

Sustainable Urban Transport: Improving Mobility Conditions for Vulnerable Road Users in Sub-Saharan Africa

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1 Introduction

Urbanization is a spreading phenomenon worldwide. In 2007 already 50% of the earth's population lived in urban areas (Lexas 2015), a share that is expected to rise to 66% by 2050 (United Nations 2015). In the last few decades urbanization in developing countries caught up unprecedented dimensions. With the growing population transport demand increases. At the same time energy consumption and greenhouse gas emissions rise rapidly. Africa is by far the smallest producer of CO₂ emissions worldwide (Fig. 1) at the moment. The Intergovernmental Panel on Climate Change (Sims et al. 2014, p. 603) expects that transport demand per capita in developing countries increases at a faster growing rate in the next decades though. Aggressive mitigation measures are requested to prevent transport emissions from rising above the rates of other energy sectors in 2050.

Energy consumption and CO₂ emissions are growing fastest in the transport sector (Meyer et al. 2012). From 1971 to 2006 global transport energy use rose steadily between 2 and 2.5% per year, closely paralleling growth in economic activity around the world (Ajanovic et al. 2012, p. 1). Transport accounts for about 28% of global energy demand (GEA 2012, p. 49) and one quarter of energy-related greenhouse gas emissions in the European Union (European Commission 2016). Over 70% of these emissions are caused by road transport—almost solely by motorized individual traffic (Fig. 2).

Cities suffer the most from overpopulation, heavy traffic, poor air quality, noise pollution and accidents. Urban traffic produces up to a quarter of traffic caused greenhouse emissions and is responsible for nearly 70% of all traffic accidents (European Commission 2011, p. 8).

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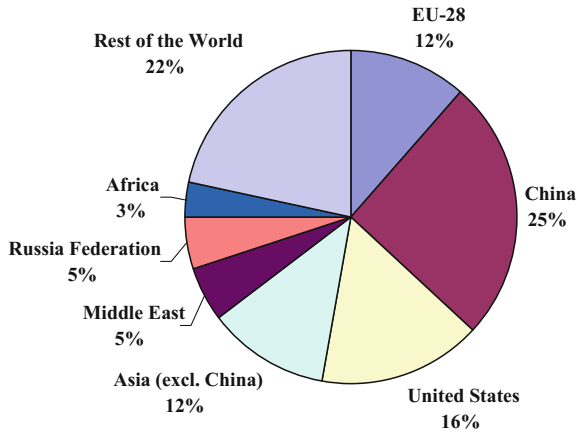


Fig. 1 CO₂ emissions worldwide 2012 (European Commission 2015 p. 18)

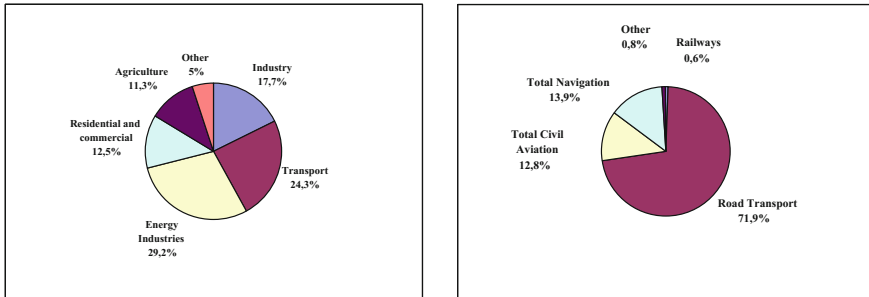


Fig. 2 EU greenhouse gas emissions by sector and by transport mode 2012 (European Commission 2016)

The goal of this paper is to discuss measures for a significant improvement of conditions for vulnerable road users in Sub-Saharan Africa, in order to build a future oriented, economically and ecologically feasible and socially balanced traffic system.

With regard to the CO₂ reduction target non-motorized transport modes are preferable to motorized ones. At the same time walking or cycling are often connected with very low prestige and considered as transport modes of the poor. This view has to be changed as well as the popular focus on the expansion of the motorized traffic.

In Sub-Saharan Africa it is not so much the change of choice rather than the change of attitudes toward sustainable transport modes. Addis Ababa for instance has an exemplary high share of non-motorized traffic (NMT). Moreover the design of the road traffic environment has to consider the needs of vulnerable road users specifically because the vast majority in the population are pedestrians.

The following steps are taken to reach the goal of the paper:

- First of all, mobility behaviour and its motivation will be examined for a better understanding of the choices people make.
- Second, a few indicators which are relevant for the urban mobility behaviour will be described (situation of Vienna and Addis Ababa).
- Third, the authors will develop measures from a traffic psychological point of view which aim at increased protection of vulnerable road users. By focusing on the weakest group, a more equal traffic system shall be promoted and, at the same time, awareness for transport modes with low greenhouse gas (GHG) emissions and low energy consumption shall be raised.
- Finally, the good practice examples of how to improve NMT modes will show that (even little) efforts can make a difference.

This paper is not based on one empirical study about influencing traffic behaviours. The authors use a heuristic approach to derive measures and solutions. They refer to empirical knowledge out of their working environment of traffic sociology and psychology of the last decades. The paper discusses why and how changes should be implemented from a social scientific point of view considering psychological aspects as well.

2 Levels of Influence on Mobility Behaviour

“Mobility” for the purpose of this paper is used as physical and circular mobility which refers to daily travels of households and their members (Herry et al. 2011, 87).

The road traffic system is a system of relations and behaviours. Road users’ behaviours do not arise from simple, distinct and deterministic cause-effect relations. There are interdependencies between individual actors, between individuals and their environment and also between individuals and vehicles. In order to understand those interdependencies and to deduce specific measures, factors on the five levels of the Diamond in Fig. 3 are considered:

- The individual itself (and its characteristics; for instance its internal processes like motives, attitudes, experiences)
- The vehicle (and its characteristics such as physical and technical aspects-size, height, speed, power; technical features like assistance systems etc.)
- Infrastructure (including road and space characteristics like road width and-surface, etc.)
- Society including existing laws and traffic rules and also public discussions like for instance discussed conflicts between cyclists and car drivers etc.
- Interaction between road users including non-verbal gestures like for instance waving to say ‘thank you’ but also verbal articulations, for example an angry car driver screaming at the crossing pedestrian etc.

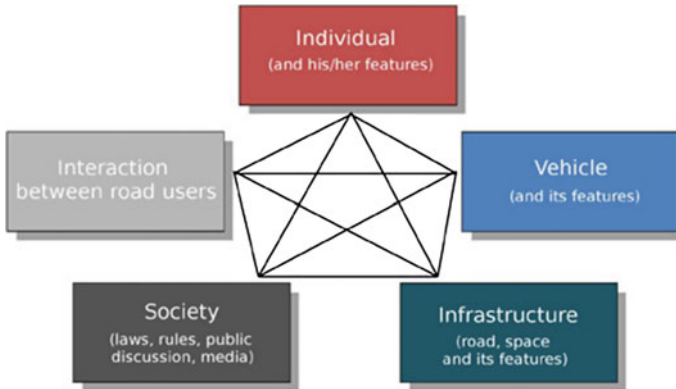


Fig. 3 Diamond—levels of influence on traffic behaviour (Risser 2000)

The factors of all five areas in the Diamond interact with each other. Changes in one area usually cause changes in one or more of the other areas.

3 Mobility in Addis Ababa and Vienna

When interpreting mobility differences between cities, countries and continents various factors have to be considered (see also Diamond Fig. 3). The modal split is crucial for analysing mobility behaviours and participation in road traffic. The numbers of driver license holders, out-of-house mobility, numbers of trips per person, trip distances, durations of trips, purpose of trips (work, spare time, shopping, pick-up services etc.) are examples for important details that mobility surveys commonly collect.

Mobility data in general are rather difficult to obtain. Mobility surveys are not conducted frequently and the methods of data collection vary from country to country, even from survey to survey. Therefore comparisons between mobility data have to be treated with caution. The historical, social and economic situation (gender, household incomes, land use patterns, traditions) need to be taken into consideration. Comparisons between cities, countries and continents are difficult but necessary, if target-group-specific measures shall be developed.

In the following a few key figures of mobility such as the modal split, the household income and accidents will be described for Addis Ababa and Vienna and the differences in their development plans will be pointed out.

The modal split of passenger traffic or passenger transport mode share “refers to the percentage of passenger journeys or trips by the main mode of transport” (LTA 2011, p. 60).

3.1 Mobility in Vienna: A Few Indicators

Vienna, with about 1.8 million inhabitants (City of Vienna 2015a), is the largest city and the capital of Austria.

3.1.1 Modal Split in Vienna

Latest modal split data of Vienna (City of Vienna 2015b) show a 39% share for the public transport, 28% of motorized individual traffic (27% cars + 1% motorbike), 26% of walking and 7% cycling (Fig. 4).

3.1.2 Household Income Distribution

64% of Austrian households in 2014 are one or two-person households. The average household income is 3404 Euros/month. 10% of all Austrian households do have an income less than 1139 Euros/month. (Statistik Austria 2015a, own calculations).

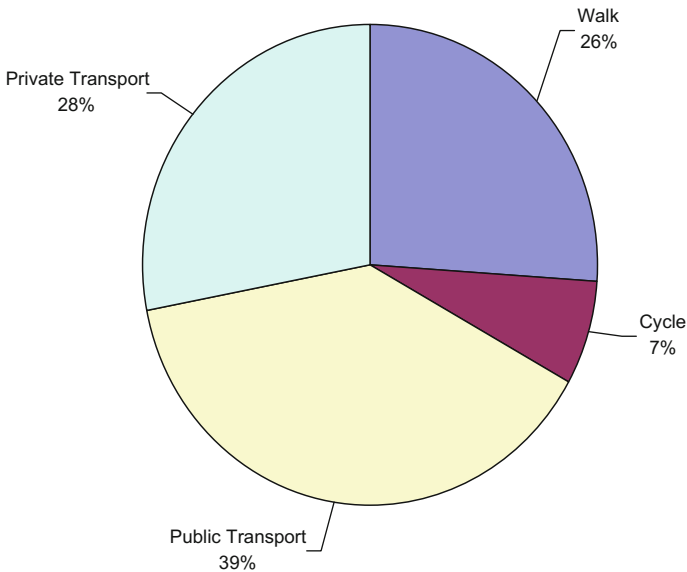


Fig. 4 Modal split of Vienna 2014 (City of Vienna 2015b)

3.1.3 Motor Vehicle Accidents

Fatal traffic accidents in Austria in the past two decades are on the decline. In the year 2000 4925 accidents happened in Vienna, 34 of them ended deadly. 2014 more accidents happened in total numbers (5802) but less people (21) died on the roads. About 20% of the accident victims were pedestrians (Statistik Austria 2015b).

3.1.4 Past and Future Ambitions

Since 1993 the public transport share in Vienna rose constantly every year from 29% (Wiener Stadtwerke 2015) to the current share of 39%. Motorized individual traffic on the other side was reduced significantly from 36% in 2001 (Herry et al. 2007) to 27% in 2014 (City of Vienna 2015b). Cycling experienced an upward trend for the last two decades, whereas walking stayed on almost the same level with a slight decreasing tendency in the last few years (Wiener Stadtwerke 2015; City of Vienna 2015b). Ongoing efforts, however, point in one direction: Vienna actively promotes public transport use, cycling and walking. STEP 2025 (City of Vienna 2014), the urban development plan for Vienna, actually plans a long term reduction of motorized individual traffic (MIT) up to the aspired goal of 15% in 2030. The modal split target for 2025 is “80:20”—80% of all trips shall be covered by public transport, walking or cycling, whilst the current MIT share shall be reduced to 20%.

3.2 *Mobility in Addis Ababa: A Few Indicators*

Addis Ababa, the capital of Ethiopia, also seen as “political capital” of the continent, is a very fast growing city. In 1984 it counted 1.4 Million inhabitants, while the latest census reported 3.3 Million inhabitants (Central Statistical Agency 2015).

3.2.1 Modal Split

In Addis Ababa (Fig. 5) walking is clearly the dominant mode of transport with a share of 60%, followed by the use of public transport ([mini-]buses and taxis), chosen for 27% of all trips. Cycling (7%) as well as private transport by car or motorbike (6%) are rather rarely used modes.

The figure indicates that 94% of all trips are covered by sustainable transport modes. Compare to Vienna’s targeted 80% in 2025!

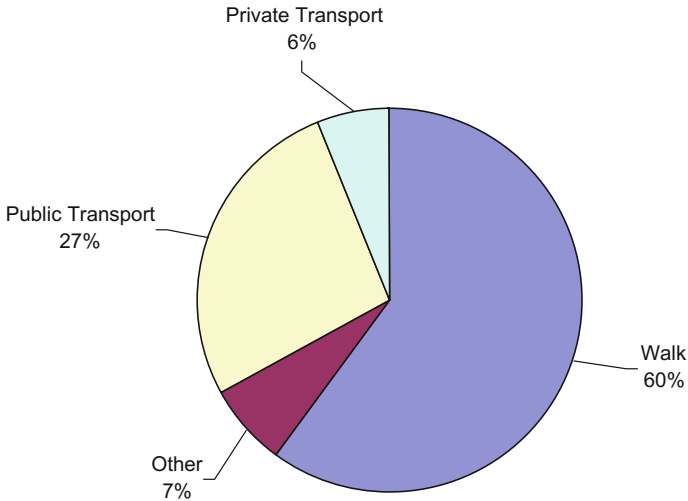


Fig. 5 Modal split Addis Ababa (Nyarirangwe 2008)

3.2.2 Household Income

The census in 2007 counted an average monthly household income of about 31 Euros (~ 725 Ethiopian Birr) with an average household size of 4, 1 persons. Over 60% of the population of Addis Ababa live below the poverty line with an income less than 20 Euros per household per month (Bogale 2012).

3.2.3 Accidents

Against the background of the high modal split share of non-motorized road users and the marginal number of car drivers, Ethiopian accident figures assume alarming proportions. Vulnerable road users such as pedestrians, children, seniors or disabled people are the most frequent victims. (Materu et al. 1999) Data from the Addis Ababa Police Commission indicate 391 deaths out of 3003 car accidents in 2013/14 (Abdu 2015). Half of road traffic accident deaths in Ethiopia are pedestrians (IRIN 2011) other studies indicate even higher fatality rates under pedestrians (e.g. Akloweg et al. 2011).

3.2.4 Future Prospects

Due to the expansion of Addis Ababa the demand for public transport services is also growing rapidly. Car ownerships do not increase at the same pace as the growth of the population (TRL 2002). Private transport modes like cars or

motorcycles, are too expensive for the vast majority of the people. Therefore the role of public transport will gain importance and, of course, walking will remain one of the most commonly used modes of transport.

Forecasts though predict a modal shift of 15% moving from walking to the motorized transport (Wondimu 2012, p. 7). Car ownership at the moment is still very low (below 100 vehicles per 1000 of population) but it is expected to increase rapidly with economic growth. Air pollution by GHG emissions is a serious concern given the distribution of very old, low cost and poorly maintained vehicles. (Voukas and Palmer 2012) Strategies to adapt and mitigate climate change are discussed in urban development plans (Intergovernmental Panel on Climate Change 2014; CRGE Vision 2012; Bogale 2012; TRL 2002) but exact numbers which relate to the future measures and interventions are missing.

4 Measures to Promote and Support Sustainable Urban Transport

Taking into account the continuing urbanization, cities have to handle serious challenges to achieve substantial reductions of greenhouse gas emissions. Crucial targets regarding the transport sector are (AAR 2014, p. 922):

- Car traffic avoidance (reduction of driven distances).
- Modal shift to sustainable transport modes such as public transport and NMT.
- Implementation of “Zero-Emission-Vehicles” and renewable energy sources.

Talking about Sub-Saharan Africa, the authors add one target:

- Maintaining the generally very high share of non-motorized road users, under better conditions though (i.e. make it a bonus instead of a problem).

To achieve those targets different kinds of measures or their combination have to be implemented. Political measures like fiscal political instruments, spatial planning and legal measures, technological innovations for conventional and new alternative resources have controlling functions for instance. Infrastructure is another effective tool. Efforts are made worldwide to reduce GHG emissions. Psychological factors are underestimated respectively ignored systematically though. Mobility behaviour is a very complex interdependency between individuals, their environment and the vehicle.

The following elaborations concentrate on areas where psychology has to be implemented to influence and/or change and to promote sustainable mobility behaviours.

4.1 Design of Public Space and Traffic Environment

Infrastructure affects traffic behaviour strongly. Here a few examples (from highly regulated street spaces in Vienna):

- If people can choose between two ways, they will take the shorter one.
- Cars would not be used in a city where no parking space is offered.
- If red phases of pedestrian lights are too long people will not wait for the green light.
- Broad and straight streets induce speeding-car drivers would not accept tempo limits of 30 km/h.

Measures on the infrastructural level consist of elements improving communication between traffic users, of constructional speed reducing road design, of arrangements reminding of rules (section control for instance), self explaining roads and alike (Risser 2011).

Regarding the adaptation and mitigation of environmental damage actions on the infrastructural level need to focus specifically on traffic calming. Besides the fact that traffic calming measures have great impact on traffic safety, GHG emissions of the motorized individual traffic, too, can be reduced significantly by lowering the speeds.

Speed limits are especially effective if they optimize the flow of traffic. Less acceleration and braking manoeuvres reduce consumption and emissions as well as abrasion and fine dust resuspension (Umweltbundesamt 2016). In Austria for instance, displays on urban motorways remind car drivers to reduce speed, in cases of increased risk of exceeding the permitted emission and fine dust limits.

Speed limits only make sense if violations are sanctioned. A fine is one possible way. Immediate negative effect e.g. by speed bumps is another. Latter makes the driver feel physically the exceeded speed (Fig. 6). Drivers have to slow down and other traffic users like pedestrians who want to cross are noticed better. Visual stimuli (Fig. 7) and aesthetically appealing design are further possibilities to induce desired mobility behaviour.

Fig. 6 Speed bump in Vienna

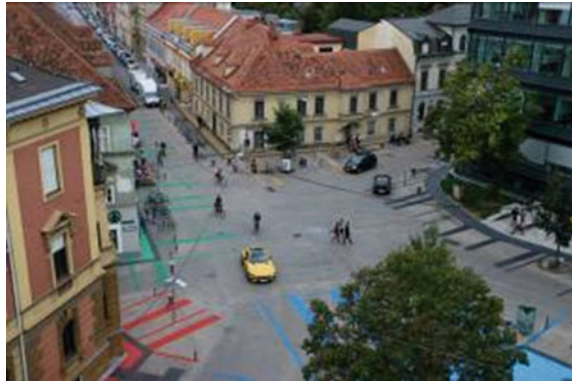


Fig. 7 Lane divider in Vienna



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Fig. 8 Shared space on Sonnenfelsplatz in Graz



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For car drivers making swift headway might be the primary interest. For pedestrians, aesthetic aspects, safety issues or an easy access to infrastructure are additional decisive factors. Important in this context is to keep walking distances as short and direct as possible, otherwise illegal behaviours are prompted or people start avoid walking altogether (Risser 2015). Green zones with plants, sitting benches or fixtures for play or rest upgrade public space and invite people to stay and socialize.

Shared space is a concept where all road users equally move in open space. Traffic signs, traffic lights, pedestrian islands etc. are reduced to a minimum; the only regulation is “to give way to the right”. Providing space and opportunity for communication and interaction is the core principle of shared space and it secures a smooth traffic and movement flow in this zone. By removing the channelling effect of streets, the motorized traffic loses its dominance and the manifold meaning of traffic mixed with social life, culture and history of the place restores its balance (Fig. 8).

The shared space philosophy is based on respect for each other and mutual consideration on the road. By introducing intentional insecurity and ambiguity all players are forced to make eye contact and interact.

4.2 *Social Marketing and Communication*

Regulations, laws, financial incentives and urban infrastructure-in the past and nowadays-produce and promote pre-eminently car dependant mobility. Mobility management is one promising method to counteract this unfortunate trend and to make passenger transport environmentally friendlier instead.

Mobility Management is built on the cooperation of all parties involved-transport companies, enterprises, communities, tourist organisations and affected individuals (VCO 2003). It includes economic instruments and measures of awareness raising activities. Marketing or campaigns are appropriate tools to promote specific attitudes and behaviours. They have to take into account the inhomogeneity of road user groups. Both “car drivers” and “pedestrians” are not homogeneous units. Individuals in all these groups find themselves in different stages of problem awareness or willingness to change behaviour. Marketing and campaigning tools have to consider those varying levels and have to start at the particular stage where the individuals stand (Chaloupka-Risser et al. 2011).

There are numerous psychological models which provide hints how attitudes and behavioural patterns can be influenced. Most promising are holistic approaches addressing people on different levels. One of those, the Social Marketing Model by Kotler and Armstrong (1996), is a communication model, which considers the promoting of an idea as a process in which the needs and wishes of individuals are targeted. This has been proven to be successful in terms of influencing decision making processes of individuals. The following policies need to be addressed:

- **Information policy:** learn as much as you can about needs and interests of your target group(s) and key players
- **Product and distribution policy:** develop adequate (technical) solutions that promote desired behaviour, easy-to-adopt strategies which enforce the desired behavioural patterns; display the products appropriately
- **Incentive and pricing policy:** link the desired behavioural patterns to positive (extrinsic) stimuli in order to motivate individuals to change their usual behavioural patterns
- **Communication policy:** inform the target group about the benefits and that their needs and interests will be satisfied if they adopt this particular behavioural change.

5 Good Practice Examples

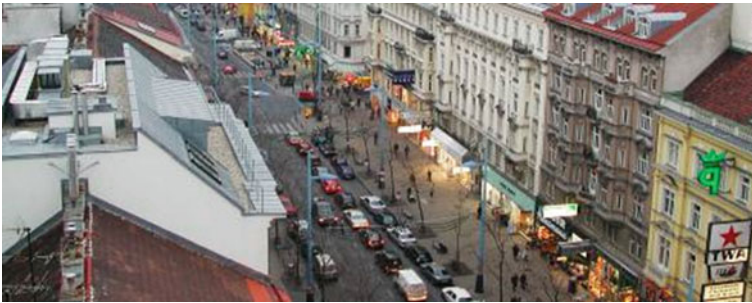
5.1 *Traffic Calming Zone in Vienna*

One example for a very successful traffic calming project is the “Shared-space Mariahilferstraße” in Vienna. This is one of the main shopping streets. It suffered

heavily from congestion, air pollution and traffic noise. In 2014/15 it was successfully transformed into a traffic calmed encounter zone. The actual infrastructure design is characterized by an easy accessible and safe path network, free space to interact, shop, sit, rest, eat and drink or play. It includes consume free areas and comfortable street furniture. It accommodates all road users-pedestrians, cyclists, car drivers, old and young. The re-modelling of the street was done in a participatory process. The residents were involved in the planning (information policy) and the project “Mariahilferstraße” has been frequently discussed in public media (product and distribution policy-communication policy) (Figs. 9 and 10).

5.2 *Improving Pedestrian Mobility in Addis Ababa*

During a summer workshop (ETH-EiABC) in 2014 a group of Swiss and Ethiopian architecture and urban planning students developed a number of low-cost



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Fig. 9 Mariahilfer Straße BEFORE traffic calming



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Fig. 10 Mariahilfer Straße AFTER traffic calming

interventions that, without great changes or constructional measures, could be applied to the existing traffic organization and infrastructure while bringing about a progressive and environmentally friendly and lasting improvement of the situation of pedestrians.

The project targeted the wide area of Churchill Road, one of the main traffic arteries of the city, its transportation hub-the minibus station and its busy surroundings with numerous open stalls and sellers. In the planning and designing process the uniformly bad infrastructure for pedestrians along the road (no maintenance, malfunctioning pavements, misappropriation of space like street vending, parking, material storage during construction work) and the poorly equipped and crowded waiting area of the minibus station were remodelled. The old muddy island was replaced with a new, hard ground surface, it was extended by 3 m and equipped with new seats for waiting passengers (Figs. 11 and 12). The plan envisioned: planting of new trees providing shade from sun and rain for the passengers; artificial trees serve as weather protection until the trees are fully grown; seats encircle the trees; new adjustable weather protection (pull-out/fold-in roof) for

Fig. 11 Minibus stop in Addis Ababa



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Fig. 12 Model for rain protected bus stop with sitting facilities



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the sellers and their customers along the road to the minibus station; clean and improved sanitary facilities free of charge next to the minibus station.

The task at hand was to find a bottom-up solution and to design a safe and serviceable zone for pedestrians and passengers; the issues that needed to be considered were: number of people and minibusses, waiting passengers, number of pedestrians on the street and sidewalk, number of people crossing at red, usage of the crosswalk, missing weather protection for street sellers and buyers, lack of seating and sanitary facilities at the minibus stop etc.

The advantage of the bottom-up planning approach is that the existing situation is taken, necessary interventions-small and cost-effective-are made, and the impact of the interventions is great, while the existing structure and organization remains intact. The proposed interventions lead to temporary and later permanent solutions.

6 Conclusion

Industrial countries pursue relentlessly and with remarkable (financial) efforts the objective of distinctive reduction of motorized individual traffic; at the same time non-motorized traffic, public transport modes and multimodality are strongly promoted.

Developing countries start from a different position. They can benefit from the great advantage of having very high modal split shares for NMT. Therefore the aim is to show how this generally sustainable mobility behaviour can be made more attractive and individuals voluntarily choose it.

For decades the car was the criterion of “good life”, of success, a highly coveted status symbol. This is still the case for many people. Especially in developing countries walking or cycling are deemed to be “transport modes of the poor”. This image has to be upgraded. With the policies of social marketing and awareness raising campaigns, non-motorized transport modes can be promoted and communicated as means of the future. They are sustainable and cost-effective, they are physically and psychologically healthy, consume very little space and enhance quality of life. This message has to be communicated through different channels-governments, public authorities, politicians, media, educational institutions and others. Sustainable mobility behaviour has to become an attractive choice people actively make.

In order to support this change of attitude and to make it safe, infrastructure needs to reflect respect for vulnerable road users, the vast majority in Sub-Saharan countries.

The following table gives an overview of measures on different levels of influence on traffic behaviour based on the “Diamond” (in Chap. 2) (Table 1).

Improving preconditions for vulnerable road users and the image of NMT in countries like Ethiopia and cities like Addis Ababa can prevent them from sliding

Table 1 Measures on the different levels of influence

	Skills	Knowledge	Willingness
Individual	(Target group specific) training	Information, education	Social marketing
Communication with other traffic users	“Learning by doing”; concepts like “shared space” or “self explaining roads” promote communication	Knowledge transfer e.g. informal norms like “imitating”	Mobility management; role models; social marketing; e.g. awareness raising campaigns
Society, Structures		Profound information in media about NMT- e.g. people killed by cars, preconditions for vulnerable road users etc.; no one-sided presentations in favour of motorized traffic	Upgrade image of NMT; subsidies for NMT and public transport; taxes for motorized traffic; spatial planning
Vehicle	User friendliness, telematics; techno-logical innovations including practical low-tech solutions	User-friendly operation instructions, telematics	Vehicle characteristics: type, design, power and speed, equipment; technological innovations
Infrastructure	Easy use of infrastructure; reducing traffic signage to a minimum to avoid confusion (e.g. shared space)	Traffic signals-look at the needs of vulnerable road users; rules; sanctions for violations;	Traffic calming; speed reducing road design; attractive design inviting to stay in public spaces; green zones; parking space management etc.

into mobility and traffic conditions extremely difficult to make undone. A sustainable traffic system able to provide a safe, available and accessible mobility for all citizens can be achieved with comparatively little efforts before motorization takes over and captures the majority of the population.

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