Assessment of pedestrian system output

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Abstract

Assessment of the overall value of a pedestrian system raises a lot of difficult theoretical issues which are dealt with very differently in various disciplines. The proposed assessment of the pedestrian systems output is inspired by settings from multiple disciplines, thereby combining dimensions with the aim to allow for a more transparent discussion of trade-offs and synergies between impacts and objectives.

The understanding of how the pedestrian system works is inspired by system theory. The pedestrian system is viewed as a dynamic, open, complex and evolutionary system. For the assessment of the pedestrian systems output, a homeopathic approach is proposed; the value of the systems output is addressed in terms of how well it reinforces the self-correcting, self-healing and survival mechanisms of the social, physical, economical and political environment.

When trying to implement these principles, ethical considerations related to the definition of 'correcting', 'healing' and 'survival' mechanisms can not be ignored. These are not necessarily directly related to the final outcomes, but to the process through which these final outcomes are reached. To complicate things further, the overall outcomes have to be examined in their distributional effects. A capability approach helps to tackle this dimension. Although there are not many applications at the macro policy level, the method is promising in the way it enables a structured discussion on benefits, distributional issues and ethics.

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Introduction

The evaluation of the pedestrian system output consists of one main question: *what effects will (packages of) interventions have for general stakeholder interests and/or for society in general?* The pedestrian system functions in an environment, and continuously interacts with it in various ways (figure 1). In systems theory words, the pedestrian system is an open system.

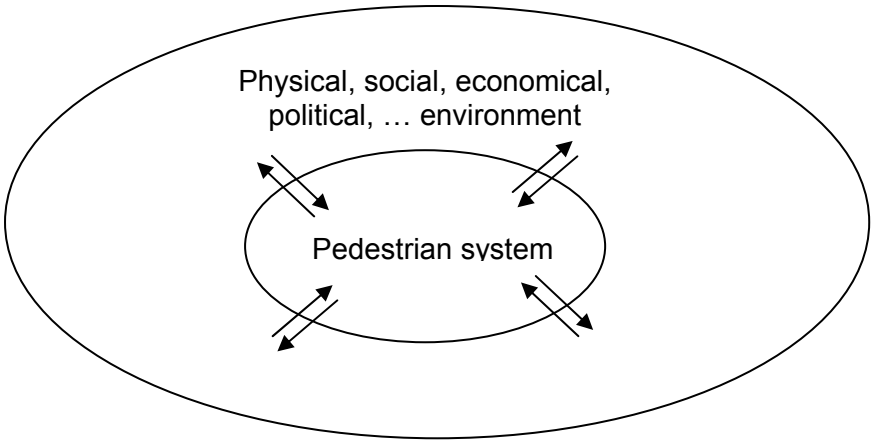
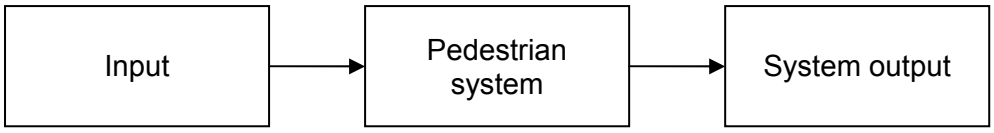
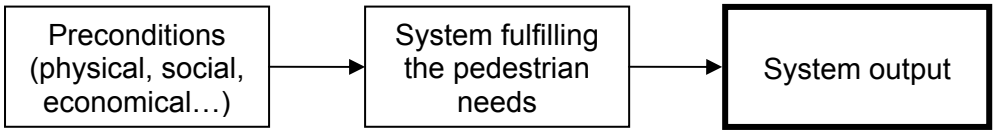


Figure 1. The pedestrian system is an open system.

Pedestrian have needs and the pedestrian system functions when these needs are fulfilled (figure 2a). In other words, the system does not process input to generate output; it needs preconditions in the environment in order to function, i.e. to fulfil the needs of pedestrians (figure 2b). The scope of the system output assessment not the functioning of the system itself, but the assessment of what it generates. In the identification of pedestrian needs, sustainability of walking is considered a precondition because it is a human activity, and as such should not go at the expense of the survival of the community on the short and longer terms. This is represented by a feedback loop (2c).



(2a)



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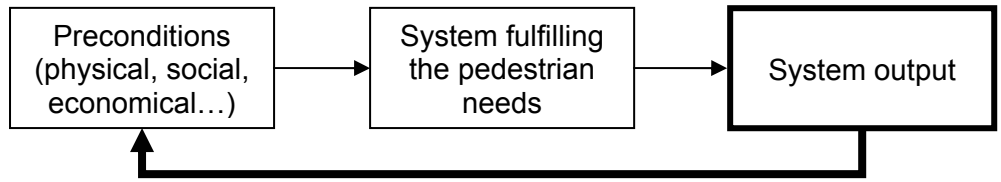

2c.

Figure 2. Scope of the assessment of the system output

In order for the system to be sustainable, the output needs to have a positive or neutral impact on the preconditions. The output should be at least compatible, but preferably supporting, or limiting threats, or even reinforcing the possibility of the system to function. A few illustrations:

- the output reinforces the input: people need to be healthy in order to be able to walk. A pedestrian system that functions well, stimulates walking, and walking is good for health;
- the output limits threats to the input: empty public spaces may be perceived as unsafe. One output of the pedestrian system consists of bringing pedestrians in public space, thus reducing this unsafety;
- the output supports the input: more pedestrians are better heard by decision makers, and infrastructure is improved to meet the pedestrian needs;
- the output is compatible with the input: walking improves bonding with the environment, but one does not need to feel attached to an environment to walk there.

To what extend the output relates in a positive way to the preconditions for the system to function, is a key to assess the sustainability of the pedestrian system. There are different mechanisms involved. The basic principle proposed for the assessment of the system output, is to search for an answer to the following questions:

1. To what extent does the system output improve (reinforce, support, …) the possibility to walk (for the individual, in the community, in society as a whole?)
2. To what extent does the system output improve (or at least not deteriorate) the environmental, economical, political and organisational context?
3. How robust is the system output to deal with individual, community, and societal threats?

In this last question several mechanisms can be considered, going from corruption, political opportunism of policymakers, negotiation processes where ‘I owe you’ may influence the outcome, etc. Dealing with these issues would lead us too far, as different normative systems – not all of them rational – can be observed. We refer to the chapter on compliance and satisfaction mechanisms for a better understanding of what types of threats can be expected, and how they can be understood and dealt with. In the following section, we further focus on the direct feedback in question 1 (output pedestrian system – input pedestrian system) and on the impact of the output on the context in question 2 (output pedestrian system – context).

How can the output of the pedestrian system to its (environmental, social, economical, political, organisational etc.) context be assessed?

Before the output of any system can be assessed, it needs to be specified. This is particularly the case for a complex system, such as the one we are dealing with. The structure of a *complex system* is not a simple feedback loop where one system state dominates the behaviour. Cause and effect are often not closely related in either time or

space, and there is a multiplicity of interacting feedback loops and nonlinear relationships. The complex system is of high order, meaning that there are many system states (or levels). It contains positive-feedback loops describing growth processes as well as negative, goal-seeking loops. The cause of a difficulty may lie far back in time from the symptoms, or in a completely different and remote part of the system. In fact, causes are usually found, not in prior events, but in the structure and policies of the system. In the complex system, when we look for a cause near in time and space to a symptom, we usually find what appears to be a plausible cause. But it is usually not the cause. The complex system presents apparent causes that are in fact coincident symptoms. The high degree of time correlation between variables can lead us to make cause-and-effect associations between variables that are simply moving together as part of the total dynamic behaviour of the system (Forrester J. 1990).

This leads us to the search of adequate methods to specify outputs of the complex pedestrian system. *System dynamics* offers a method for understanding the dynamic behaviour of such complex systems. The basis of the method is the recognition that the structure of any system — the many circular, interlocking, sometimes time-delayed relationships among its components — is often just as important in determining its behaviour as the individual components themselves. It is also claimed that because there are often properties-of-the-whole which cannot be found among the properties-of-the-elements, in some cases the behaviour of the whole cannot be explained in terms of the behaviour of the parts (Forrester J. 1990).

While there is a common agreement among system thinkers that a system is a dynamic and complex whole, interacting as a structured functional unit within an environment, the boundary between the system and the environment can be interpreted differently. These boundaries can be seen as permeable and variable in time and space. *Evolutionary systems*, similar to dynamic systems, are understood as open, complex systems, but with the capacity to evolve over time (Dyer, 2005). If we consider the pedestrian system as an open, complex evolutionary system, then the interaction between the system and its environment is not constant, and the systems outputs are indicative and flexible rather than comprehensive and fixed.

Because the output of the system influences the preconditions for the system to continue functioning, mechanisms inspired by the evolution theory (Darwin, 1859) can be used to assess the output: how well does the system fit in its environment?, how adaptive is the system? which advantage does the system have compared to other systems?...

The next move with regard to the assessment of pedestrian system output is to find out which assessment and evaluation methods are available for this purpose, what data and information needs are, pro's and con's, choices to be made, criteria for choices, etc. An overview of useful evaluation methods is extracted from the European Impact Assessment Guidelines, for the assessment of non-market impacts, in particular to environment and health, and from methods of comparing impacts (European Commission, 2005).

Methodological considerations

A **cost-benefit analysis** entails identifying and evaluating expected economic, environmental and social benefits and costs of proposed public initiatives. A measure is considered justified where net benefits can be expected from the intervention.
Advantages:

- accounts for all (negative and positive) effects of policy measures
- allows comparison of the ordering of costs with the ordering of benefits of the proposal over time

- can also be used to rank alternative (including non-regulatory) proposals in terms of their net social gains (or losses).

Disadvantages:

- cannot include impacts for which there exist no quantitative or monetary data
- difficulties in establishing the social discount rate
- usually more expensive and time consuming than other, less broad, methods
- may lead to distributional issues being overlooked.

A **cost-effectiveness analysis** requires calculating the cost needed to achieve a desired outcome, allowing the costs of different options to be compared. It is an alternative to cost-benefit analysis in cases where it is difficult to value benefits in money terms. Cost-effectiveness analysis offers a ranking of regulatory options based on 'cost per unit of effectiveness' of each measure.

Advantages:

- offers a more relaxed approach towards benefit measurement than cost-benefit analysis
- useful to compare alternatives that are expected to have more or less the same outcome.

Disadvantages

- does not resolve the choice of the optimal level of benefits
- concentrates on a single type of benefit (the intended effect of the measure), excluding possible side-effects
- provides no assistance as to whether a regulatory proposal would provide net gains to society

The term **multi-criteria analysis** covers a wide range of techniques that share the aim of combining a range of positive and negative impacts in a single framework to allow easier comparison of scenarios and decision-making. The technique can be useful where there is a large amount of information on a number of different impacts, and that information is in different formats. It allows impacts to be presented that are a mixture of qualitative, quantitative and monetary and of varying degrees of certainty.

Advantages

- recognises multi-dimensionality of sustainability
- allows different types of data (monetary, quantitative, qualitative) to be compared and analysed in the same framework with varying degrees of certainty
- provides a transparent presentation of the key issues at stake and allows trade-offs to be outlined clearly; contrary to other approaches such as cost-benefit analysis, it does not allow implicit weighing
- enables distributional issues and trade-offs to be highlighted.

Disadvantages

- includes elements of subjectivity, especially in the weighting stage where the analyst needs to assign relative importance to the criteria
- because of the mix of different types of data, cannot always show whether benefits outweigh costs
- time preferences may not always be reflected.

The **risk analysis** assesses the risk of an undesirable event occurring, and the possible consequences to individuals and to society if it occurs. Risk appraisals can then be used to determine the options available to reduce or eliminate the risk and/or its consequences.

Advantages

- scientific assessments of risks make crucial contributions to regulatory decisions, especially in the areas of public health and safety, environmental protection, resource exploitation, wealth creation, innovation and national security indicating whether the policy will be effective in reducing risks in a significant manner.

Disadvantages

- risk impacts may be diverse and not commensurate (that is, brought into a common measure);
- does not normally involve an assessment of the costs likely to occur if the undesirable event does happen;
- takes no account of negative and positive impacts other than risks linked with the proposed measures to deal with the risk and/or its consequences;
- should not be used as the sole basis for deciding whether to take action or for determining the type of action to be taken.

Variants of these methods exist and can be used when appropriate. Examples are cost assessment, risk-risk assessment, etc.
We can also use techniques to value changes in risks of events occurring. This is extremely useful, indeed necessary, when looking at many environmental or health impacts. For example, many policies will try to reduce the risk of illness or death. We cannot – and do not seek to – place a monetary value on our own lives or on other individuals' lives. However, changes in risks are a different matter. While no one would trade their life for a sum of money, most people will be prepared to choose between safety equipment with different prices and offering different levels of safety, or between different ways of crossing a street compared to the saving of time. We can therefore identify the value individuals place on small changes in risk.

Sensitivity analysis explores how the outcomes or impacts of a course of action would change in response to variations in key parameters and their interactions. It may be that a single factor is crucial to the decision of whether or not an option is worth implementing. In such cases a useful form of sensitivity analysis is to identify how much the value of the factor would have to fall (if it is a benefit) or rise (if it is a cost) to make it not worth undertaking the option.
Advantages

- it is often a good way to handle the analysis of uncertainties.

Disadvantages

- when dealing with complex systems this tends to oversimplify reality.

The **capability approach** offers an alternative framework, by starting from on the individual well being (Schokkaert, 2009). The method offers a multi-dimensional perspective on well-being, integrating considerations of freedom and distribution. It focuses attention on final rather than intermediate objectives, and therefore on the overall structure of outcomes with feedback and trade-offs. Compared to the above mentioned more traditional approaches, the capability approach includes a concern for more qualitative dimensions. Currently, the most applications of the method are at the individual level. At macro policy level, the method seems promising as it enables a structured discussion on benefits, distributional issues and ethics. Due to its young nature, the method needs to be used with caution.

All the proposed approaches suffer from disadvantages, which make them more suitable for some assessments than for other (see a.o. Hauer 2009). The main difficulty lies in the fact that an assessment is never value free. Even the choice of an assessment method is not value free. Aware of this limiting condition, we propose an empirical solution, combining elements from various methods.

The pedestrian system output assessment.

Homeopathy is founded on 'holistic' and 'vitalistic' paradigms, which may be interpreted - at least in part - in terms of a framework provided by the theory of dynamic systems and of complexity. Similar to the holistic concept, a complex system is like a network, where individual parts interact and influence the system as a whole. The system is seen as

dynamic, not static. Homeopathy is often recognized in modern science as an applied approach of complex systems. Within homeopathy for example, a person's illness in a given location is an emergent property of the person as a whole, indivisible system, not something separate that is to be isolated out and treated (Bell, 2005).The homeopathic systems approach is based on appreciation of three main properties of complex systems: non-linearity, self-organization, and dynamicity. The original goal of homeopathy is better understanding of homeopathic phenomena and therapeutic settings for human health (Bellavite, 2003). These principles can also be applied to other systems. In software development, for example, self-healing principles and processes are modelled and are increasingly applied to improve the robustness of the systems.

This principle is very much in line with the basic principle proposed for the assessment of the system output (figure 2). If we apply this principle to the value of a systems output, the assessment is addressed in terms of how well it improves the self-correcting, self-healing and survival mechanisms of the social, environmental, economical and political systems. When trying to implement these principles, ethical considerations related to the definition of 'correcting', 'healing' and 'survival' mechanisms can not be ignored. These are not necessarily directly related to the final outcomes, but to the processes through which these final outcomes are reached. To complicate things further, the overall outcomes have to be examined in their distributional effects.

Aware that there is no perfect, neither universally applicable assessment method, we propose to reformulate our questions as:

1. To what extent does the pedestrian system output improve the objective and subjective preconditions to fulfil the pedestrian needs?
2. To what extent does the system improve (or at least not deteriorate) the self-correcting, self-healing and survival mechanisms which exists in the environmental, economical, social, political and organisational context?
3. How does the pedestrian system help achieve 'higher goals'?

An evaluation of current and potential impact of pedestrian quality intervention programs

To what extent does the pedestrian system output improve the objective and subjective preconditions to fulfil the pedestrian needs?

In order to answer this question, the previous chapters on needs are screened in search for potential feedback loops. This exercise is not intended to provide a comprehensive overview, rather to illustrate how the question could be answered. Further elaboration is certainly possible on indirect effects, we don't take interactions between system outputs into considerations, and the time dimension could be added to differentiate between immediate, short, medium or long term effects. Even with these restrictions, the exercise allows us to identify strengths and weaknesses of the pedestrian system in terms of how well it can sustain and/or reinforce itself.

Homeostatic/subsisdence feedback

- Children need to be able to walk for their mental and physical health ↔ Children need to have sufficient mental and physical health in order to walk.
- Elderly have a better health and longer life expectancy when they walk ↔ elderly need to live and be healthy in order to be able to walk

- Routes to destinations or transfer points need to be conspicuous (findable), convenient (without obstacles), comfortably walkable, and safe and secure.
  - The extent to which the pedestrian system improves these preconditions, is very circumstantial. For example, finding a railway station or a tourist attraction in a city may be easier when many people walk towards it, but crowding may be uncomfortable, or even an obstacle
- Skill based level behaviour ↔ the more people walk, the better their skills to walk

Psychological feedback

- People need to a 'territory' to be able to walk ↔ by walking, the surrounding becomes part of the known territory
- Persons that are not confident about heir abilities to cope with situations under way (…) have strong needs to be certain that they will not get surprised by unexpected mishaps ↔ the more people walk, the more they can gain confidence about the route and about their abilities (as in this is 'my' bench)

Aesthetic feedback

- People prefer to walk where the aesthetics of the environment fit their lifestyle ↔ by walking people can express their lifestyle preferences (for example promenade in posh neighbourhoods, on fancy streets, …)
  - Because aesthetic experiences are person, group and culture related, this may be a negative feedback loop. Some pedestrians have incompatible tastes, or even dislike each other (for example, some people find noisy children annoying, the smell of people eating and drinking while walking may be disgusting to other pedestrians, …)
- Monotonous environment are less pleasant for pedestrians ↔ the presence of people (pedestrians) bring movement in the environment, and breaks the monotony.

Social feedback

- A convenient social climate and social cohesion, company, … are needed for people feeling better when walking ↔ walking *can* improve the social climate
  - It is important to mention that this is not necessarily the case. Depending on the context, there may even be a negative feedback: elderly people feeling unsecure walking where many youngsters hang around, women 'not belonging' in the street in certain cultures, … In such cases, walking by some may discourage walking by others

Public/political feedback

- The pedestrian system needs a political system committed to provide facilities and services (cf. The European Charter of Pedestrian's Rights) ↔ the more voters walk, the more the political system will pay attention to their needs
- Conflicts with traffic need to be prevented; pedestrians need to be facilitated to cross major roads at for them convenient locations, and the speed of motor vehicles should not exceed 30 km/h at the crossings, in order to allow drivers to spot crossing pedestrians in time to stop ↔ when many pedestrians cross the street, they are more visible to drivers, and when many people walk in a neighbourhood, the number of crossing places may prevent traffic from driving at high speed. When there are conflicts in areas with lots of pedestrians, the pedestrians may very well win, i.e. prevent traffic from driving through.

The weakness of this approach is that it doesn't consider 'competition'. The pedestrian system may reinforce itself, but *theoretically* still be out competed by other alternatives. For

example, other ways of expressing lifestyle preferences may become more fashionable than walking in a fancy street. While this can constrain walking at a certain scale, in a specific environmental, economical, social, political and organisational context, it will never *in fact*, out compete the pedestrian system. The main reason is: walking is a precondition for any journey, even when it is complementary to the use of transport modes: one has to walk to the car, the bus stop, … The pedestrian system is nested everywhere in the transport system, and by enlargement, in any system involving human beings. Some people have no alternative but to walk to their destination, others are barely aware that they walk. *Walking is a precondition for any system to function as a whole, not something separate that is to be isolated out and treated on its own.* In this, we recognise the basic idea behind the design for all principle.

When examining these potential feedback loops, it is important to keep in mind interactions between different scales. The systems output at community level may reinforce or conflict with individual needs (i.e. the need for privacy vs. safety), or the opposite may also be the case: individual needs may conflict with societal needs, leading to malfunctions as corruption, etc.

To what extent does the system improve (or at least not deteriorate) the self-correcting, self-healing and survival mechanisms which exist in the environmental, economical, social, political and organisational context?

Social climate/equity

How can one assess in how far pedestrians in the streets improve the social climate and equity?

The example from 'Streets to live by' (Lusher et al. 2008), illustrates how the success of a liveable street is measured by its outcomes in terms of the strength of the community: street life, pedestrian volume, stationary activities, pedestrian diversity, social interaction, social network and ownership, public health, healthy/liveable streets. It is clear that not all the system outcomes can be measured

Political and organisational context

There is no better argument for embedding walking in the political context, than the "Ministry of Silly Walks" sketch from the Monty Python's Flying Circus, (episode 14). Walking as a stand alone ministry or policy makes no sense.

A good political system needs to be aware that the needs of the pedestrian system should be embedded in all decision making. It should be a reflex to check the effect of decisions and measures on the pedestrian system. This may not require major legal changes or rules. It mostly requires awareness, which can be stimulated by initiatives such as the international charter for walking (Walk21).

The environmental context

Walking as well as cycling fit into a 'zero' tolerance for both energy consumption and emissions, at the global level (reduction of greenhouse gases and energy consumption), at the local level (reduction of equipment expenses, reduction of the environmental nuisances, improvement of the living environment and of the conviviality of municipalities), at the individual level (positive impact on health and on household finances, empowerment of the individuals composing the family unit).

These findings date from the seventies and eighties and seem trivial today. Moreover, they are also persistently repeated in most local mobility planning studies.

Steg et al. (2008, p 18, 19, 20) state that purely individual goods can readily be valued on the basis of their economic, emotional and social significance of the subject. The meaning and value assigned to collective goods are far more remote, because these goods are shared, extend beyond one's own backyard and often have a significance far exceeding an individual lifetime.

The systems impact should be valued for the current and future situation (time horizon = 2040) = present (market) value, and for future (option) value. At this point the long term existence value (independent of human economic and/or social use) is not taken into account.

Methods for the assessment of non-market impacts, in particular on environment and health, are summarized in the EU Impact assessment guidelines (European Commission, 2005). Techniques have been developed to estimate the costs and benefits in money terms of goods that do not have a market value, describing the 'willingness to pay' or the 'willingness to accept' a particular outcome. They include Stated preference methods (contingent valuation, conjoint analysis, choice experiments) and Revealed preferences methods (travel cost method, hedonic pricing). Stated preference methods can be obtained by constructing hypothetical markets and asking people via questionnaires and interviews the value of a given outcome. These techniques have been used, for example, to value reduction in risks of premature deaths and non-fatal injuries, and existence value for the environment and historic buildings. Revealed preference methods are based on evidence from market transactions, for example the correlation of noise disturbance with house prices.

The technique of benefit or cost transfer (usually just called 'benefits transfer') can also be used to estimate values of impacts that do not have market prices. In this technique, values obtained in one study are transferred to a different study. For example, estimates of the costs of preventing a motorway accident in one Member State might be used to estimate the costs in other Member States. Using this technique increases the uncertainty of the estimated values, but can be helpful to give an order of magnitude of likely impacts, or if there are time and money constraints. When valuing impacts, the proportionality principle applies, as in all parts of Impact Assessment: don't devote a lot of energy to putting a value on non-marketed impacts if they are a very small part of the overall impacts.

The International Charter of Walking (Walk21)

The Charter shows how to create a culture where people choose to walk. The charter identifies the needs of people on foot and provides a common framework to help authorities refocus their existing policies, activities and relationships to create a culture where people choose to walk. The mind map of the charter can be interpreted as a graphic representation of how to improve the self-correcting, self-healing and survival mechanisms which exist in the environmental, economical, social, political and organisational context.

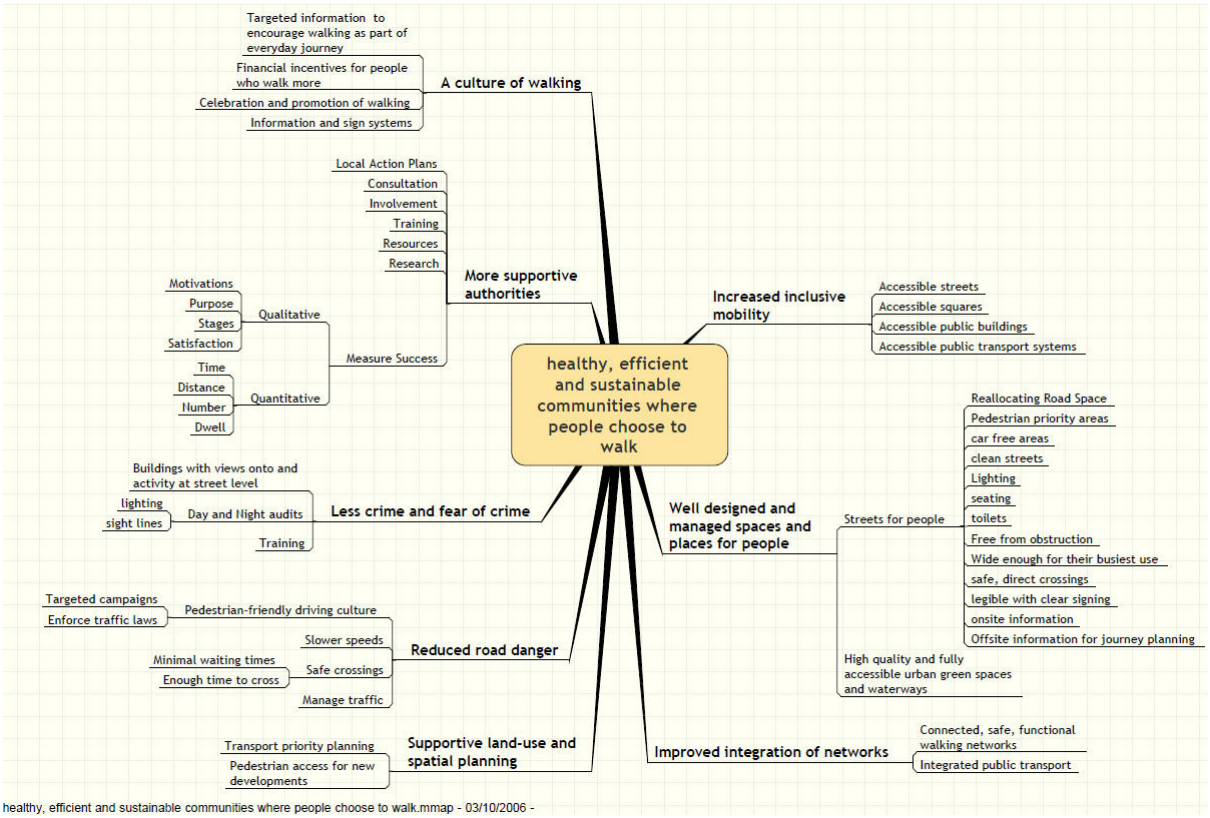

Figure 3. Mindmap of Walk21 representing “how we believe healthy, efficient and sustainable communities, where people choose to walk, can be achieved”.

How does the system help achieve ‘higher goals’?

When dealing with ‘higher goals’, ethical considerations can not be ignored. We start with an a priori list of crucial dimensions, inspired a.o. by the Universal Declaration of Human Rights (United Nations, 1948). According to Nussbaum (2000), the ten capabilities which should be supported by all democracies are: life, health, integrity, senses-imagination and thought, emotions, practical reason, affiliation, other species, play, control over ones environment. This list is not fixed, and can be adapted over time. It helps framing the pedestrian systems output in a broader context. We will not further elaborate on the problems of measuring and indexing the contribution of the pedestrian system at this point, and propose it as a checklist to keep in mind whenever dealing with strategies and measures to improve the pedestrian system.

Conclusion

The key question for the assessment of the pedestrian system output is formulated as “What effects will (packages) of interventions have for the general stakeholder interests and/or for society in general?” Because the pedestrian system is a holistic, complex system, the answer is searched in a homeopathic system approach. The key question can be reformulated as: 1) “To what extent does the pedestrian system output improve the objective and subjective preconditions to fulfil the pedestrian needs?”, 2) “To what extent does the system improve (or at least not deteriorate) the self-correcting, self-healing and survival mechanisms which exists in the environmental, economical, social, political and organisational context?”, and 3) “How does the pedestrian system help achieve ‘higher goals’?”.

An answer to the first question is proposed by searching for feedback loops in the previous chapters dealing with Coherence and Integration. While evidence was found that the pedestrian system reinforces itself (the output stimulates the input), negative feedback could also be identified, and the feedback can be complex, in some cases positive for some pedestrians, and negative for others.

The second question leads us to the embeddedness of the pedestrian system in the environmental, economical, social, political and organisational context. Awareness appears to be a key issue. The International Charter of walking provides a common framework to help authorities refocus their existing policies, activities and relationships to create a culture where people choose to walk. The central idea is to stimulate healthy, efficient and sustainable communities where people choose to walk.
For the third question, instead of an answer, a list of dimensions is proposed, which helps framing the pedestrian systems output in a broader context.
To conclude, rather than assessing the pedestrian system output, this paper reflects about the principles and reasoning that underpin such assessment, and illustrates it with examples.

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