveness of measures***

The report shows that accident and injury prevention can be cost-effective in many different areas. All measures described in the report have been evaluated by means of CBA. They are a selective sample and there are presumably far more measures in all areas, that are cost-effective. However, not all measures have been evaluated by means of CBA, and not all CBA that are conducted are published. All measures have been evaluated in a specific context (e.g. size of potential losses, local geography, organizational culture). The extent to which results can be transferred to other contexts depend on their similarity. The inventory of measures can not be used as a “shopping guide”. None of the measures can be expected to lead to the same results in other contexts. An assessment of how cost-effective measures can be expected to be should take into account the following questions:

- How large is the expected size of losses?
- How effective will the measure be in reducing losses?
- What other measures are already existing?
- What costs will be associated to the implementation of the measure?
- How cost-effective will the measure be according to different perspectives (e.g. company, private, insurance company)?
- What are the expected consequences of errors of judgment?

### ***Use of CBA***

CBA can be used to support decisions on whether or not a specific measure should be implemented, choices between different measures, the development of strategies for the allocation of resources between different measures, or for prioritization of different types of damages or injuries. A CBA can identify the measures or areas where the greatest loss prevention can be achieved for a given amount of money. In complex decision processes, CBA can create transparency regarding the distribution of benefits and costs of measures between different interest groups of stakeholders.

The results of CBA are strongly influenced by the types of costs and benefits that are taken into account in the analysis by the valuation of the benefits, and by the time perspective of the analysis. Therefore, the results are relatively easy to manipulate and thereby to misuse. This is however not a general argument against the use of CBA, but it demonstrates the importance of clear and explicit statements of the assumptions according to which CBA are conducted.

A limitation of CBA can be the lack of monetary valuations of non-market goods. Benefits that can not be expressed in monetary terms can not be included in CBA.

Another limitation may be that economic efficiency is not always seen as the most important reason for implementing (or not implementing) measures, or that for example political or ethical arguments are seen as more important. Moreover, measures that are cost-effective according to a societal perspective may not be so according to other perspectives and therefore not seem to be an attractive investment.

In our opinion, there are no decisive objections to the use of CBA in choices involving accident or injury prevention measures. The use of CBA will hardly lead to poorer decision making, except when the analyses are biased and not transparent. CBA does not prevent taking into account other than economic arguments in decisions. CBA can contribute to a more effective use of resources for the prevention of accidents and injuries, as shown by the analyses in this report.

CBA of accident and injury prevention measures should take a societal perspective. This is the comprehensive approach to CBA. CBA can not be conducted for all possible accident and injury prevention measures because too little is known about the effects of such measures. This should be an incentive to do more research. It is likely that better results could be achieved in the prevention of accidents and injuries if measures were to a larger degree than today evaluated by means of CBA.