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Safe and joyful cycling for senior citizens

Lars Leden

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VTT, Bergsmansvägen 3, PB 1000, 02044 VTT
tel. växel 020 722 111, fax 020 722 4374

VTT Technical Research Centre of Finland, Vuorimiehentie 3, P.O. Box 1000, FI-02044 VTT, Finland
phone internat. +358 20 722 111, fax +358 20 722 4374

VTT, Lämpömiehenkuja 2, PL 1000, 02044 VTT
puh. vaihde 020 722 111, faksi 020 722 7056

VTT, Värmemansgränden 2, PB 1000, 02044 VTT
tel. växel 020 722 111, fax 020 722 7056

VTT Technical Research Centre of Finland, Lämpömiehenkuja 2, P.O. Box 1000, FI-02044 VTT, Finland
phone internat. +358 20 722 111, fax +358 20 722 7056

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Abstract

Demographic changes show that the absolute number and portion of the population in Europe that can be categorized as older or very old will continue to grow over the next several years. One aim should be to keep them active and healthy for as long a time as possible. Exercise, for example cycling, plays an important role in this context but data shows that the elderly bicyclists are overrepresented in crashes when compared with their exposure to traffic. Senior cyclists' needs and preferences should be a base for developing a safe and joyful cycling environment. A special focus is how to use Intelligent Transport Systems, ITS, to increase safety and quality. This project uses literature reviews, in-depth crash data analysis, questionnaires with senior cyclists, questionnaires with experts, and an expert workshop to identify potential ITS applications for improving elderly bicycling. The last tool (the expert workshop) included two group discussions structured according to two philosophically different models: The Diamond model and The Multiple comfort model.

All tools tested here seem to work well together for developing ideas for countermeasures that ensure safe and joyful cycling for senior citizens. With one exception, all aspects mentioned in the expert questionnaire were taken up in group discussions in the expert workshop.

Probably, Intelligent Speed Adaptation on cars is the most efficient measure to provide safe cycling, but other ITS measures are also needed to provide safe and joyful cycling for senior citizens and raise the profile of cycling as such. ITS measures could be linked to, or built into, existing equipment such as navigation systems, cycle computers, and traffic signal control boxes. ITS measures could also increase the comfort for elderly cyclists, *e.g.* automatic locking and opening of bicycles at a distance by using the key as for cars with remote-controlled locks.

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Preface

The research presented in the current publication was done as a case study within the HUMANIST post-doc grant to the author. The grant included a post-doc exchange fellowship at Factum, Vienna for three months in the spring of 2007 and another three months in the autumn of 2007. This was a great experience for me and I would like to express my sincere gratitude to Ralf Risser, Christine Chaloupka and all other members of the Factum staff for all advice, help and kindness. Part of the stay in Vienna was sponsored by Åke och Greta Lissheds stiftelse.

One of the topics of Lars Leden's post-doc grant was to gather knowledge to be used as a base for developing safer cycling for elderly by means of ITS technologies. This was done in cooperation between VTT Technical Research Centre of Finland, Luleå University of Technology and Factum, and it was sponsored by Skyltfonden of the Swedish Road Administration, SRA and the HUMANIST post-doc grant. A draft of this publication was discussed at the HUMANIST TFC conference on Joint Cognitive Models for Human Centred Design in Vienna in September 2007 and also at an expert workshop before the conference at Factum. I would like to express my sincere gratitude to all participants and especially those participating in the expert workshop: Ralf Risser, Karin Ausserer, Corinne Brusque, Christine Chaloupka and Christine Turetschek.

I would also like to thank Peter Rosander and Mikael Lyckman both working at Luleå University of Technology, who interviewed the elderly bicyclists by phone in the pilot project to develop and test the questionnaire to the elderly bicyclists. I would also like to thank Sven Lindoff, secretary of the Cycling Promotion in Sweden (Cykelfrämjandet) for helping us with finding a stratified sample of members for the questionnaire and also for executing the mailing. I would also like to express my sincere appreciation to all sponsors including Anita Ramstedt at Skyltfonden, part of the Swedish Road Administration (SRA) for financing part of the research, and all colleagues, bicyclists and the following experts for giving fruitful information to achieving safe cycling for elderly: Allessandro Drago, Italy; anon. colleague from Ireland; Thomas Krag, Denmark; Per Gårder, United States; Karin Ausserer, Austria; Geoff Gardner, the UK; Leif Jönsson, Sweden; Sören U. Jensen, Denmark, Christer Hydén, Sweden; Michael Meschik, Austria; Michal Beim, Poland; Antero Naskila, Finland; and Dirk Boenke and Jürgen Gerlach, Germany; and to Per Gårder also for proofreading a draft of this publication; and last but not least to my daughter Laura Leden for coding, analyzing and reporting the questionnaire to the senior cyclists.

Contents

List of acronyms

ISA	*Intelligent speed adaptation* (ISA) warns and regulates driving speed according to the speed limits of the road.
ITS	*Intelligent Transportation Systems* (*ITS*) refers to the use of information technologies such as computers, telecommunications, GPS (Global Positioning System) and the Internet to improve transportation system performance and efficiency, *e.g.* to improve traffic flow and management, provide information to transport users, track and manage commercial transport operations, enforce traffic laws, and improve road safety. These technologies can be applied to private and commercial vehicles, public transport, and road infrastructure (TDM Encyclopedia, 2005).
TELEMATICS	*Telematics* refers to the use of telecommunications and computerized electronics that connect a driver or a vehicle to external services, such as navigation systems, pricing and emergency signals.

1. Background and purpose

Demographic changes show that the portion of the population in Europe that can be categorized as older or very old will continue to grow over the next several years. The absolute number of older people will also continue to grow and since there will be more old people, one aim should be to keep them active and healthy for as long a time as possible. Exercise, for example cycling, plays an important role in this context – it supports us to stay healthy in all phases of our lives. The health effects of cycling are well documented (Kraft, 2002; Manetta *et al.*, 2005; Oja *et al.*, 1998). Bicycling is possible almost without any limitation of age, so bicycling is an ideal way to stay active at an older age. Apart from the advantages for our physical constitution, cycling could increase mobility at an older age. It is a fact that senior citizens often have to renounce the mobility they desire, as a drivers' license or a car is missing more often than for the general population. The bicycle could become an ideal means of transportation for many senior citizens, in order to fulfill their individual needs of mobility, and to stay active and mobile at an older age provided that bicycling is safe. But data shows that the elderly bicyclists are overrepresented in crashes when compared with their exposure to traffic (Gustafsson and Thulin, 2003). Maring and Schagen (1990) support the findings. The older the person, the more fragile he/she is; also a speed limit of 30 km/h per hour might be too high for the elderly. Elderly pedestrians place themselves at greater risk when crossing streets with traffic in two directions as a result of wrongly estimating the time of arrival of moving vehicles, and/or the under-compensation of slower walking speeds (Oxley *et al*., 1997). Therefore, measures are needed. The following five tools for idea generation were applied for identifying user's needs and developing countermeasures for safe and joyful cycling for senior citizens:

1. literature review
2. crash data analysis
3. questionnaires with senior cyclists
4. questionnaires with experts
5. an expert workshop with group discussions structured according to two different models.

The outcome of each tool is described below. However, the results of the literature review are presented as a part of the description of the outcomes of the four other tools. At the end of the paper the outcomes of the five tools are compared and discussed.

A special focus has been how to use Intelligent Transport Systems, ITS, to develop safe and joyful cycling for senior citizens. This is not done in a systematic for pedal cyclists before, but Bayly *et al.* (2006) gives a comprehensive example how to apply ITS on motor cycle safety.

2. Crash data analysis

The aim with the analysis described in this chapter is to find key parameters in the crash data that are crucial in explaining why crashes involving elderly (older than 64 years) as bicyclists are occurring. Such contributing crash factors will be compared to crash factors for other age groups. A set of hypotheses were formulated and tested.

2.1 Hypotheses

How the risk of a fatal crash or an injury depends on the vulnerable road user's age was investigated for different circumstances. The following hypotheses were formulated through discussions in a small expert team:

1. Elderly bicyclists have higher risks than younger age groups.
2. The consequences of crashes are more severe for elderly bicyclists compared to other age groups and increase with vehicle speeds.
3. Elderly bicyclists are more often involved in fatal crashes outside built-up areas compared to other age groups.
4. In fatal crashes, elderly bicyclists are less often in a hurry compared to other age groups.
5. In fatal crashes on hilly streets, elderly bicyclists are more often involved than others.
6. In fatal crashes in darkness, elderly bicyclists are more often involved than other age groups.
7. Elderly bicyclists are more often involved in crashes at intersections than other age groups.
8. Elderly bicyclists are more often involved in fatal crashes when intending to turn left compared to other age groups.
9. Elderly bicyclists are more often involved in fatal single-vehicle crashes and in crashes with pedestrians and other bicyclists compared to other age groups.
10. Elderly bicyclists are more often involved in fatal crashes when the road surface is damaged compared to other age groups.
11. In fatal crashes, elderly bicyclists are more often impaired by health problems compared to other age groups.
12. In fatal crashes, elderly bicyclists obey rules less often compared to other age groups.

13. Elderly use mountain bikes less often when involved in fatal crashes compared to other age groups.
14. When involved in fatal crashes, elderly have fewer speeds (gears) on their bicycles compared to other age groups'.
15. When involved in fatal crashes, the footbrake on elderly's bicycles is less often in working order compared to other age groups'.
16. When involved in fatal crashes, the front light on elderly's bicycles is less often in order compared to other age groups'.
17. When involved in fatal crashes in darkness, the front light on elderly's bicycles is less often in working order compared to other age groups'.
18. When involved in fatal crashes, elderly bicyclists less often use reflectors compared to other age groups.

2.2 Data description

Three data sets were made available. The *first* data set is the Finnish road crash investigating teams' data (VALT in-depth crash data) from the years 1995–2005 which includes a detailed description of 459 fatalities involving bicyclists in varying road environments. The data is classified into the age groups: children (0–17 years), adults (18–64 years), and elderly (65 years and older). Altogether, there are 256 bicyclists older than 64 years. Only a few bicyclists are 90 years old or older, see Table 1.

However, some of the analyses presented here were made earlier (Johansson *et al.*, 2004) using a somewhat smaller VALT data set with fatal injuries from 1995–2001. This data set is now presented with focus on elderly bicyclists' safety.

Table 1. Elderly bicyclists ages, Finnish road crash investigating teams' data for the years 1995–2005.

Age group	Frequency	Percent
65–69	52	20.3
70–74	79	30.9
75–79	70	27.3
80–84	38	14.8
85–89	12	4.7
90–94	5	2.0
95–99	0	0.0
Total	256	100

The *second* data set is based on Swedish travel surveys and self-reported crash data from 1996–2000. This data set is compared to crash data from the Swedish Road Administration as presented by Gustafsson and Thulin (2003).

The *third* data set includes 17 843 police-reported fatalities and injuries with pedestrians and bicyclist in Finland during the years 1989–2002. This data set is used to test Hypotheses 2 and 7.

2.3 Results, test of hypotheses

Hypothesis 1: Elderly bicyclists have higher risks than younger age groups.

Swedish travel surveys

Table 2. Risk of injury and fatal crash for bicyclists per million kilometers cycled and consequence of bicycle crashes 1996–2000 (Gustafsson and Thulin, 2003).

	Risk of injury	Risk of fatal or severe injury	Risk of fatal injury	Consequence
Urban traffic				
1–6 years	1.219	0.179	0.007	0.006
7–14 years	1.263	0.242	0.009	0.007
15–24 years	1.394	0.238	0.005 (low risk)**	0.004
25–44 years	1.081	0.199 (low risk)**	0.007 (low risk)**	0.006
45–64 years	1.221	0.283	0.015	0.012
65–84 years	1.664	0.506 (high risk)**	0.075 (high r.)* **	0.045
1–84 years	1.244	0.255	0.014	0.011
Non-urban traffic				
1–6 years	0.261	0.058	0.000	0.000
7–14 years	0.331	0.112	0.009 (low risk)**	0.026
15–24 years	0.282	0.084 (low risk)**	0.012 (low risk)**	0.041
25–44 years	0.330	0.119	0.009 (low risk)**	0.029
45–64 years	0.321	0.141	0.028	0.086
65–84 years	0.379	0.180 (high risk)* **	0.071 (high risk) * **	0.188
1–84 years	0.325	0.125	0.023	0.071

* Significantly different than the expected value based on exposure and total number of crashes (at 95% significance level) Poisson.
** Significantly different than the expected value based on exposure and total number of crashes (at 95% significance level) Normal distribution.
Consequence is defined as number of fatal injuries per reported injury crash.

Swedish travel surveys and selfreported crash data from 1996–2000 have been compared to crash data from the Swedish Road Administration (Gustafsson and Thulin, 2003). The data is used to calculate the risk for bicyclists of different ages; as fatal injuries or severe injuries per million kilometers cycled, see Table 2. Elderly, older than

64 years, always have higher risks than younger age groups, and the consequences of the crashes are also always the most seroius. The latter is likely to be explained by elderly having more fragile bodies.

Swedish travel surveys

Independent of road user age, most bicyclists cross the street at sites not equipped with marked pedestrian or bicyclist crossings or signals, see Table 3 (based on data by Gustafsson and Thulin, 2003). The risk of injury and the consequences of the crashes are also the highest there. The risk of injury and the consequences of the crashes are always the highest for elderly bicyclists compared to other age groups independent of if there is a marked crossing or not. In the analysis above, speed limit and crossing-facility type were analyzed without consideration of each other. Co-variation may mean that the isolated 'true' effect of either facility type is not that which is described above. Rather, it may be that most marked crosswalks are located in low-speed downtown areas whereas many pedestrian (and bicycle) crashes occur along outlying arterials where the spacing between crosswalks is much greater. Also, facilities such as crosswalks are often provided where pedestrian volumes are high, and high pedestrian volumes by themselves lower the risk that an individual pedestrian or cyclist will be involved in a crash (Ekman, 1996; Leden, 1997).

Table 3. Exposure and risk of injury (injury, severe injury or fatal) and consequences in urban areas for bicyclists per million bicycle passages, 1996–2000 (Gustafsson and Thulin, 2003). (Crossings in a tunnel or on a bridge separated from the vehicle traffic is not included in the exposure presented in the table.)

	No crossing facility			Marked crossing			Marked crossing with signal			Total no.
Age	Expo-sure (%)	Risk of injury	Conse-quences	Expo-sure (%)	Risk of injury	Conse-quences	Expo-sure (%)	Risk of injury	Conse-quences	of million person passages
1–6 years	72	0.4387	0.0114	24	0.4350	0.0000	1	5.4278*	0.0000	89
7–14 years	*68*	0.5813	0.0130	*17*	0.5839	0.0038	*4*	0.7550	0.0000	674
15–24 years	*58*	0.4376	0.0040	*21*	0.5930	0.0000	*14*	0.3550	0.0205	1099
25–44 years	*56*	0.3839	0.0039	*21*	0.4722	0.0065	*15*	0.2361	0.0179	1601
45–64 years	*65*	0.3138	0.0166	*17*	0.7358	0.0060	*11*	0.2896	0.0086	1024
65–84 years	*59*	0.9268*	0.0683	*19*	1.6982*	0.0538	*13*	0.4221	0.0435	238
1–84 years	61	0.4339	0.0152	19	0.6239	0.0104	*12*	0.3178	0.0163	4725

* Significantly higher than the expected value based on exposure and total number of crashes (at 95% significance level).

Conclusion: The hypothesis is supported. Elderly bicyclists have higher risk than younger age groups. The consequences of the crashes were also the highest for elderly.

Hypothesis 2: The consequences of crashes are more severe for elderly bicyclists compared to other age groups and increase with vehicle speeds.

Swedish travel surveys

In most of the different types of crashes the *consequences* (number of fatal crashes per sum of fatal and other crashes) increased with vehicle speed and the age of the vulnerable road user, see Table 4. The consequence of crashes at intersections was less serious when a turning vehicle was involved compared to if the vehicle was not turning.

Table 4. Consequence for bicyclists by age and speed limits.

Speed	Children	Adults	Elderly	All	All total
On marked crossing at intersection, not turning vehicles					
30	0.000	0.000	0.000	0.000	0.021
40	0.000	0.012	0.050 (low)*	0.014	
50	0.008	0.010	0.075 (high)*	0.020	
60	0.032	0.023	0.125 (high)*	0.043 (high)*	
On marked crossings at intersections, turning vehicles					
30	0.000 (low)*	0.062 (high)*	0.000 (low)*	0.035 (high)*	0.018
40	0.000 (low)*	0.010	0.046 (high)*	0.014	
50	0.011	0.015	0.049 (high)*	0.019	
60	0.000 (low)*	0.000 (low)*	0.045 (high)*	0.006	
On marked crossing on link					
30	0.000 (low)*	0.000 (low)*	0.000 (low)*	0.000 (low)*	0.023
40	0.012	0.000 (low)*	0.038	0.008	
50	0.002	0.015	0.085 (high)*	0.024	
60	0.032	0.024	0.100	0.049 (high)*	

* Significantly different than the average (at 95% significance level).

Finnish police reported data

It was also explored at what posted speed fatalities for different age groups occurred. As can be seen in Table 5 especially children, but also elderly, are frequently fatally injured on roads with posted speeds of 60 km/h or higher. The difference between age groups is significant.

Table 5. Share of bicyclists fatally injured at posted speeds 60 km/h or more.

	Total no. of fatal crashes	*Share at posted speed 60 km/h or more (%)*	chi2	p (df=2)
Children	80	*69*	11.21982	0.003661
Adults	88	*43*		
Elderly	86	*52*		
Total	255	*54*		

Finnish road crash investigating teams' crash data

Of all bicyclists that were fatally injured in Finland 1995–2001, 86% were killed at actual (estimated) vehicle speeds of 31 km/h or higher, see Table 6. There is no significant difference with respect to different age groups.

Table 6. No. of bicyclists fatally injured vs. vehicle speeds.

	No. of bicyclists fatally injured	*Vehicle speed 31 km/h or more (%)*	chi2	p (df=2)
Children	57	*93*	3.12311	0.210
Adults	106	*83*		
Elderly	120	*86*		
Total	283	*86*		

Swedish travel surveys

For bicyclists aged 1–64, the risk is lower in 30-km/h zones compared to other urban areas; 0.65 bicyclists were fatally or severely injured per bicyclist-traveled kilometer compared to 1.06 in other urban areas. The risk in non-urban traffic was lower than in urban traffic which may seem surprising. A reason may be that bicyclists are better separated in non-urban traffic and that cross side-streets are much less frequent than in urban areas. For bicyclists older than 64, the risk was lower in 30-km/h zones than for other age groups. In other words, 30-km/h zones are especially safe for elderly bicyclists. The risk is higher in the other two types of environments for people older than 64 compared to younger bicyclists, see Table 7.

Table 7. Risk of injury or fatal crash for pedestrians per million bicycle passages. Risk of injury or fatal crash for bicyclists per million bicycle kilometers 1996–2000 (Gustafsson and Thulin, 2003).

	30 km/h -streets	**Other urban traffic**	**Non-urban traffic**
Total no. of fatal or severe injured bicyclists per million traveled kilometer. Average 0.73.			
1–64 years	0.65	1.06	0.32 (low)*
65–84 years	0.40	1.54 (high)*	0.38

* Significantly different than the average based on exposure and total number of crashes (at 95% significance level). Normal distribution.

Conclusion: The hypothesis is supported. The consequences of crashes are more severe for elderly bicyclists compared to other age groups and increase with vehicle speeds.

Hypothesis 3: Elderly bicyclists are more often involved in fatal collisions outside built-up areas compared to other age groups.

Finnish road crash investigating teams' crash data

Elderly bicyclists are not more often involved in fatal collisions outside built-up areas compared to other age groups according to analysis of 1995–2005 data. Child bicyclists are significantly (p=0.00035) more often involved in fatal crashes outside built-up areas (56%) than elderly (39%) and other adult bicyclists (30%), see Table 8.

Table 8. Fatally injured bicyclists.

	No. of bicyclists fatally injured	*Share inside or close to built-up areas (%)*	*Share outside built-up areas (%)*	chi2	p (df=2)
Children	85	*44*	*56*	15.90452	0.000352
Adults	165	*70*	*30*		
Elderly	209	*61*	*39*		
Total	459	*61*	*39*		

Conclusion: The hypothesis is not supported.

Hypothesis 4: In fatal crashes elderly bicyclists are less often in a hurry compared to other age groups.

Finnish road crash investigating teams' crash data

In fatal crashes (from 1995–2001) elderly bicyclists are less often (5%) in hurry compared to other age groups (11%), see Table 9.

Table 9. Fatally injured bicyclists that were in a hurry.

	Number of fatal crashes when					
	not in a hurry	in a hurry	Total	*Share in a hurry (%)*	chi2	p (df=2)
Children	28	6	34	*18*	4.85671	0.088
Adults	49	4	53	*8*		
Elderly	61	3	64	*5*		
Total	138	13	151	*9*		
						p (df=1)
Children	28	6	34	*18*	3.19354	0.074
Not children	110	7	117	*6*		
Total	138	13	151	*9*		
Elderly	61	3	64	*5*	1.39243	0.238
Not elderly	77	10	87	*11*		
Total	138	13	151	*9*		

Conclusion: The hypothesis is supported. In fatal crashes elderly bicyclists are less often in a hurry compared to other age groups.

Hypothesis 5: In fatal crashes on hilly streets, elderly bicyclists are more often involved than others.

Finnish road crash investigating teams' crash data

According to Table 10, there are no significant differences with respect to age in the number of bicyclists fatally injured at streets that had a downhill grade. About one third of all bicyclists that are fatally injured were killed on downhill streets.

Table 10. Number of bicyclists severely injured on downhill streets.

	No. of fatal crashes Down hill	Not down hill	Total	*Share down hill %*	chi2	p (df=2)
Children	17	39	56	*30*	0.83005	0.660
Adults	39	85	124	*31*		
Elderly	31	87	118	*26*		
Total	87	211	298	*29*		
						p (df=1
Children	17	39	56	*30*	0.00243	0.961
Not children	70	172	242	*29*		
Total	87	211	298	*29*		
Elderly	31	87	118	*26*	0.59052	0.442
Not elderly	56	124	180	*31*		
Total	87	211	298	*29*		

No significant difference with respect to age is seen in the number of bicyclists fatally injured on streets that had an uphill slope, with 19% of all bicyclists fatally injured on uphill streets, see Table 11.

Table 11. Number of bicyclists severely injured on uphill streets.

	No. of fatal crashes when Up hill	Not up hill	Total	*Share up hill %*	chi2	p (df=2)
Children	13	43	56	*23*	3.31826	0.190
Adults	18	106	124	*15*		
Elderly	27	91	118	*23*		
Total	58	240	298	*19*		
						p (df=1)
Children	13	43	56	*23*	0.35943	0.549
Not children	45	197	242	*19*		
Total	58	240	298	*19*		
Elderly	27	91	118	*23*	1.11758	0.290
Not elderly	31	149	180	*17*		
Total	58	240	298	*19*		

Conclusion: The hypothesis is not supported.

Hypothesis 6: In fatal crashes, elderly are more often involved than other age groups when it is dark.

Finnish road crash investigating teams' crash data

In darkness (incl. dawn and dusk), non-elderly adult bicyclists are significantly (p=4.1E-10) more often involved in crashes (37%) than elderly (11%), see Table 12. There is a significant difference with respect to different age groups, but not the expected one.

Table 12. Fatally injured bicyclists.

	No. of bicyclists fatally injured	*Share in daylight (%)*	chi2	p (df=2)
Children	85	*87*	43.22442	4.1109E-10
Adults	164	*63*		
Elderly	207	*89*		
Total	79	*79*		

Conclusion: The hypothesis is not supported.

Hypothesis 7. Elderly bicyclists are more often involved in crashes at intersections than other age groups.

Finnish police reported data

The majority, about two thirds, of all bicyclist crashes at marked bicyclist crossings occur at intersections, see Appendix 1. Elderly bicyclists are not more often involved in crashes at intersections than other age groups.

Most of the crashes do not involve a turning vehicle, see Appendix 2.

Conclusion: The hypothesis is not supported.

Hypothesis 8: Elderly bicyclists are more often involved in fatal crashes when intending to turn left compared to other age groups.

Finnish road crash investigating teams' crash data

22% of elderly intend to turn left in fatal crashes compared to 8% for adults and 14% for children, see Table 13. The difference is significant (p=0.0012).

Table 13. Bicyclists fatally injured when intending to turn left.

	Intending to turn left		Other types of accidents		chi2	p (df=2)
	N	(%)	N	(%)		
Children	12	*14*	73	*86*	13.40044	0.001231
Adults	13	*8*	152	*92*		
Elderly	45	*22*	164	*78*		
Total	70	*15*	389	*85*		

Conclusion: The hypothesis is supported. Elderly bicyclists are significantly more involved in crashes when intending to *turn left* compared to other age groups.

Hypothesis 9: Elderly bicyclists are more often involved in fatal single-vehicle crashes and in crashes with pedestrians and other bicyclists compared to other age groups.

Finnish road crash investigating teams' crash data

18% of the adult bicyclists are involved in single-vehicle crashes compared to 2% for children and 5% for elderly. The differences are significant (p=5,85E-06), see Table 14. For crashes involving other pedestrians, other bicyclists, or mopeds, the share is about 7% for all age groups.

Table 14. Fatally injured bicyclists.

	No. of bicyclists fatally injured	*single*	chi2	p (df=2)	*counterpart (%) pedestrian, bicyclist or moped*
Children	85	*2*	24.097	5.85E-06	*5*
Adults	165	*18*			*8*
Elderly	209	*5*			*6*
	459	*9*			*7*

Conclusion: The hypothesis is not supported.

Hypothesis 10: Elderly bicyclists are more often involved in fatal crashes when the road surface is damaged compared to other age groups.

Finnish road crash investigating teams' crash data

Elderly bicyclists are not over-involved in crashes where the road surface is in disrepair, see Table 15.

Table 15. Fatally injured bicyclists.

	No. of bicyclists fatally injured	*Share at damaged road surface (%)*	chi2	p (df=2)
Children	71	*10*		
Adults	148	*12*		
Elderly	187	*7*		
Total	406	*9*		

Conclusion: The hypothesis is not supported.

Hypothesis 11: In fatal crashes elderly bicyclists more often are impaired by health problems compared to other age groups.

Finnish road crash investigating teams' crash data

As expected, elderly bicyclists in crashes are significantly more often impaired by bad sight (p=3.52E-05) and/or bad hearing (p=3.52E-05) as well as being impaired by taking medication (p=7.89E-08) compared to other age groups, see Tables 16–18.

Table 16. Bicyclists fatally injured with bad sight.

	No. of bicyclists fatally injured	*Share of bicyclists with bad sight (%)*	chi2	p (df=2)
Children	59	*2*	12.45605	0.001973
Adults	108	*3*		
Elderly	150	*13*		
Total	317	*7*		

Table 17. Bicyclists fatally injured with bad hearing.

	No. of bicyclists fatally injured	*Share of bicyclists with bad hearing (%)*	chi2	p (df=2)
Children	59	*0*	20.50766	3.52E-05
Adults	108	*5*		
Elderly	150	*18*		
Total	317	*10*		

Table 18. Bicyclists fatally injured when impacted by medicine.

	No. of bicyclists fatally injured	*Share of bicyclists impacted by medicine (%)*	chi2	p (df=2)
Children	49	*10*	32.709	7.89E-08
Adults	82	*45*		
Elderly	116	*59*		
Total	247	*45*		

Conclusion: The hypotheses concerning elderly bicyclists' health problems are all supported.

Hypothesis 12: In fatal crashes, elderly bicyclists obey rules less often compared to other age groups.

Finnish road crash investigating teams' crash data

The share of elderly bicyclists which do not obey rules are similar to adult bicyclists, see Table 19. Not obeying rules could mean, for example, that the shortest way is chosen though forbidden, that the cyclist is impaired by alcohol, or not sufficiently alert.

Table 19. Bicyclists fatally injured when not obeying the rules.

	No. of bicyclists fatally injured	*Share bicyclists not obeying rules (%)*	chi2	p (df=2)
Children	28	*71*	1.711496	0.424965
Adults	75	*83*		
Elderly	75	*81*		
Total	178	*80*		

Non-elderly adult bicyclists are significantly more often (p=0.00024) affected by alcohol (50% proven impaired) than elderly bicyclists (9%), see Table 20. Affected is in this analysis defined as a measured blood alcohol level above 0.0 percent.

Table 20. Bicyclists fatally injured when impacted by alcohol.

	No. of bicyclists fatally injured	*Share of bicyclists affected by alcohol (%)*	chi2	p (df=2)
Children	64	*2*	92.26608	9.22E-21
Adults	78	*50*		
Elderly	144	*9*		
Total	286	*25*		

Conclusion: The hypothesis is not supported.

Hypothesis 13: Elderly use mountain bikes less often when involved in fatal crashes compared to other age groups.

The data shows that 46% of child bicyclists involved in single-vehicle crashes use a mountain bike compared to 11% of adults and 1% of elderly. The difference is significant (p=5.0273E-20), see Table 21.

Table 21. Bicyclists fatally injured when using a mountain bike.

	No. of bicyclists fatally injured	*Share bicyclists using a mountain bike (%)*	chi2	p (df=2)
Children	61	*46*	96.67093	5.0273E-20
Adults	139	*11*		
Elderly	174	*1*		
Total	374	*12*		

Conclusion: The hypothesis is supported. When involved in fatal crashes, elderly bicyclists less often use mountain bikes compared to other age groups.

Hypothesis 14: When involved in fatal crashes, elderly have fewer speeds (gears) on their bicycles compared to other age groups'.

There are significantly (p=2.6 E-09) fewer gears on elderly's bicycles, when involved in fatal crashes, compared to other age groups'. The share without gears is 29% for child bicycles, 40% for adults' and 67% for elderly's, see Table 22.

Table 22. Bicycles without gears.

	No. of bicyclists fatally injured	*Share of bicycles without gears (%)*	chi2	p (df=2)
Children	49	*29*	45.87757	2.61165E-09
Adults	106	*40*		
Elderly	134	*67*		
Total	289	*51*		

Conclusion: The hypothesis is supported. When involved in fatal crashes, there are significantly fewer gears on elderly's bicycles compared to other age groups'.

Hypothesis 15: When involved in fatal crashes, the footbrake on elderly's bicycles is less often in working order, compared to other age groups'.

About 90% of all age groups' bicycles involved in fatal crashes had a footbrake in working order, see Table 23.

Table 23. Bicycles with footbrake in working order.

	No. of bicyclists fatally injured	*Share of bicycles with footbrake in working order (%)*	chi2	p (df=2)
Children	46	*91*	2.646774	0.266232027
Adults	95	*86*		
Elderly	116	*93*		
Total	240	*90*		

Conclusion: The hypothesis is not supported.

Hypothesis 16: When involved in fatal crashes, front lights on elderly's bicycles is less often in working order compared to other age groups'.

The front lights on elderly's bicycles are more often in working order compared to other age groups'. There is a significant difference between age groups' bicycles, but not the expected one, see Table 24.

Table 24. Bicycles with front light in order.

	No. of bicyclists fatally injured	*Share of bicycles with front light in order (%)*	chi2	p (df=2)
Children	65	*22*	20.08783	4.34493E-05
Adults	130	*38*		
Elderly	166	*53*		
Total	361	*42*		

Conclusion: The hypothesis is not supported.

Hypothesis 17: When involved in fatal crashes in darkness, the front light on elderly's bicycles is less often in working order compared to other age groups'.

There was no significant difference between different age groups' bicycles' front light use, see Table 25.

Table 25. Bicycles with front light in use.

	No. of bicyclists fatally injured	*Share of bicycles with front light in use (%)*	chi2	p (df=2)
Children	64	*6*	3.759582	0.152622027
Adults	114	*16*		
Elderly	120	*11*		
Total	298	*12*		

Conclusion: The hypothesis is not supported.

Hypothesis 18: When involved in fatal crashes, elderly bicyclists less often use reflectors compared to other age groups.

A slightly higher share of the elderly's bicycles is equipped with a front reflector, but the difference is not significant, see Table 26. About 80% of all age groups' bicycles were equipped with a reflector at the rear and 50% had reflectors on the front and rear wheels, see Table 27–29. Elderly's bicycles were significantly more often equipped with pedal reflectors, see Table 30.

Table 26. Bicycles with front reflector.

	No. of bicyclists fatally injured	*Share of bicycles with front reflector (%)*	chi2	p (df=2)
Children	60	*40*	1.420038	0.491634979
Adults	123	*41*		
Elderly	158	*47*		
Total	341	*43*		

Table 27. Bicycles with reflector at the rear.

	No. of bicyclists fatally injured	Share of bicycles with reflector at the rear (%)	chi2	p (df=2)
Children	59	73	2.809972	0.245370444
Adults	125	78		
Elderly	158	83		
Total	342	80		

Table 28. Bicycles with reflector on front wheel.

	No. of bicyclists fatally injured	*Share of bicycles with reflector on the front wheel (%)*	chi2	p (df=2)
Children	68	*51*	0.45118	0.798045241
Adults	134	*52*		
Elderly	169	*49*		
Total	371	*50*		

Table 29. Bicycles with reflector on the rear wheel.

	No. of bicyclists fatally injured	*Share of bicycles with reflector on the rear wheel (%)*	chi2	p (df=2)
Children	68	*51*	0.804081	0.668953783
Adults	134	*52*		
Elderly	169	*47*		
Total	371	*50*		

Table 30. Bicycles with pedal reflector.

	No. of bicyclists fatally injured	*Share of bicycles with pedal reflectors (%)*	chi2	p (df=2)
Children	59	*85*	8.049293	0.017869737
Adults	129	*81*		
Elderly	161	*92*		
Total	349	*87*		

Conclusion: The hypotheses are not supported.

3. A questionnaire to senior cyclists in Sweden

3.1 Background and purpose

Interviews with 31 bicyclists (15 men and 16 women), all members of the Cycling Promotion in Sweden (Cykelfrämjandet), were done as a pilot project to test and finalize a questionnaire about needs and safety of elderly bicyclists, see Leden and Risser (2007).

To gather more extensive knowledge about elderly bicyclists a questionnaire, see Appendix 4, was sent to more than 500 members of the Cycling Promotion in Sweden (Cykelfrämjandet) in June 2007.

The results from the questionnaires are presented below. When interpreting the results it should be remembered that the respondents are members of the Cycling Promotion in Sweden and have more experience in cycling and matters related to cycling, than people in general in Sweden and therefore not representative for all bicyclists of that age in Sweden. However having experienced respondents can of course be an advantage also when gathering background information to be used to develop a strategy and measures to obtain safe and joyful cycling for senior citizens. They are probably also healthier. The share that finds bad hearing a safety problem is small, only 9%, but increases somewhat after age 75. 18% of elderly bicyclists fatally injured are impaired by bad hearing according to Finnish road crash investigating teams' data.

3.2 Method and data description

To gather more extensive knowledge about elderly bicyclists the Cycling Promotion in Sweden (Cykelfrämjandet) was contacted about sending a questionnaire to their members. Altogether there were 923 members 65+ in the member register of the Cycling Promotion. Most members (51%) age 65–74 are living in the Middle region of Sweden. Therefore the sample was stratified to get better balance between regions and age groups. For example, the questionnaire was sent to 'only' 118 members (*i.e.* one fourth of the total 472 members) in the age group 65–74 in the Middle region of Sweden, see Table 31. What region an individual belongs to were determined through the members' postal code, see Appendix 3.

Table 31. Number of questionnaires sent to members of the Cycling Promotion.

Region/Age	65–74	75–84	85+	Total
North	86	25	2	113
Middle	118	135	14	267
South	138	44	7	189
Total number	342	204	23	569

As seen in Table 31, the questionnaire was sent to a total of 569 members of the Cycling Promotion. The mailing occurred in June 2007. Altogether 364 answers were received in due time, corresponding to a response frequency of 64%. However 13 persons answering were less than 65 years old, so answers were received from 351 members age 65+, corresponding to a response frequency of 61%, see Table 32. The answer frequency decreased with increasing age and was 61% in average. Seven respondents (2%) were 85+. The oldest one was 89 years.

Table 32. Number of received answers.

Region/Age	65–74	75–84	85+	Total	Answer frequency (%)
North	56	16	1	73	65
Middle	69	73	4	146	55
South	99	21	2	130	69
Total number	224	118	7	349	54
Answer frequency (%)	65	58	30	61	

40% of the respondents were female, but in the northern region the share was higher (52%), see Tables 33 and 34.

Table 33. Respondents' age distribution (%).

Age	65–69	70–74	75–79	80–84	85+	Total
Age distribution	*42*	*23*	*22*	*12*	*2*	*100*
Share of female respondents	*45*	*33*	*46*	*31*	*0*	*40*
Total number	146	79	77	42	7	351

Table 34. Share of female respondents (%).

Region/Age	65–69	70–74	75–79	80–84	85+	Total
North	*53*	*40*	*78*	*57*	*0*	*52*
Middle	*39*	*46*	*41*	*22*	*0*	*37*
South	*46*	*18*	*44*	*27*	*0*	*36*
Total	45	0	46	29	0	40

The answers received were distributed by size of municipality where they reside and age group according to Table 35.

Table 35. Share of received answers (%).

Municipality size / Age	65–69	70–74	75–79	80–84	85+	Total
Rural	*4*	*8*	*4*	*4*	*0*	*3*
Small	*5*	*8*	*5*	*5*	*0*	*4*
Medium	*11*	*7*	*12*	*7*	*0*	*10*
Larger	*80*	*76*	*83*	*83*	*100*	*80*
Total number	145	78	77	42	7	349

3.3 Cycle habits

A major part of the respondents travel away from home quite often: 60% daily and 38% a few times a week. In the age group 65–69 it is somewhat more common to make a daily journey compared to older age groups, see Table 36.

Table 36. How often elderly makes a journey regardless of mode (%).

	Age group					
	65–69	70–74	75–79	80–84	85+	Total
Daily	*69*	*56*	*48*	*62*	*50*	*60*
A few times a week	*30*	*41*	*48*	*38*	*50*	*38*
Once a week	*1*	*1*	*3*	*0*	*0*	*1*
Other	*0*	*3*	*1*	*0*	*0*	*1*
Total number	146	79	77	42	6	350

43% of the respondents use a bike daily and 50% a few times a week, see Table 7a. The frequency is not dependant on age but dependent on region of residence and size of municipality, see Tables 37a–c.

Table 37a. How often respondents used a bike. Share of answers (%).

	Age group					
	65–69	70–74	75–79	80–84	85+	Total
Daily	*45*	*41*	*42*	*42*	*50*	*43*
A few times a week	*47*	*53*	*48*	*54*	*50*	*50*
Once a week	*4*	*3*	*3*	*2*	*0*	*3*
Other	*4*	*4*	*8*	*2*	*0*	*5*
Total number	144	79	77	41	6	347

Table 37b. How often respondents used a bike. Share of answers (%).

	Region			
	North	Middle	South	Total
Daily	*29*	*40*	*53*	*43*
A few times a week	*63*	*50*	*43*	*50*
Once a week	*4*	*4*	*2*	*3*
Other	*4*	*6*	*3*	*5*
Total number	73	144	127	345

Table 37c. How often respondents used a bike. Share of answers (%).

	Municipality size				
	Rural area	Small	Medium	Large	Total
Daily	*18*	*14*	*27*	*48*	*43*
A few times a week	*67*	*64*	*64*	*46*	*50*
Once a week	*0*	*14*	*3*	*3*	*3*
Other	*18*	*7*	*6*	*4*	*5*
Total number	11	14	33	278	345

Female respondents uses the bike daily more often than male, see Table 37d.

Table 37d. How often respondents used a bike. Share of answers (%).

	Gender		
	Female	Male	Total
Daily	*48*	*40*	*43*
A few times a week	*46*	*52*	*50*
Once a week	*1*	*4*	*3*
Other	*5*	*4*	*5*
Total number	140	205	346

Almost all respondents cycle in the spring, summer and autumn, but only 40% do it in the wintertime; and only 12% cycle during the winter in northern Sweden, whereas 35% do it in the middle, and 61% in the southern region, see Tables 38a and 38b.

Table 38a. The share of elderly cycling in different seasons of the year (%).

	Age group					
Season	65–69	70–74	75–79	80–84	85+	Total
Autumn	*92*	*92*	*88*	*90*	*86*	*91*
Winter	*43*	*34*	*39*	*36*	*57*	*40*
Spring	*97*	*99*	*95*	*95*	*86*	*96*
Summer	*100*	*99*	*97*	*98*	*100*	*99*
Total number	146	79	77	42	7	351

Table 38b. The share of elderly cycling in different seasons of the year (%).

	Region			
Season	North	Middle	South	Total
Autumn	*78*	*94*	*96*	*91*
Winter	*12*	*35*	*61*	*40*
Spring	*92*	*96*	*100*	*97*
Summer	*100*	*99*	*99*	*99*
Total number	73	144	130	348

The foremost reason that elderly ride bicycles is to get exercise, which 94% of the respondents state as a reason, see Table 39. Other often stated reasons are: because it is joyful (84%), because it gives freedom (73%), because it is easy (72%), and because it is easy to park (66%). The only reason which got a response below 50% that is included in the list of the questionnaire is "because cycling is fast". Furthermore, only 58% find cycling cheap. *Note* that on this and several other questions, respondents are allowed to give several answers, see Appendix 4.

Table 39. Reasons why the elderly bike. Share of answers (%).

Reason	*Share*
Easy	*72*
Exercise	*94*
Cheap	*58*
Joyful	*84*
Environmentally friendly	*69*
Fast	*48*
Easy to park	*66*
Gives freedom and independence	*73*
Other	*19*
Total number	351

The elderly use a bike most often during trips to the store. About 76% usually use a bike for such trips, see Table 40. Almost two thirds use a bike also when visiting friends and a little more than half use a bike during trips to the library, swimming-hall or similar destinations. Fewer use a bike during vacation. A big share of the respondents also checked off the alternative 'other', and the majority of these people meant bike usage for exercise and excursions.

Table 40. Share of the elderly that state that they usually choose to go by bike to a certain destination (%).

	Share
Store	*76*
Friends	*60*
Library, swimming-hall or similar	*55*
During vacation	*39*
Other: exercise	*16*
Other: excursion	*5*
Other	*18*
Total number	351

The foremost reason that the elderly leave their bikes at home and use another means of transportation is related to bad road conditions during the winter (which is the reason too that so many do not bike at all during the winter): slipperiness (81%), insufficient snow removal (79%) and snowfall (77%), see Table 41a. Temperatures below zero Celsius restrain about half of the elderly from cycling; also rain, darkness and wind restrain from cycle. There is also differences between the different regions, see Table 41b. All reasons expect 'wind' and 'insufficient snow removal' are stated as reasons for leaving their bike at home considerably more often by elderly in northern Sweden than in the two other regions. As for differences depending on municipality size there is a trend that the share of elderly who leave their bike at home because of the weather increases the smaller the municipality the respondent lives in, see Table 41c. This applies especially to rain and darkness, which restrain only one third of the elderly in larger but more than two thirds of riders in rural areas. 7% of all respondents stated that none of the listed alternatives has a crucial influence on their usage of bikes.

Table 41a. Circumstances for leaving the bike at home. Share of answers (%).

	Age group					
	65–69	70–74	75–79	80–84	85+	Total
Rain	*27*	*37*	*40*	*40*	*57*	*34*
Darkness	*32*	*42*	*49*	*38*	*57*	*39*
Wind	*22*	*23*	*19*	*26*	*43*	*23*
Snowfall	*74*	*85*	*74*	*76*	*71*	*77*
Temperature below zero degrees Celsius	*42*	*56*	*52*	*57*	*43*	*49*
Slipperiness	*81*	*84*	*82*	*79*	*57*	*81*
Insufficient snow removal	*79*	*85*	*79*	*67*	*86*	*79*
For ex. Saturday night (feels unsafe)	*16*	*18*	*25*	*19*	*0*	*19*
Rush hour	*16*	*18*	*16*	*14*	*14*	*16*
Other	*7*	*3*	*3*	*2*	*14*	*5*
None of these are crucial	*8*	*6*	*5*	*12*	*0*	*7*
Total number	146	79	77	42	7	351

Table 41b. Circumstances for leaving the bike at home. Share of answers (%).

	Region			
	North	Middle	South	Total
Rain	*52*	*35*	*24*	*35*
Darkness	*52*	*39*	*33*	*40*
Wind	*29*	*17*	*26*	*23*
Snowfall	*86*	*73*	*75*	*77*
Temperature below zero degrees Celsius	*62*	*55*	*36*	*50*
Slipperiness	*86*	*75*	*84*	*81*
Insufficient snow removal	*78*	*74*	*85*	*80*
For ex. Saturday night (feels unsafe)	*26*	*13*	*21*	*19*
Rush hour	*14*	*17*	*15*	*16*
Other	*5*	*2*	*7*	*5*
None of these are crucial	*3*	*10*	*6*	*7*
Total number	73	145	130	349

Table 41c. Circumstances for leaving the bike at home. Share of answers (%).

	Municipality size				
	Rural area	Smaller	Medium	Larger	Total
Rain	*82*	*43*	*32*	*32*	*34*
Darkness	*82*	*57*	*47*	*35*	*39*
Wind	*45*	*43*	*29*	*20*	*23*
Snowfall	*100*	*86*	*79*	*74*	*77*
Temperature below zero degrees Celsius	*91*	*86*	*53*	*44*	*49*
Slipperiness	*100*	*93*	*85*	*79*	*81*
Insufficient snow removal	*91*	*79*	*79*	*78*	*79*
For ex. Saturday night (feels unsafe)	*0*	*21*	*15*	*19*	*18*
Rush hour	*18*	*50*	*15*	*14*	*16*
Other	*0*	*7*	*6*	*5*	*5*
None of these are crucial	*0*	*7*	*3*	*8*	*7*
Total number	11	14	34	280	349

Also, long distances are a reason that elderly choose not to use a bike. Some leave their bikes at home when the distance in one direction is more than 6–10 kilometres. Two thirds (65%) of the respondents do not like biking if the (one-way) distance is above 15 kilometres, see Table 42a, and only 17% find distances longer than 20 kilometres a suitable distance, whereas a small share are willing to bike quite a bit further. There are no big differences between genders and age groups, except that that the share that bike only up to 5 kilometres increases with age. The municipality size affects how far the distance has to be for the elderly to leave their bikes at home. Of those who live in rural areas, almost half are willing to bike as far as 16–20 kilometres, and the share that is willing to bike more than 20 kilometres is somewhat larger in rural areas and in smaller municipalities compared to medium and larger municipalities. See Table 42b.

Table 42a. How far away a destination needs to be for the elderly to abstain from using a bike. Share of answers (%).

	Age group					
km	65–69	70–74	75–79	80–84	85+	Total
0–5	*11*	*12*	*16*	*21*	*29*	*14*
6–10	*38*	*42*	*38*	*29*	*0*	*37*
11–15	*13*	*15*	*16*	*5*	*29*	*14*
16–20	*23*	*15*	*18*	*11*	*29*	*19*
21–30	*5*	*8*	*9*	*13*	*14*	*8*
31–40	*7*	*3*	*3*	*8*	*0*	*5*
41–50	*1*	*1*	*1*	*8*	*0*	*2*
51–	*2*	*4*	*0*	*5*	*0*	*2*
Total number	142	74	71	38	7	332

Table 42b. How far away a destination needs to be for the elderly to abstain from using a bike. Share of answers (%).

	Municipality size				
km	Rural area	Smaller	Medium	Larger	Total
0–5	*9*	*15*	*9*	*14*	*14*
6–10	*9*	*31*	*44*	*38*	*37*
11–15	*9*	*15*	*13*	*14*	*13*
16–20	*46*	*15*	*19*	*19*	*19*
21–30	*18*	*15*	*3*	*7*	*7*
31–40	*0*	*0*	*6*	*6*	*5*
41–50	*0*	*0*	*0*	*2*	*2*
51–	*9*	*8*	*6*	*1*	*2*
Total number	11	13	32	265	330

Almost all (94%) of the elderly stated that they usually bike on paths or use cycle tracks. However the share that usually bike on cycle tracks decreases somewhat the smaller the municipality is. About 87% stated that they usually bike also on smaller roads. However the share that bikes on roads decreases in the older age groups. Of those who live in larger municipalities somewhat fewer stated that they usually bike on roads than of those who live in smaller municipalities. About two thirds of all respondents bike in mixed traffic. However the share that stated that they usually bike in mixed traffic is somewhat higher in the age group 65–69 than in the other age groups and lower among those who live in rural areas than in other municipality sizes. Only 14% usually bike on the sidewalk, and that share decreases with age. The share of the elderly that bike on sidewalks is larger (about one fifth) than in other areas both in smaller municipalities and in northern Sweden. See Tables 43a, 43b and 43c.

Table 43a. Road types on which the elderly usually bike. Share of answers (%).

	Age group					
	65–69	70–74	75–79	80–84	85+	Total
Smaller roads	*90*	*89*	*86*	*81*	*57*	*87*
Cycle tracks	*93*	*96*	*96*	*90*	*86*	*94*
Mixed traffic	*72*	*58*	*57*	*64*	*57*	*64*
Side walks	*18*	*11*	*9*	*7*	*0*	*14*
Other	*6*	*8*	*9*	*5*	*0*	*7*
Total number	146	79	77	42	7	351

Table 43b. Road types on which the elderly usually bike. Share of answers (%).

	Region			
	North	Middle	South	Total
Smaller roads	*89*	*84*	*88*	*87*
Cycle tracks	*90*	*94*	*96*	*94*
Mixed traffic	*63*	*66*	*64*	*64*
Side walks	*22*	*10*	*13*	*13*
Other	*8*	*7*	*5*	*7*
Total number	73	145	130	349

Table 43c. Road types on which the elderly usually bike. Share of answers (%).

	Municipality size				
	Rural area	Small	Medium	Larger	Total
Smaller roads	*91*	*100*	*97*	*84*	*87*
Cycle tracks	*73*	*79*	*85*	*97*	*94*
Mixed traffic	*55*	*64*	*62*	*65*	*64*
Side walks	*0*	*21*	*12*	*13*	*13*
Other	*0*	*7*	*3*	*8*	*7*
Total number	11	14	34	280	349

3.4 Equipment

The most commonly used equipment is lights, which are used by 82% of the respondents, see Tables 44a and 45a. Most common are battery-powered lights followed by traditional dynamo-operated ones where the generator touches the tire. Some respondents have a dynamo in the hub, see Table 46. The second most common equipment is a helmet, which is used by 80% of the elderly. The remaining one fifth does not own one. The helmet use is lower in southern regions, see Table 44b. About two thirds of the respondents use a bicycle-bag or basket *and* reflectors. The use of reflectors increases with the size of the municipality. Contrary, reflective vests are used only by 17% of the respondents, but in rural areas the usage is close to 50%. The usage of helmets and reflectors increases with age; else there are no significant differences, see Table 44c. Rear-view mirrors are used by a few respondents, but are desired by quite many respondents (28%), especially in rural areas and in the Northern region, see Table 45b. The age of the respondent does not seem to influence their use or lack of use of rear-view mirrors. Winter tires and winter cycles are desired by one fifth of the respondents. However, more than half of the respondents stated that they do not miss having any equipment or that they have no opinion. See Tables 44b, 45b and 45c.

Table 44a. Usage of cycle equipment. Share of answers (%).

	Municipality size				
	Rural area	Small	Medium	Larger	Total
Helmet	*82*	*79*	*82*	*80*	*80*
Reflexes	*45*	*50*	*62*	*67*	*65*
Winter tires	*0*	*0*	*9*	*10*	*9*
Winter bike	*0*	*7*	*6*	*7*	*7*
Lights	*64*	*64*	*65*	*83*	*82*
Reflective vest	*45*	*43*	*35*	*13*	*17*
Bicycle-bag, basket	*64*	*86*	*68*	*66*	*66*
Rear-view mirror	*9*	*14*	*6*	*7*	*7*
Other equipment	*9*	*0*	*6*	*7*	*7*
Total number	11	14	34	280	349

Table 44b. Usage of cycle equipment. Share of answers (%).

	Region			
	North	Middle	South	Total
Helmet	*86*	*83*	*72*	*80*
Reflectors	*59*	*70*	*64*	*65*
Winter tires	*8*	*14*	*5*	*9*
Winter bike	*7*	*10*	*3*	*7*
Lights	*81*	*77*	*88*	*82*
Reflective vest	*19*	*15*	*19*	*17*
Bicycle-bag, basket	*71*	*62*	*68*	*66*
Rear-view mirror	*7*	*7*	*8*	*7*
Other equipment	*8*	*7*	*6*	*7*
Total number	73	145	130	349

Table 44c. Usage of cycle equipment. Share of answers (%).

	Age group					
	65–69	70–74	75–79	80–84	85+	Total
Helmet	*78*	*81*	*75*	*90*	*100*	*79*
Reflexes	*63*	*65*	*64*	*76*	*86*	*65*
Winter tires	*13*	*4*	*9*	*7*	*14*	*9*
Winter bike	*7*	*8*	*6*	*5*	*14*	*7*
Lights	*85*	*87*	*77*	*76*	*57*	*81*
Reflective vest	*22*	*15*	*12*	*19*	*0*	*17*
Bicycle-bag, basket	*66*	*67*	*69*	*62*	*57*	*66*
Rear-view mirror	*7*	*6*	*9*	*7*	*0*	*7*
Other equipment	*8*	*4*	*6*	*12*	*0*	*7*
Total number	146	79	77	42	7	351

Table 45a. Desired equipment. Share of answers (%).

	Municipality size				
	Rural area	Small	Medium	Larger	Total
Helmet	*0*	*0*	*6*	*6*	*6*
Reflexes	*0*	*0*	*3*	*4*	*3*
Winter tires	*18*	*7*	*15*	*18*	*17*
Winter bike	*18*	*14*	*12*	*15*	*15*
Lights	*0*	*0*	*3*	*3*	*3*
Reflective vest	*9*	*7*	*21*	*15*	*15*
Bicycle-bag, basket	*0*	*0*	*3*	*2*	*2*
Rear-view mirror	*36*	*21*	*26*	*28*	*28*
Other equipment	*0*	*0*	*0*	*3*	*3*
No opinion	*36*	*21*	*24*	*27*	*26*
Desires nothing	*27*	*50*	*32*	*25*	*28*
Total number	11	14	34	280	349

Table 45b. Desired equipment. Share of answers (%).

	Region			
	North	Middle	South	Total
Helmet	*5*	*5*	*8*	*6*
Reflexes	*4*	*3*	*3*	*3*
Winter tires	*15*	*19*	*15*	*17*
Winter bike	*15*	*14*	*15*	*15*
Lights	*1*	*4*	*2*	*3*
Reflective vest	*19*	*12*	*15*	*15*
Bicycle-bag, basket	*1*	*2*	*2*	*2*
Rear-view mirror	*38*	*25*	*25*	*28*
Other equipment	*3*	*3*	*2*	*3*
No opinion	*22*	*23*	*32*	*26*
Desires nothing	*23*	*32*	*25*	*28*
Total number	73	145	130	349

Table 45c. Desired equipment. Share of answers (%).

	Age group					
	65–69	70–74	75–79	80–84	85+	Total
Helmet	*5*	*6*	*6*	*7*	*0*	*6*
Reflexes	*1*	*4*	*4*	*10*	*0*	*3*
Winter tires	*15*	*14*	*27*	*12*	*0*	*17*
Winter bike	*16*	*11*	*21*	*7*	*0*	*15*
Lights	*1*	*3*	*4*	*7*	*0*	*3*
Reflective vest	*14*	*15*	*14*	*17*	*14*	*15*
Bicycle-bag, basket	*3*	*1*	*1*	*2*	*0*	*2*
Rear-view mirror	*27*	*29*	*27*	*26*	*29*	*27*
Other equipment	*2*	*3*	*1*	*7*	*0*	*3*
No opinion	*32*	*24*	*25*	*14*	*14*	*26*
Desires nothing	*23*	*30*	*29*	*38*	*43*	*28*
Total number	146	79	77	42	7	351

Table 46. Type of cycle lights. Share of answers (%).

	Share
Battery-powered	*60*
Tire dynamo	*39*
Hub dynamo	*11*
Only reflector	*0*
Other equipment	*1*
Has none	*3*
Total number	348

3.5 Traffic environment, information and safety

The most common sites or maneuvers the elderly avoid are roundabouts, left turns and crossing streets without a cycle crossing, see Table 47. Also according to the analysis of Finnish in-depth crash data left-turns were hazardous to the elderly cyclists. Especially the oldest respondents state that they avoid roundabouts. Also cycle tracks with moped traffic are avoided by many. The most common reason that the elderly avoid any site or maneuver is that they feel insecure. Many choose to walk their bike, when they perceive something dangerous such as drivers of cars that do not stop or take cyclists into consideration and cars and mopeds that are driven too fast. However, 41% of the respondents do not avoid any site or maneuver.

Table 47. Sites or manoeuvres the respondents avoid. Share of answers (%).

	Age group					
	65–69	70–74	75–79	80–84	85+	Total
No	*47*	*44*	*32*	*29*	*43*	*41*
Do not know	*3*	*8*	*5*	*5*	*0*	*5*
Roundabouts	*20*	*19*	*29*	*29*	*29*	*23*
Left turn	*18*	*16*	*19*	*24*	*0*	*19*
Crossing streets without cycle crossing	*14*	*27*	*18*	*12*	*29*	*18*
Crossing streets with cycle crossing	*8*	*10*	*7*	*10*	*14*	*8*
Cycle track with mopeds	*14*	*9*	*13*	*12*	*0*	*12*
Crossing streets at a traffic signal	*2*	*1*	*3*	*2*	*14*	*2*
Other	*5*	*3*	*8*	*10*	*0*	*6*
Total number	146	79	77	42	7	351

A majority of people states that they consider traffic signals to be helpful, and the share with this opinion increases with age, see Table 48a and for different municipality size Table 48b. Many stated that traffic signals are necessary, especially to enable crossing the road at dense traffic, and that signals increase safety. However, some prefer to get off and walk their bike across a street. Others comment that it is important to respect traffic signals and not ride bikes against red lights.

Table 48a. Are traffic signals useful for bicyclists? Share of answers (%).

	Age group					
	65–69	70–74	75–79	80–84	85+	Total
Yes	*79*	*83*	*88*	*88*	*100*	*84*
Neither nor	*9*	*9*	*5*	*5*	*0*	*8*
No	*6*	*0*	*0*	*5*	*0*	*3*
No opinion	*6*	*8*	*7*	*3*	*0*	*6*
Total number	140	78	74	40	7	339

Table 48b. Are traffic signals useful for bicyclists? Share of answers (%).

	Municipality size				
	Rural area	Small	Medium	Larger	Total
Yes	*82*	*73*	*73*	*85*	*83*
Neither nor	*9*	*0*	*13*	*8*	*8*
No	*0*	*9*	*3*	*3*	*3*
No opinion	*9*	*18*	*7*	*5*	*6*
Total number	11	11	30	276	337

According to the elderly, the biggest safety problems are potholes, slipperiness and insufficient snow removal; 76, 74 and 70% of the respondents have referred to these factors as safety problems, see Tables 49a–b. However, according to the analysis of the Finnish in-depth crash data, elderly bicyclists are not over-involved in crashes where the road surface was damaged. Possibly the explanations are that elderly ride slower and less in darkness compared to other age groups. Slipperiness and insufficient snow removal are problems especially in southern Sweden. Major problems are also curb stones and cars going too fast.

Table 49a. Safety problems. Share of answers (%).

	Age group					
	65–69	70–74	75–79	80–84	85+	Total
Potholes	*75*	*73*	*79*	*76*	*71*	*76*
High curb stones	*61*	*66*	*49*	*62*	*86*	*60*
Slipperiness	*75*	*77*	*69*	*76*	*57*	*74*
Insufficient snow removal	*71*	*65*	*73*	*67*	*71*	*70*
Bad hearing	*8*	*4*	*12*	*12*	*14*	*9*
Functions of the bikes	*8*	*10*	*10*	*14*	*29*	*10*
Hindrances	*17*	*16*	*22*	*19*	*29*	*19*
Missing road lighting	*28*	*24*	*25*	*17*	*29*	*25*
Cars driving too fast	*57*	*54*	*45*	*50*	*14*	*52*
Bad sight	*4*	*3*	*5*	*5*	*14*	*4*
Medication	*3*	*0*	*0*	*2*	*0*	*2*
Other	*13*	*14*	*13*	*14*	*29*	*14*
Total number	146	79	77	42	7	351

Table 49b. Safety problems. Share of answers (%).

	Region			
	North	Middle	South	Total
Potholes	*75*	*81*	*69*	*76*
High curb stones	*62*	*60*	*60*	*60*
Slipperiness	*71*	*70*	*80*	*74*
Insufficient snow removal	*62*	*68*	*77*	*70*
Bad hearing	*10*	*9*	*8*	*9*
Functions of the bikes	*11*	*10*	*10*	*10*
Hindrances	*22*	*19*	*16*	*18*
Missing road lighting	*26*	*21*	*29*	*25*
Cars driving too fast	*53*	*50*	*53*	*52*
Bad sight	*3*	*6*	*3*	*4*
Medication	*1*	*3*	*1*	*2*
Other	*11*	*14*	*14*	*14*
Total number	73	145	130	349

One third of the respondents consider bicycle parking facilities to function well and another third states that they function neither well nor bad, see Table 50. The most common comment is that there are too few lots for bicycle parking and that they often are too crowded or not secure against theft, and often there are not enough pollards to fasten the bike to. However, 62% of the respondents say that the risk of theft does not limit their bike usage, see Table 51.

Table 50. How bicycle parking functions. Share of answers (%).

	Municipality size				
	Rural area	Small	Medium	Larger	Total
Very good	*0*	*7*	*3*	*4*	*4*
Good	*18*	*14*	*23*	*40*	*36*
Neither good, nor bad	*46*	*36*	*39*	*34*	*35*
Bad	*0*	*0*	*13*	*14*	*13*
Very bad	*0*	*7*	*7*	*4*	*4*
No opinion	*36*	*36*	*16*	*4*	*8*
Total number	11	14	31	273	339

Table 51. Does the risk of theft limit the use of the bike? (%)

	Municipality size				
	Rural area	Small	Medium	Larger	Total
Yes	*0*	*0*	*6*	*6*	*6*
Sometimes	*9*	*36*	*27*	*29*	*28*
No	*91*	*57*	*64*	*61*	*62*
No opinion	*0*	*7*	*3*	*4*	*4*
Total number	11	14	33	278	346

One third of the respondents state that signage and route information for bicyclists is good and another third that it is neither good nor bad, see Table 52. The most frequent comment about posting of signs is that the quality is varying too much. It is good at some sites and bad at others. It is sometimes completely missing and other times damaged.

Table 52. How posting of signs is perceived. Share of answers (%).

	Municipality size				
	Rural area	Small	Medium	Larger	Total
Very good	*0*	*7*	*3*	*6*	*5*
Good	*36*	*14*	*12*	*41*	*36*
Neither good, nor bad	*55*	*36*	*33*	*34*	*34*
Bad	*0*	*14*	*30*	*12*	*14*
Very bad	*9*	*14*	*9*	*4*	*5*
No opinion	*0*	*14*	*12*	*4*	*5*
Total number	11	14	33	274	342

It is desirable to get information about changes in rules and other news important to cyclists according to almost a third, see Tables 53 and 54. Especially respondents older than 80 years state that information is important. However, Maring and van Schagen (1990) conclude that older bicyclists (60+) were deficient regarding knowledge while showing the most positive attitudes. The subjects over 70 performed much worse than the rest of the older group concerning knowledge.

Table 53. How does information about rules and news work for cyclists? Share of answers (%).

	Age group					
	65–69	70–74	75–79	80–84	85+	Total
Very good	*0*	*4*	*3*	*0*	*0*	*1*
Good	*30*	*20*	*32*	*42*	*57*	*30*
Neither good, nor bad	*35*	*41*	*29*	*32*	*14*	*34*
Bad	*22*	*25*	*13*	*10*	*14*	*19*
Very bad	*8*	*5*	*5*	*2*	*14*	*6*
No opinion	*5*	*5*	*17*	*15*	*0*	*9*
Total number	145	79	75	41	7	347

Table 54. Does information about rules and news work for cyclists? Share of answers (%).

	Municipality size				
	Rural area	Small	Medium	Larger	Total
Very good	*0*	*0*	*0*	*2*	*1*
Good	*18*	*21*	*15*	*33*	*30*
Neither good, nor bad	*36*	*29*	*41*	*34*	*34*
Bad	*27*	*43*	*32*	*16*	*19*
Very bad	*9*	*7*	*6*	*6*	*6*
No opinion	*9*	*0*	*6*	*10*	*9*
Total number	11	14	34	276	345

What the elderly say would increase their biking is linked to what they say is important for increased traffic safety. Increased safety would lead to increased biking among the elderly. Requests dealing with the physical design of roads are especially a demand for more and better cycle tracks. Communication between road users expressed as more and better consideration are also perceived to increase their feeling of security and thereby increase their biking, see Tables 55 and 56. More cycle tracks is the most stated alternative both on the question about what would increase the biking of the elderly and on the question about what would increase traffic safety. Other safety-increasing factors that would increase biking are better maintenance of cycle tracks, road users taking each other into better consideration, and removal of mopeds from cycle tracks.

Table 55. Factors that would increase biking among the elderly. Share of answers (%)

	Gender		
	Women	Men	Total
More cycle tracks	*13*	*12*	*13*
Better cycle tracks	*4*	*4*	*4*
Maintenance of cycle tracks	*3*	*2*	*3*
Possibility to bring the bike onto buss/train	*12*	*4*	*7*
Health	*5*	*5*	*5*
Better weather	*2*	*4*	*3*
Better bike parking facilities	*2*	*3*	*3*
Motivation	*1*	*3*	*2*
More time	*1*	*2*	*2*
Consideration between road users	*1*	*1*	*1*
No mopeds on cycle tracks	*1*	*0*	*1*
Other	*16*	*18*	*17*
Already bike often	*9*	*6*	*7*
Total number	140	209	351

Table 56. Factors that would increase traffic safety and security for cyclists. Share of answers (%).

	Gender		
	Women	Men	Total
More cycle tracks	*48*	*29*	*36*
Separated cycle tracks	*9*	*17*	*14*
Better cycle tracks	*8*	*5*	*6*
Consideration between road users	*31*	*10*	*12*
Education about traffic rules	*9*	*9*	*9*
No mopeds on cycle tracks	*6*	*8*	*7*
Lower speed among cars	*4*	*4*	*4*
No passing too close	*2*	*5*	*4*
Use of helmet	*3*	*4*	*4*
Maintenance of cycle tracks	*6*	*2*	*3*
No pedestrians on cycle tracks	*1*	*3*	*3*
Lighting on cycle tracks	*6*	*0*	*3*
Broader roadsides	*2*	*2*	*2*
Other	*33*	*29*	*29*
Total number	140	209	351

Almost half of the respondents state that their bike usage would increase if there was a possibility to bring the bike onto busses and trains. This view is especially common (57%) among the youngest group, see Table 57. The most common comment is that such a possibility would facilitate going on bike holidays or longer bike excursions or to use the bike at the destination.

Table 57. Should the bike usage increase if there was a possibility to take the bike onto the bus or train? Share of answers (%).

	Age group					
	65–69	70–74	75–79	80–84	85+	Total
Yes	*57*	*41*	*47*	*32*	*14*	*47*
Sometimes	*23*	*32*	*28*	*22*	*29*	*26*
No	*13*	*17*	*10*	*22*	*14*	*14*
No need	*6*	*11*	*15*	*24*	*43*	*12*
Total number	145	79	74	41	7	346

4. Expert questionnaire

An expert questionnaire, see Appendix 5, was distributed during the Velo-city 2007 conference. All together, 14 experts answered. At the outset the experts were asked to describe, in their own words, the preconditions for using the bicycle as a means of transport. The most common preconditions mentioned were:

- safety and a feeling of security when cycling
- the existence of a network of roads for cycling including appropriate bike parking facilities
- positive attitudes from users and non-users.

This is much in accordance with the opinions expressed by the senior cyclists. Some experts stressed the importance of an urban policy for cycle mobility. Reasonable physical and mental abilities of the cyclists were also considered as important preconditions.

According to the experts, the most important needs concerning infrastructure for senior citizens are comfortable, wide bike paths or cycle streets away from main streets, with good directional signage. High curb stones and steep gradients should be avoided. An electric motor could be useful up-hills. Many experts mentioned the importance of detectors well in advance of signalized intersections to give cyclists the possibility to get a green light without having to slow down or dismount their bicycles.

Low motor vehicle speeds achieved by Intelligent Speed Adaptation (ISA) or by other means was by many considered as a prerequisite for safety. Other suggestions to increase safety include warning signals or warning lights to warn cyclists of approaching motor vehicles or vice versa at intersections. Such warning devices could also be useful when a motor vehicle is approaching a bike from behind (or a bike is approaching a pedestrian, but then the sound has to be “gentle” so that pedestrians are not scared). ITS can be used to get better guidance for and visibility of bicyclists at night time, for example through led-lights in the pavements or by increasing the intensity of street lighting at times when cycle traffic is present.

With respect to suggestions to improve the design and equipment of the bike itself, an upright seating position and a low bike frame making it easy to climb on and off the bike was stressed. Some equipment facilitating turning left would be useful as many senior citizens have a stiff neck and bad balance. A rear-view mirror could help, as stated by senior cyclists, but improvements are also possible by designing the infrastructure, so that it becomes unnecessary to merge with motor vehicles when turning left. As mentioned above, cycle tracks are an efficient means to increase safety for elderly bicyclists, as they reduce accidents with left-turning bicyclists (Jensen, 2006).

Almost all experts suggested a digital map for on-line route guidance when cycling and also for trip planning before the trip starts. On-line devices like Personal Digital Assistants (PDAs) could also be used, for example, to get local weather information or to find time tables for public transport and especially to see whether it is allowed to bring the bike on the tram or bus. A special design of the devices making it easy for elderly to use them was considered crucial.

The following automatic types of equipment for bikes were considered important to test and further develop:

- automatic locking and opening at a distance by using the key as for cars
- automatic gears
- automatic turning on and off of bicycle lamps (with power supply from a reliable dynamo)
- automatic elevating of the saddle after mounting.

Also Spolander (2007) suggests a lower more upright riding position and automatic gear changing. Further he gives a list of components which can be improved ergonomically and functionally, and concludes that a design which give better comfort also seems to give better safety.

Experts were also asked to estimate the extent ITS can be used to increase safety and quality. There was no consensus about the effect on safety. Some experts were very optimistic about safety effects (often by introduction of collision avoidance or Intelligent Speed Adaptation on cars), others were not. All experts agreed that 'quality' when cycling could be increased. Many experts stated that ITS systems could raise the profile of cycling as such, which would be a very important side effect.

Experts were also asked to state requirements for ITS devices. According to the experts, the devices should be reliable, accurate and easily accessed. One expert elaborated on this further and stated that the requirements should be that such car-based systems for controlling speeds etc, are universal, *i.e.* that they work in a systematic way and that there is enforcement (or other type of control) of non-compliance with rules at every location where there is interaction between cyclists and cars. It was suggested that ITS measures are linked to or built into existing equipment such as navigation systems, cycle computers, and traffic signal control boxes.

5. An expert workshop

The last tool (the expert workshop) included two group discussions structured according to two philosophically different models: The Diamond model and The Multiple comfort model.

5.1 The Diamond model

The Diamond model proposed by Risser (2000) includes five areas from which behaviour-steering effects originate and it mirrors also the fact that effects, or areas, are interrelated, see Figure 1. Risser and Ausserer (2007) argue that traffic safety experts cannot take decisions that will be accepted by relevant groups, and they certainly will not get their co-operation, without communicating with them in an appropriate way.

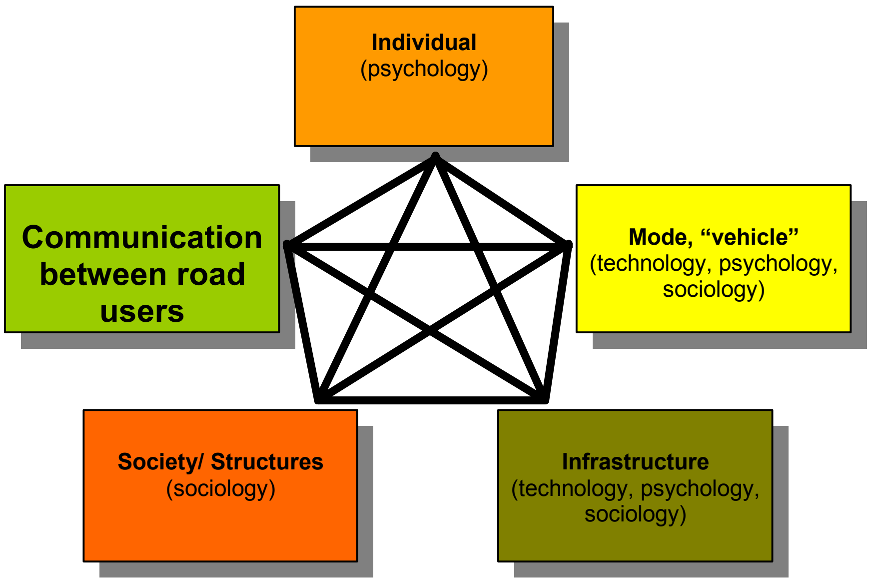

Figure 1. The Diamond (Risser, 2000).

5.2 Discussion results according to the Diamond model

The following *individual* measures were proposed by the group members to develop safe and joyful cycling for senior citizens:

- training
- bike pooling
- information & instruction.

The following measures concerning *the bicycle*:

- saddle for men and women in different forms
- easily handable lock
- telematics (GPS)
- reflectors and other means to improve visibility
- use light materials
- stable and easily useable stand
- assistance for all kinds of communication (*e.g.* rear mirrors and side blinkers).

The following measures concerning *infrastructure*:

- elevated crossings or humps
- give space to bicyclists and pedestrians
- places to rest
- awareness raising infrastructure design, including blinking lights, red-coloured lanes, intelligent traffic lights
- sign-posting – big letters and consistent
- route guidance by signs, telematics (GPS)
- bicycle parking facilities (shelters, video protection)
- transport on public means
- continuity of the bicycle network.

The following measures concerning *society and structures*:

- include knowledge about cyclists' needs and characteristics in driving school curricula
- information of the public about rules, health issues
- creating a positive image in the media
- increase and improve research
- change rules and regulations
- focus law enforcement on problems of unprotected road users
- regulations concerning "para-"cyclists (scooters, roller skaters, in-line skaters).

And the following measures concerning *communication between road users*:

- infrastructure measures (slow down cars, give place for communication)
- laws and regulations enhancing and securing communication
- equipment (rear mirror, Chinese bell)
- training and workshops
- infrastructure to increase bicyclists' awareness of pedestrians and car drivers' awareness of bicyclists, incl. infrastructure-based telematics.

5.3 The Multiple comfort model

There are a lot of models to explain driver behavior. Wilde (1994) argues that on an aggregated level road users tend to target a certain level of risk (risk homeostasis). This target level of risk can be modified by rewarding safe road user behavior. Summala (2005) argues that the following five issues are the most important ones to explain driver behavior on a strategic, tactical and operational (individual) level:

- safety margins (to survive)
- good or expected progress of trips
- rule following (according to the law and social rules)
- vehicle/road system (bicycle and infrastructure)
- pleasure of driving and pleasure of cycling.

The model is slightly modified to also fit to explain cyclists' behavior.

Safety margins imply a concept of available time, which is one basis for the behavioral adaptation phenomenon. One example of this phenomenon is that the safety effect of raising bicycle crossings implying reduced vehicle speeds, were more or less canceled out by increased bicycle speeds (Leden *et al.*, 2000).

Good or expected progress of trips applies also for cyclists. Cyclists like to maintain their speed and are often hesitating when it comes to braking. As mentioned above many experts mentioned the importance of detectors well in advance of signalized intersections to give cyclists the possibility to get a green light without having to slow down or dismount their bicycles. Gradients, especially downhill, are hazardous especially for cycling children as they were reluctant to brake (Leden, 1989).

The analysis of Finnish in-depth crash data revealed that 80% of the cyclists had not obeyed some rule. Though this figure is certainly biased due to the fact that the conclusions are often based on the surviving car driver's statements, *rule following* is obviously critical also for cyclists.

According to Summala the vehicle/road system for cars usually implies smooth car/road performance. This is often not the case for the *cycle*/road system. A cycle design for elderly cyclists based on new technology is lacking.

Adequate *bicycle infrastructure* is often missing in Europe, except in the Netherlands and Denmark, and if it exists, it often does not comply with the best practise (Leden, 1999). Cycle tracks in urban areas should be designed *one-directional.* Drivers do not expect cyclists from the 'wrong' direction. Two-directional cycle-tracks deteriorate safety, see *e.g.* Linderholm (1992), Pasanen (1992), Summala *et al.* (1996) and Räsänen *et al.* (1998). The quality of sign posting for cyclists is varying as stated above. This is not the case for motor vehicles. However, the most stated safety-increasing measure according to the senior cyclists is construction of more *cycle tracks*. More than one third of the respondents want this. Also according to research, cycle tracks are an efficient mean to increase safety for elderly bicyclists, as they reduce accidents with left-turning bicyclists (Jensen, 2006). Jensen concludes that elderly bicyclists (65+) had a significant reduction in injuries, of about 55%, when one-directional cycle tracks (with truncated cycle tracks or raised cycle crossings) were constructed in Copenhagen, though risk increased by 12% if all age groups were included in the analysis.

Both European and American experiences show that *bicycle facilities* promote biking. For example, Nelson and Allen (1997) found a positive association between miles of bicycle "pathways" per 100 000 residents and the percentage of commuters using bicycles for 18 cities in US. The "pathways" included both cycle tracks and cycle lanes, but they did not include streets with wide shoulder. Similar results from Europe are reported, for example, by Nettelblad (1987) and Gårder *et al.* (1998).

Pleasure of driving will be *pleasure of cycling*, which obviously is an important topic for senior cyclists as 84% of the respondents stated that joyfulness is a reason for them to cycle. Measures should keep or increase the pleasure of cycling.

5.4 Discussion results according to the Multiple comfort model

As already mentioned the second group discussion was structured according to this model.

The following measures were suggested concerning *safety margins*:

- make cars visible using through infrastructure design and warning lights in the pavement.

The following measures concerning *good or expected progress of trips*:

- giving right of way to cyclists if there are traffic lights
- hindrances for cars in the pavement to reduce speed
- rumble strips for cyclists
- special advice on signs at dangerous crossings
- warning lights.

The following measures concerning *rule following*:

- discussion about rules within authorities
- direct feedback of surrounding is needed – ITS?
- virtual rumble strips (vibration).

The following measures concerning *vehicle/road system*:

- ongoing cycle lanes or information about how to go on
- navigation systems for cyclists
- parking areas and shelters.

The following measures concerning *pleasure of cycling*:

- things mentioned before should/can keep or increase the pleasure of cycling.

6. Conclusions

All tools tested here seem to work well together for developing ideas for countermeasures that ensures safe and joyful cycling for senior citizens. With one exception, all aspects mentioned in the expert questionnaire were taken up in group discussions in the expert workshop.

Probably, Intelligent Speed Adaptation on cars is the most efficient measure to provide safe cycling, but other ITS measures are also needed to provide safe and joyful cycling for senior citizens and raise the profile of cycling as such. ITS measures could be linked to, or built into, existing equipment such as navigation systems, cycle computers, and traffic signal control boxes. ITS measures could also increase the comfort for elderly cyclists, *e.g.* automatic locking and opening of bicycles at a distance by using the key as for cars with remote-controlled locks.

Executive summary

Demographic changes show that the absolute number and portion of the population in Europe that can be categorized as older or very old will continue to grow over the next several years. One aim should be to keep them active and healthy for as long a time as possible. Exercise, for example cycling, plays an important role in this context but data shows that the elderly bicyclists are overrepresented in crashes when compared with their exposure to traffic. Senior cyclists' needs and preferences should be a base for developing a safe and joyful cycling environment. A special focus is how to use Intelligent Transport Systems, ITS, to increase safety and quality. This project uses literature reviews, in-depth crash data analysis, questionnaires with senior cyclists, questionnaires with experts, and an expert workshop to identify potential ITS applications for improving elderly bicycling. The last tool (the *expert workshop*) included two group discussions structured according to two philosophically different models: The Diamond model and The Multiple comfort model.

Three data sets were made available for the *crash data analysis*. The first data set is the Finnish road crash investigating teams' data (VALT data) from the years 1995–2005 which includes a detailed description of 459 fatalities involving a bicyclist in varying road environments. The data is classified into the age groups children (0–17 years), adults (18–64 years) and elderly (65 years and older). Altogether there are 256 bicyclists older than 64 years. Only a few bicyclists are 90 years old or older. The second data set includes Swedish travel surveys and self reported crash data from 1996–2000. This data have been compared with crash data from the Swedish Road Administration by Gustafsson and Thulin (2003). The third data set includes 17 843 police reported fatalities and injuries with pedestrians and bicyclist in Finland during the years 1989–2002. The three data sets are used to test altogether 18 hypotheses to find out reasons behind the higher risks for senior cyclists. The analysis supports the following hypotheses:

- Elderly bicyclists have a significantly ($p=0.05$) higher risk than younger age groups.
- The consequences are significantly ($p=0.05$) more severe for elderly bicyclists compared to other age groups and increase with vehicle speeds.
- Elderly bicyclists are significantly ($p=0.0012$) more involved in crashes when intending to *turn left* compared to other age groups. 22% of elderly in fatal crashes intend to turn left compared to 8% for adults and 14% for children. Goldenbeld (1992) found similar results, that elderly bicyclists often have problems at intersections and especially when turning left.

- As expected, elderly bicyclists are significantly more often impaired by bad sight (p=3.52E-05) and/or bad hearing (p=3.52E-05) as well as being impaired from taking medication (p=7.89E-08) in crashes compared to other age groups.
- Elderly bicyclists are less often *in a hurry* (5%) in crashes compared to other age groups (11%). Of the bicyclists that were fatally injured in 1995–2001, there were a higher percentage of children (18%) that were in a hurry than among other age groups (6%). Differences were not significant.

Somewhat unexpectedly, it was found that:

- Elderly bicyclists obey traffic rules no more and no less than other age groups. However, non-elderly adult bicyclists are significantly more often (p=0.00024) affected by alcohol (50% proven impaired) than elderly bicyclists (9%).
- In darkness (incl. dawn and dusk), non-elderly adult bicyclists are significantly (p=4.1E-10) more often involved in crashes (37%) than elderly (11%).
- There is no significant difference between age groups' bicycle front light and reflector use, and the footbrake on elderly's bicycles is not less often in good working order compared to other age groups' bicycles.
- Child bicyclists are significantly (p=0.00035) more often involved in fatal crashes outside built-up areas (56%) than elderly (39%) and other adult bicyclists (30%).
- Elderly bicyclists are not over-involved in crashes where the road surface is in disrepair.
- Elderly bicyclists are not significantly more involved in fatal crashes on hilly streets than other bicyclists.
- Adult bicyclists are significantly (p=5,85E-06) more often involved in single-vehicle crashes compared to other age groups. For crashes involving other pedestrians, other bicyclists or mopeds there is no significant difference between age groups.

A *questionnaire* was sent to more than 500 members of the Cycling Promotion in Sweden (Cykelfrämjandet) to gather knowledge about elderly bicyclist and their needs. Almost all respondents make a trip and use a bike at least a few times per week. The foremost reasons that the elderly ride bikes are to get exercise, because it is joyful, because it gives freedom and because it is easy. Most prefer to bike to the store, but more than half also use their bike when visiting friends and the library, swimming-hall or similar destination. The most common reasons for the elderly to leave their bike at home and use another means of transportation are slipperiness, insufficient snow removal and snowfall. One third states that 6–10 kilometers in one direction is a suitable distance to bike, and few bike more than 20 kilometers in one direction. Almost half of the elderly state that their biking would increase if it was possible to bring the bike on buses and trains.

The sites or maneuvers that elderly avoid the most are roundabouts, left turns and crossing streets at locations without a cycle crossing. Especially the oldest respondents state that they avoid roundabouts. According to the elderly, the biggest safety problems are potholes, slipperiness and insufficient snow removal. Major problems are also curb stones and cars driving too fast. What the elderly say would increase their biking is linked to what they say is important for increased security and traffic safety. Increased security would lead to increased biking among the elderly. Requests dealing with the physical design of roads are especially a demand for more and better cycle tracks. Communication between road users expressed as more and better consideration are also perceived to increase their feeling of security and thereby increase their biking.

The most stated safety-increasing measure according to the senior cyclists is construction of more *cycle tracks*. Also according to research, cycle tracks are an efficient mean to increase safety for elderly bicyclists, if designed and maintained according to best-practice. One reason is that they reduce accidents with left-turning bicyclists (Jensen, 2006) and left-turning is a problem for elderly. Elderly bicyclists are significantly more involved in crashes when intending to *turn left* compared to other age groups according to the in-depth crash data analysis. And elderly bicyclists are also significantly more often impaired by bad sight and/or bad hearing in crashes compared to other age groups according to the in-depth crash data analysis, which also of-course has to be taken in consideration and best-practice could include consistent sign-posting using big letters and awareness raising infrastructure design, including blinking lights, red-coloured lanes, intelligent traffic lights etc.

The fourth tool the *expert questionnaire* was distributed during the Velo-city 2007 conference. All together, 14 experts answered. At the outset the experts were asked to describe, in their own words, the preconditions for using the bicycle as a means of transport. The most common preconditions mentioned were:

- safety and a feeling of security when cycling
- the existence of a network of roads for cycling including appropriate bike parking facilities
- positive attitudes from users and non-users.

This is much in accordance with the opinions expressed by the senior cyclists. Some experts stressed the importance of an urban policy for cycle mobility. Reasonable physical and mental abilities of the cyclists were also considered as important preconditions.

According to the experts, the most important needs concerning infrastructure for senior citizens are comfortable, wide bike paths or cycle streets away from main streets, with good directional signage. High curb stones and steep gradients should be avoided. An electric motor could be useful up-hills. Many experts mentioned the importance of detectors well in advance of signalized intersections to give cyclists the possibility to get a green light without having to slow down or dismount their bicycles.

Low motor vehicle speeds achieved by Intelligent Speed Adaptation (ISA) or by other means was by many considered as a prerequisite for safety. Other suggestions to increase safety include warning signals or warning lights to warn cyclists of approaching motor vehicles or vice versa at intersections. Such warning devices could also be useful when a motor vehicle is approaching a bike from behind (or a bike is approaching a pedestrian, but then the sound has to be “gentle” so that pedestrians are not scared). ITS can be used to get better guidance for and visibility of bicyclists at night time, for example through led-lights in the pavements or by increasing the intensity of street lighting at times when cycle traffic is present.

With respect to suggestions to improve the design and equipment of the bike itself, an upright seating position and a low bike frame making it easy to climb on and off the bike was stressed. Some equipment facilitating turning left would be useful as many senior citizens have a stiff neck and bad balance. A rear-view mirror could help, as stated by senior cyclists, but improvements are also possible by designing the infrastructure, so that it becomes unnecessary to merge with motor vehicles when turning left.

Almost all experts suggested a digital map for on-line route guidance when cycling and also for trip planning before the trip starts. On-line devices like Personal Digital Assistants (PDAs) could also be used, for example, to get local weather information or to find time tables for public transport and especially to see whether it is allowed to bring the bike on the tram or bus. A special design of the devices making it easy for elderly to use them was considered crucial.

The following automatic types of equipment for bikes were considered important to test and further develop:

- automatic locking and opening at a distance by using the key as for cars
- automatic gears

- automatic turning on and off of bicycle lamps (with power supply from a reliable dynamo)
- automatic elevating of the saddle after mounting.

The last tool (the *expert workshop*) included two group discussions structured according to two philosophically different models: The Diamond model and The Multiple comfort model. First follows some of the proposals to develop safe and joyful cycling for senior citizens from the group discussion structured according to the Diamond model. The Diamond model proposed by Risser (2000) includes five areas from which behaviour-steering effects originate.

A *cycle* designed and equipped for elderly cyclists:

- saddle for men and women in different forms
- easily handable lock
- reflectors and other means to improve visibility
- use light materials
- stable and easily useable stand
- assistance for all kinds of communication (*e.g.* rear mirrors and side blinkers, on-line route guidance).

The following *individual* measures:

- training
- bike pooling
- information & instruction.

The following measures concerning *society and structures*:

- include knowledge about cyclists' needs and characteristics in driving school curricula
- information of the public about rules, health issues
- creating a positive image in the media
- increase and improve research
- clear and understandable rules and regulations
- focus law enforcement on problems of unprotected road users
- regulations concerning "para-"cyclists (scooters, roller skaters, in-line skaters).

And the following measures concerning *communication between road users*:

- infrastructure measures (slow down cars, give place for communication)
- laws and regulations enhancing and securing communication
- equipment (rear mirror, Chinese bell)
- training and workshops
- infrastructure to increase bicyclists' awareness of pedestrians and car drivers' awareness of bicyclists, incl. infrastructure-based telematics.

Summala (2005) argues that the following five issues are the most important ones to explain driver behavior on a strategic, tactical and operational (individual) level:

- safety margins (to survive)
- good or expected progress of trips
- rule following (according to the law and social rules)
- vehicle/road system (bicycle and infrastructure)
- pleasure of driving and pleasure of cycling.

The model is slightly modified to also fit to explain cyclists' behavior. The second group discussion was structured according to the Multiple comfort model.

The following measures were suggested concerning *safety margins*:

- make cars visible using through infrastructure design and warning lights in the pavement
- reduce speed.

The following measures concerning *good or expected progress of trips*:

- giving right of way to cyclists if there are traffic lights
- hindrances for cars in the pavement to reduce speed
- special advice on signs at dangerous crossings
- rumble strips for cyclists – reduce speed
- warning lights.

The following measures concerning *rule following*:

- discussion about rules within authorities
- direct feedback of surrounding is needed
- virtual rumble strips (vibration).

The following measures concerning *vehicle/road system*:

- ongoing cycle lanes or information about how to go on
- navigation systems for cyclists
- parking areas and shelters.

The following measures concerning *pleasure of cycling*:

- things mentioned before should/can keep or increase the pleasure of cycling.

All tools tested here seem to work well together for developing ideas for countermeasures that ensure safe and joyful cycling for senior citizens. With one exception, all aspects mentioned in the expert questionnaire were taken up in group discussions in the expert workshop.

Probably, Intelligent Speed Adaptation on cars is the most efficient measure to provide safe cycling, but other ITS measures are also needed to provide safe and joyful cycling for senior citizens and raise the profile of cycling as such. ITS measures could be linked to, or built into, existing equipment such as navigation systems, cycle computers, and traffic signal control boxes. ITS measures could also increase the comfort for elderly cyclists, *e.g.* automatic locking and opening of bicycles at a distance by using the key as for cars with remote-controlled locks.

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Appendix 1: Bicyclists fatally injured and injured at links and intersections with marked crossings

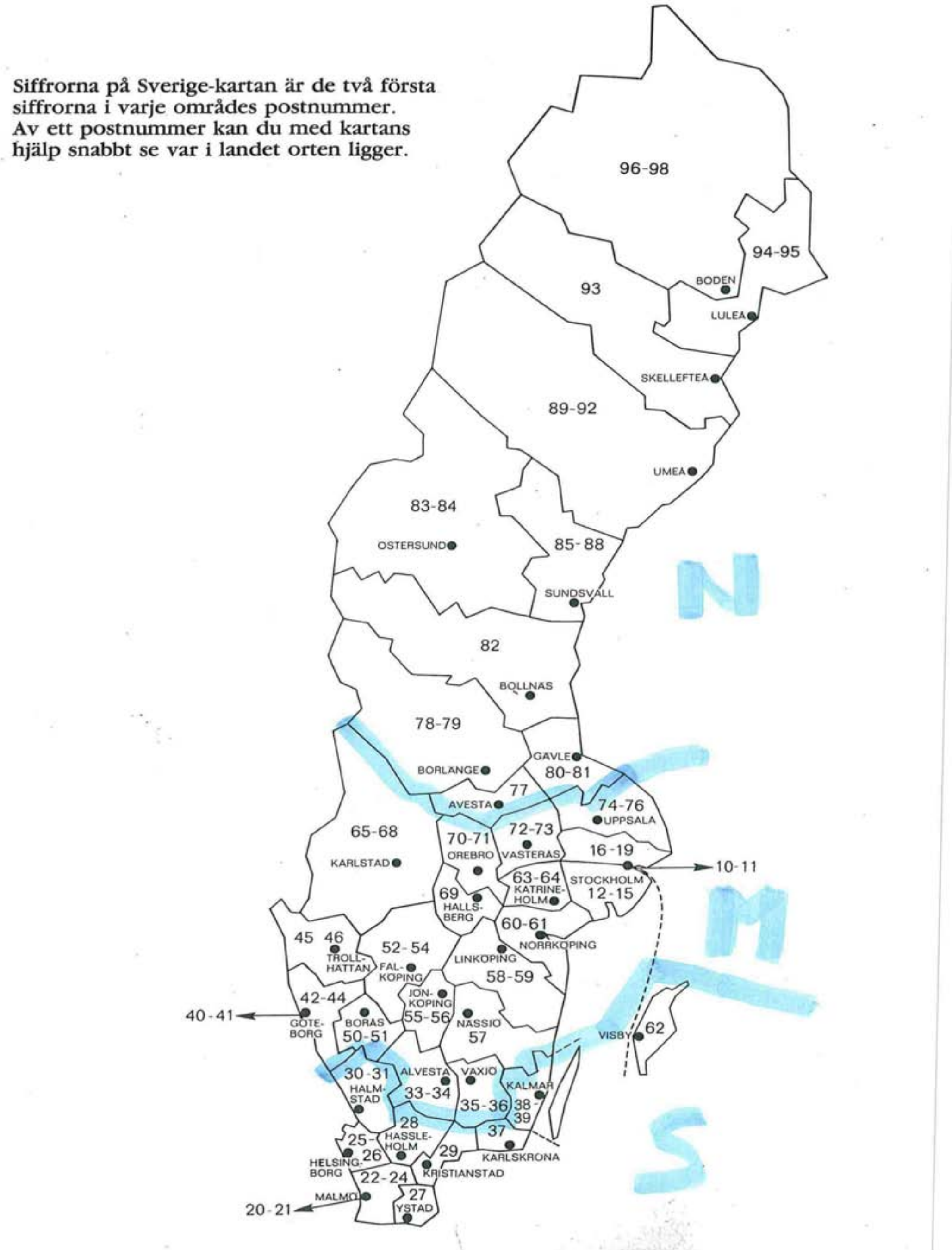
	Fatal						**Injured**					
	Link	Intersection	Total	Intersection %	chi2	p (df=2)	Link	Intersection	Total	Intersection %	chi2	p (df=2)
Children	3	9	12	*75*	0.6974	0.70561	528	959	1487	*64*	33.008	7E-08
Adults	11	24	35	*69*			789	2061	2850	*72*		
Elderly	24	42	66	*64*			269	513	782	*66*		
Total	38	75	113	*66*			1586	3533	5119	*69*		
						p (df=1)						p (df=1)
Children	3	9	12	*75*	0.1197	0.72932	528	959	1487	*64*	19.772	9E-06
Not children	35	66	101	*65*			1058	2574	3632	*71*		
Total	38	75	113	*66*			1586	3533	5119	*69*		
Elderly	24	42	66	*64*	0.2781	0.59796	269	513	782	*66*	4.8511	0.0276
Not elderly	14	33	47	*70*			1317	3020	4337	*70*		
Total	38	75	113	*66*			1586	3533	5119	*69*		

Appendix 2: Bicyclists fatally injured and injured at marked crossings at intersections and whether the involved vehicle is turning

	Fatal						**Injured**					
	Turning vehicles	Not turning vehicles	Total	*Turning %*	chi2	p (df=2)	Turning vehicles	Not turning vehicles	Total	*Turning %*	chi2	p (df=2)
Children	4	9	13	*31*	5.3122	0.07022	419	959	1378	*30*	80.4532	3E-18
Adults	23	24	47	*49*			1628	2061	3689	*44*		
Elderly	16	42	58	*28*			314	513	827	*38*		
Total	43	75	118	*36*			2361	3533	5894	*40*		
						p (df=1)						p (df=1
Children	4	9	13	*31*	0.021	0.88474	419	959	1378	*30*	69.2446	9E-17
Not children	39	66	105	*37*			1942	2574	4516	*43*		
Total	43	75	118	*36*			2361	3533	5894	*40*		
Elderly	16	42	58	*28*	3.1459	0.07612	314	513	827	*38*	1.64879	0.1991
Not elderly	27	33	60	*45*			2047	3020	5067	*40*		
Total	43	75	118	*36*			2361	3533	5894	*40*		

Appendix 3: Regions of Sweden

The numbers on the map are the first two digits of the postal codes. This code can be used to locate municipalities.



Appendix 4: Questionnaire with Elderly cyclists

The questionnaire in English translation is presented first. Below that follows the questionnaire as administered in Swedish.

Questionnaire with Elderly cyclists belonging to the Swedish Cycle Promotion (Cykelfrämjandet)

The research group 'Trafikteknik' at Luleå Technical University is conducting a bicycle-related project together with Cykelfrämjandet. The aim of the project is to see if conditions for elderly bicyclists can be improved and if this will lead to better mobility and accessibility with environmental advantages and a chance to a healthier life. However, we need a clarification of which conditions are essential for elderly to be able to ride bicycles safely.

Your answers will constitute an important basis for developing elderly's needs with respect to infrastrucure, the bicycle, and equipment for bicyclists. **If you never ride a bicycle, you do not need to respond to this questionnaire.** The results will be reported in such a way that no individuals can be identified. **Please respond no later than 18 June 2007 using the enclosed return envelope with pre-paid postage.**

Contact person: Peter Rosander, Luleå tekniska universitet,
telephone: 0920-492409,
E-mail: peter.rosander@ltu.se

Mark the alternative or alternatives that you consider closest.

How often do you make a trip with any mode of transportation? (*e.g.*, to work, to store, walk for excercise)

❑ Daily ❑ A few times per week ❑ Once per week
❑ Other, that is: ____

____

Note which seasons you ride a bicycle:

❑ fall ❑ winter ❑ spring ❑ summer

How often do you ride a bicycle?

❑ Daily ❑ A few times per week ❑ Once per week
❑ Other, that is: ____

Why do you ride a bicycle? Multiple answers can be given!

❑ Because it is easy
❑ To get exercise
❑ It is inexpensive
❑ It is fun
❑ It is environmentally friendly
❑ Fast
❑ Easy to park
❑ Gives freedom and independence
❑ Other, that is: ____

____

____

At what occasions do you typically chose the bicycle? Many answers can be checked!

❑ to the store ❑ to the library, swimming hall or similar
❑ to acquaintances ❑ during vacation
❑ Other, that is:____

At what occasions do you **not** use your bicycle? Many answers can be checked!

❑ in rain
❑ when dark
❑ when windy
❑ when snowing
❑ when below zero Celsius
❑ when slippery roads
❑ when inadequate snow removal
❑ for example on Saturday nights (feels unsafe)
❑ during rush hour
❑ other: ____
❑ no one of these is important

How far away must a destination be for you NOT to consider using your bicycle (does not apply to exercise)?

Approximately…………kilometer

What is your opinion about signage and route guidance for bicyclists?

❑ very good ❑ good ❑ neither good nor bad ❑ bad ❑ very bad ❑ no opinion

Comments:____

If there are traffic signals where you cycle, do you benefit from them?

❑ yes ❑ neither nor ❑ no ❑ no opinion

Comments:____

What do you think about information about rules and other news for bicyclists from your municipality, the Road Administration and bicycle organizations?

❑ very good ❑ good ❑ neither good nor bad ❑ bad ❑ very bad ❑ no opinion

Comments:____

Where do you typically ride your bicycle. Multiple alternatives can be checked!

❑ minor roads ❑ bicycle paths
❑ in traffic ❑ on sidewalk ❑ other: ____________________________

Are there any locations or maneuvers which you avoid because they are too dangerous for bicycling? Multiple alternatives can be checked!

❑ no
❑ don't know
❑ roundabout
❑ left turn
❑ crossing street lacking marked bicycle crossing
❑ crossing street with marked bicycle crossing (without signal)
❑ bicycle path with mopeds
❑ crossing street at a signal
Explain why ____
❑ other: ____

Which of the following factors do you consider to be a safety problem when you ride a bicycle? Multiple alternatives can be checked!

❑ potholes ❑ obstacles
❑ high curbstones ❑ street lighting lacking

❑ slippery conditions ❑ speeding motorists
❑ bad snow removal ❑ bad eye sight
❑ bad hearing ❑ medications
❑ bicycle functions (brakes, lights, etc.)
❑ other: ____

Comments:____

Do you use any special equipment when riding a bicycle? Multiple alternatives can be checked!

❑ helmet ❑ reflectors ❑ wither tires ❑ a special winter bicycle
❑ lights ❑ reflective vest ❑ bicycle bag/basket ❑ rearview mirror
❑ other, that is: ____
____

Do you miss having some special equipment? Multiple alternatives can be checked!

❑ helmet ❑ reflectors ❑ winter tires ❑ a special winter bicycle
❑ lights ❑ reflective vest ❑ bicycle bag/basket ❑ no opinion ❑ rearview mirror
❑ other, that is: ____
____

If you have bicycle lights, what type are they?
❑ battery operated
❑ dynamo against tire
❑ dynamo in the hub
❑ only reflectors
❑ other: ____
❑ have none

How do you think bicycle parking is working?

❑ very good ❑ good ❑ neither good nor bad ❑ bad ❑ very bad ❑ no opinion

Comments:____

Does the risk of theft reduce the use of your bicycle?

❑ yes ❑ sometimes ❑ no ❑ do not know

If you could bring your bike on trains and buses would that increase your bicycle use?

❑ yes ❑ sometimes ❑ no ❑ I have no need

Comments:____

What would make you cycle more?

____

____

____

____

What do you consider important for increased traffic safety and security for bicyclists?

____

____

____

____

Questions about you who answered the questions above. Remember that your answers will not be identifiable.

Gender: ❑ Woman ❑ Man

Year of birth: ________________

Postal code: ________________

Residency in:
❑ rural (less than 50 inhabitants)
❑ small municipality (50 to 199 inhabitants)
❑ medium municipality (200 to 2000 inhabitants)
❑ bigger municipality (more than 2000 inhabitants)

Do you have a car? ❑ Yes ❑ No

Thank you for taking the time to answer these questions!

Enkät med Äldre cyklister inom Cykelfrämjandet

Forskargruppen Trafikteknik vid Luleå tekniska universitet bedriver ett cykelprojekt i samarbete med Cykelfrämjandet. Projektet syftar till att se om förhållandena kan förbättras för äldre cyklister och om detta medför en ökad rörlighet och tillgänglighet med miljömässiga fördelar och chans till ett friskare liv. Det behövs emellertid en kartläggning av vilka förhållanden som krävs för att äldre ska kunna cykla säkert.

Dina svar utgör en viktig grund för att utveckla äldres behov vad gäller infrastruktur, cykeln och utrustning för cyklister. **Om Du aldrig cyklar behöver Du inte svara på denna enkät.** Resultaten kommer att redovisas på ett sådant sätt att ingen enskild person kommer att kunna identifieras. **Svara senast 18 juni 2007 i bifogat svarskuvert, portot är betalt.**

Kontaktperson: Peter Rosander, Luleå tekniska universitet, tel: 0920-492409,
E-post: peter.rosander@ltu.se

Ange det eller de alternativ som Du anser passar bäst.

Hur ofta gör Du någon resa oavsett färdmedel? (t.ex. till arbetet, affären, motionsrunda)

❑ Dagligen ❑ Några gånger per vecka ❑ En gång per vecka
❑ Annat, nämligen: ____
____

Markera under vilka årstider Du brukar cykla:

❑ hösten ❑ vintern ❑ våren ❑ sommaren

Hur ofta använder Du cykel?

❑ Dagligen ❑ Några gånger per vecka ❑ En gång per vecka
❑ Annat, nämligen: ____

Varför cyklar Du? Flera svar kan anges!

❑ för att det är enkelt
❑ jag får motion
❑ det är billigt

❑ det är roligt
❑ det är miljövänligt
❑ snabbt
❑ enkelt att parkera
❑ ger frihet eller oberoende
❑ annat, nämligen: ____
____
____

Vid vilka tillfällen väljer Du oftast cykeln? Flera svar kan anges!

❑ till affären ❑ till biblioteket, badhuset eller liknande
❑ till bekanta ❑ under semestern
❑ annat, nämligen: ____

När får cykeln stå? Flera svar kan anges!

❑ regn
❑ i mörker
❑ vid blåst
❑ snöfall
❑ vid minusgrader
❑ vid halka
❑ vid dålig snöröjning
❑ t.ex. lördag kväll (känns otryggt)
❑ i rusningstrafik
❑ annat: ____
❑ inget av dessa är avgörande

Hur långt bort får ett resmål vara för att Du ska **avstå** att använda cykel (gäller ej motion)?

Ungefär…………kilometer

Hur upplever Du skyltning och vägvisning för cyklister?

❑ mycket bra ❑ bra ❑ varken bra eller dåligt ❑ dålig ❑ mycket dålig ❑ ingen åsikt

Kommentar:____

Om det finns trafiksignaler där Du cyklar, har Du nytta av dessa?

❑ ja ❑ varken eller ❑ nej ❑ ingen åsikt

Kommentar:____

____

Hur tycker Du att det fungerar med information om regler och nyheter för cyklister från kommunen, Vägverket eller cykelorganisationer?

❑ mycket bra ❑ bra ❑ varken bra eller dåligt ❑ dåligt ❑ mycket dåligt ❑ ingen åsikt

Kommentar:____

Var brukar Du cykla? Flera alternativ kan anges.

❑ mindre vägar ❑ cykelbanor
❑ bland trafiken ❑ trottoaren ❑ annat: ____________________

Finns det någon plats eller manöver Du undviker när Du cyklar för att det är farligt? Flera svar kan anges!

❑ nej
❑ vet ej
❑ cirkulationsplats
❑ vänstersväng
❑ korsande av gata utan cykelöverfart
❑ korsande av gata med cykelöverfart (utan trafiksignal)
❑ cykelbana med mopedtrafik
❑ korsande av gata i trafiksignal
Förklara varför: ____________________________________

❑ annat: ____

Vilka av följande faktorer upplever Du som ett säkerhetsproblem när Du cyklar? Flera svar kan anges!

❑ gropar ❑ hinder
❑ höga kantstenar ❑ vägbelysning saknas
❑ halka ❑ bilisterna kör fort
❑ dålig snöröjning ❑ dålig syn
❑ dålig hörsel ❑ läkemedel
❑ cykelns funktioner (bromsar. belysning mm.)
❑ annat: ____

Kommentar:____

Använder Du någon speciell utrustning då Du cyklar? Flera svar kan anges!

❑ hjälm ❑ reflexer ❑ vinterdäck ❑ en speciell vintercykel
❑ belysning ❑ reflexväst ❑ cykelväska/korg ❑ backspegel
❑ annat, nämligen: ____

____

Saknar Du någon speciell utrustning när Du cyklar? Flera svar kan anges!

❑ hjälm ❑ reflexer ❑ vinterdäck ❑ en speciell vintercykel
❑ belysning ❑ reflexväst ❑ cykelväska/korg ❑ ingen åsikt
❑ backspegel
❑ annat, nämligen: ____

Om Du har cykelbelysning, vilken typ är det?

❑ batteridriven
❑ med dynamo mot däcket
❑ med dynamo i navet
❑ endast reflex
❑ annan: ____
❑ har ingen

Hur tycker Du att det fungerar med cykelparkeringar?

❑ mycket bra ❑ bra ❑ varken eller dåligt ❑ dåligt ❑ mycket dåligt ❑ ingen åsikt

Kommentar:____

Begränsar stöldrisken ditt nyttjande av cykel?

❑ ja ❑ ibland ❑ nej ❑ vet inte

Om möjligheten fanns att ta med cykel på buss eller tåg skulle detta utöka ditt cyklande?

❑ ja ❑ ibland ❑ nej ❑ har inget behov

Kommentar:____

Vad skulle kunna göra att Du cyklar oftare?

____
____
____
____
____

Vad anser Du är viktigt för ökad trafiksäkerhet och trygghet för cyklister?

____
____
____
____
____

Frågor om dig som besvarat enkäten. Kom ihåg att dina svar kommer att redovisas på ett sådant sätt att ingen enskild person kommer att kunna identifieras.

Kön: ❑ Kvinna ❑ Man

Födelseår: _________________

Postnummer: ________________

Typ av bostadsort:	❑ glesbygd	(mindre än 50 invånare)
	❑ mindre ort	(50 till 199 invånare)
	❑ mellanstor ort	(200 till 2000 invånare)
	❑ större ort	(mer än 2000 invånare)

Tillgång till bil? ❑ Ja ❑ Nej

Tack för att Du tog dig tid att svara på frågorna!

Appendix 5: Expert questionnaire

Expert questionnaire for how to achieve safe and joyful cycling for senior citizens by the means of telematics and other types of Intelligent Transportation Systems, ITS.

1		Please describe in your own words the preconditions for using the bicycle as a means of transport nowadays.
2		Describe the needs of older people concerning bicycle infrastructure and equipment.
2	a	What role would telematics and other types of ITS play according to your point of view?

3	To what extent can ITS be used to increase safety and quality?
4	Under what conditions can ITS help and what would be the requirements?
5	Please list some important future research questions!

Questions about you who have answered the questionnaire:

Sex: ❑ Female ❑ Male

Profession: ___________________________

Year of birth: ____

Country: ____

Thank you for answering our questions!

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