REACHING SUSTAINABLE SETTLEMENT AND BUILDING STRUCTURES AS A PROBLEM OF CHOOSING INTELLIGENT INDICATORS

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Summary

Sustainable development may only be reached by taking the characteristics in the perception of human beings into account. One of the main problems is the concentration on short-term aspects while overlooking long-term causal loops without regarding boundary conditions and constraints.

Sustainable settlement structures were previously based on pedestrians who are genetically intended to measure distances by the consumption of body-energy. The physical limits of their body formed well organised and harmoniously fitted structures to the limits of natural resources.

The intention to save body energy by using external energy, e.g. for mobility (petrol, electricity), changed the settlement structures of cities and villages just as the modal split. Due to the approaching shortage of resources, energy saving is gaining increasing importance in architecture and civil engineering, but focused on the single building object without taking mobility and mode choice into account.

Sustainable, energy minimizing structures have to include body energy aspects of human beings in particular as well as other aspects of perceiving and assessing. Intelligent indicators that reflect the system behaviour and can be used to reach a sustainable structure have to be based on the relation between human energy and the use of external energy.

Constants and variables in the transport system show the impact of external energy usage on the settlement structures and the connection between settlement structure (density), mobility (mode choice) and the cause of the urban sprawl (velocity).

Keywords: sustainability, settlement structures, indicators, mobility, transport system, energy, human behavior

1 Introduction

Due to the approaching shortage of resources, sustainability is gaining increasing importance in architecture and civil engineering.

However nowadays sustainability is highly focused on the single object. By using these narrow system borders, this approach is bound to neglect crucial feedback loops and system interactions. But sustainability requires the broadening of looked-at systems sections and in succession the definition of adequate indicators in order to describe the system behavior accordingly.

2 State-of -the-art approach

The ongoing efforts to force sustainability predominantly concentrate on the construction of buildings and rarely include the maintenance and life cycle costs. These follow-up costs account for up to 80% of the total costs, resulting in the counterproductive practice, that in most cases the vast majority of expenses is not accounted for in the planning and construction of a building.

2.1 Exclusion of causal relations on the object level

By focusing on the object orientated point of view, crucial interactions are not taken into consideration even at the smallest of scales – the construction of a building. For example the effects of the accessibility of parking spaces and public transport stops are ignored. The access (within walking distance) to the different transport modes has a considerable effect on the mode choice and thus on the modal split of a household (and on its total energy consumption, **Fig. 1**).

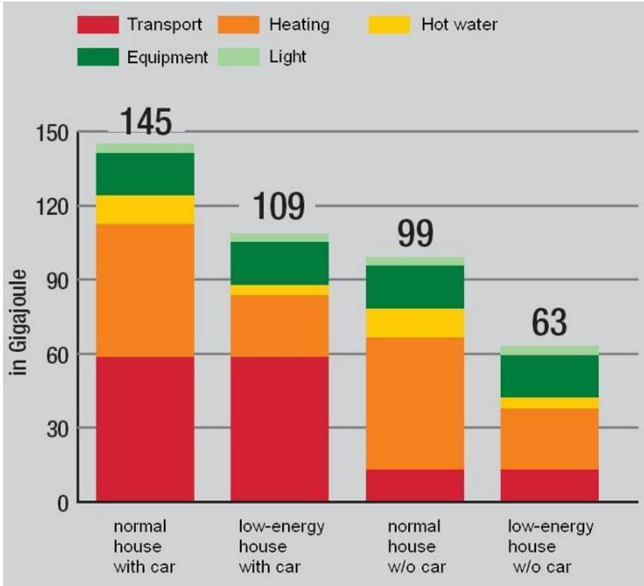

Fig. 1 Combined energy consumption of housing and transport [1]

3 Energy-minimizing structures

3.1 Settlement structure, density and mode choice

It can be shown at the example of the city of Vienna, which was built in concentric circles around the medieval city centre, that there is a close relationship between mobility and the building structure. In areas built in former times – obviously by planners who were mostly pedestrians and carriage users – the space was adopted to the needs of pedestrians. On the other hand the infrastructure in the outskirts was evidently designed by car-oriented planners, building in larger scales, wider roads and resulting in higher shares of individual motorized transport.

The first district, downtown Vienna, has the largest share of non-motorized transport due to its dense structure and its mix of functions. This share continuously falls in the succeeding outer circles of the city and is replaced by car mobility (**Fig. 2**).

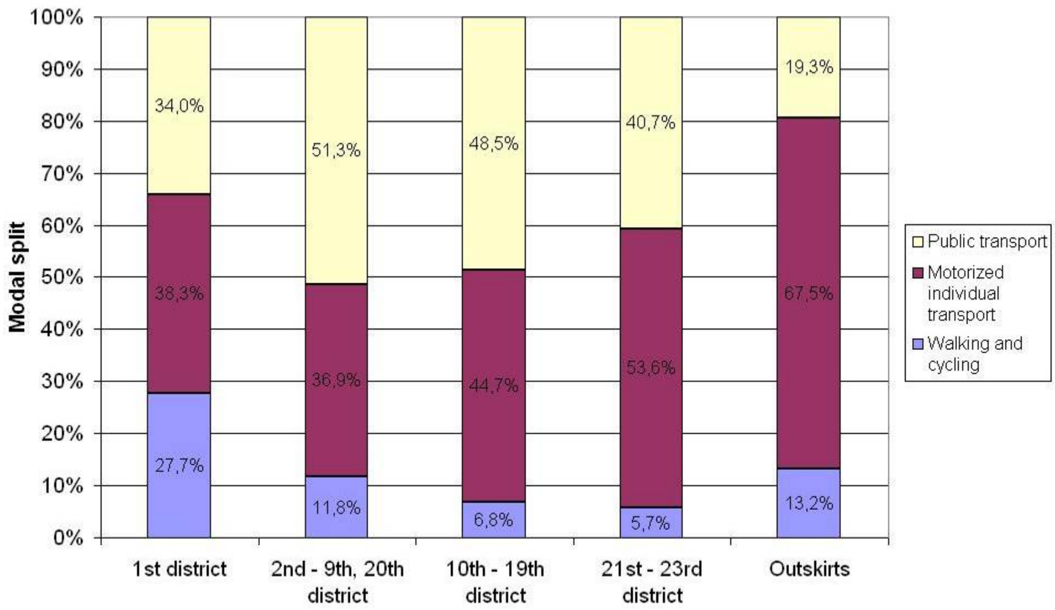

Fig. 2 Modal split of local- and out-commuters corresponding to the distance from the city centre

A comparison of old and new designs shows that the medieval planner not only satisfied the property owners' wishes but also supplied the public with additional benefits (arcades as a shelter against heat and rain, richness in detail and other forms of providing an attractive environment for pedestrians). Studies show [2], that in an attractive environment people are likely to accept distances nearly twice as long as in unattractive surroundings (**Fig. 3**).

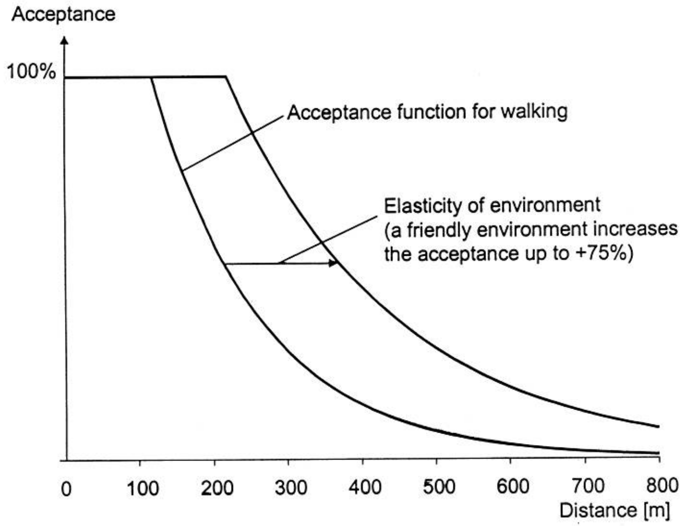

Fig. 3 Acceptance of walking distances corresponding to the attractiveness of the environment [2]

3.2 Extension of settlement structures

As already mentioned the medieval planners designed their cities for pedestrians. The dimension was restricted by walking speed and often by city walls. The settlement structures were expanded by the first means of public transport, enlarging the zone of influence into the hinterland. Ultimately high speed public and private transport pushed the city borders even further and enabled urban sprawl (**Fig. 4**). This extensive construction of infrastructure coincided with separation of functions and the triumph of the car.

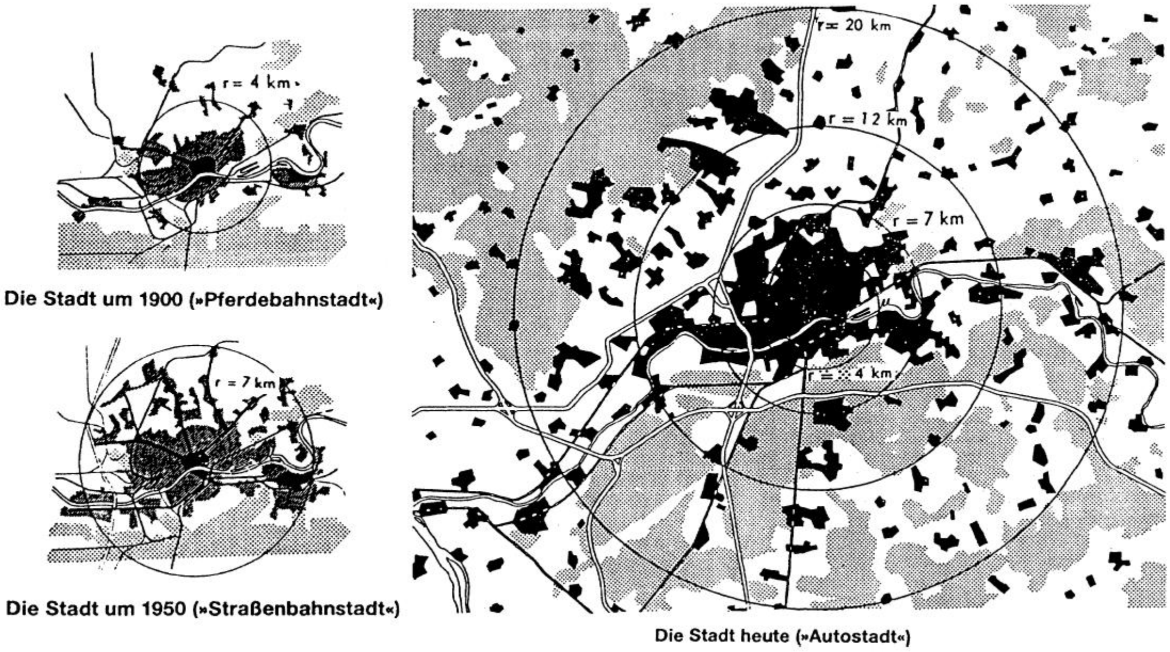

Fig. 4 The city at 1900, 1950 and today ("car city") [3]

3.3 Constants and variables in the transport system

Out of biological and evolutional reasons the overall mean of the time spent travelling is a constant of about 60 to 80 minutes per day [4]. Every expansion of the high speed public or private transport network enables higher velocities and – at constant travel times – increases the distances travelled.

Also the number of trips per person per day is a constant for the average population as the number of trip purposes doesn't change (work, shopping, leisure) [5]. Mobility is only a means to an end, compensating for the missing supply of a person's needs. Thus mobility cannot increase, only the shares of the different modes of transport can shift.

Finally the freedom of mode choice is a purely theoretical construct that would require the equidistance of parking spaces and public transport stops. As long as this requirement is not met the balance between the car and public transport will always be biased.

4 Choice of intelligent key indicators

Intelligent key indicators have to allow a representative and repeatable description of the system behaviour. Connections and feedbacks have to be clear and well-defined, and the deduced values should be integrative and – if possible – distance-to-target indicators.

These days the main targets of transport planning are the fluidity and velocity of traffic, overlooking that system goals can never be defined from the inside but have to be set externally. Velocity is in fact a key indicator to describe the causalities in the transport system. It has an impact on a lot of other fields inside and outside transportation, e.g. the number of vehicles, trip lengths, pollution, safety, etc. So velocity cannot be used as an absolute indicator for the sustainability of a system but rather as a relative one – the slower the better (for pedestrians, cyclists, shops, health and the environment).

4.1 Social, ecological and economical sustainability

A reasonable analysis of sustainability has to involve endogenous development limits in the form of distance-to-target indicators. Beside the already mentioned parameters like attractiveness (shelter against weather) and body energy consumption, expenses are playing an increasing role for various population groups. The growing energy costs, esp. in the transport sector, more and more become a problem for private households. An economic and social sustainability therefore has to not only include the maintenance costs but also the intelligent location of housing units especially to the public transport stops.

Also the design of the surroundings has to be assessed. The density of urban structures – and thus the density of opportunities (shops, etc.) – has to be increased for reasons of both savings in monetary costs as well as body energy. The limits to vertical concentration are about 4- to 5-story buildings, taking into account the body energy input.

Social sustainability seeks the improvement of living conditions for all social and demographical strata and keeps in mind the shrinking of system borders (i.e. living/operating space) of elderly people.

Nonetheless an optimization in form of the minimization of body energy must not be desirable. The American way of urban planning is based on this fundamental idea. It has led to the extensive substitution of body energy by external energy and the adherent car oriented planning with all negative effects mentioned above.

5 Conclusions

Constructional activities – even on a narrow scale – entail effects that have to be described using causal loops. The creation of attractiveness/priorities directly affects the user and can imply feedback in the form of inherent necessities (e.g. the attractiveness of car traffic entails the inherent necessity of the maximization of parking spaces). Adequate key indicators are needed to depict the system behavior accordingly.

So called end-of-pipe indicators (e.g. quantities of building materials, etc.), which can easily be compared but which are not directly related to system borders and sustainability, cannot describe the system behavior and thus are inoperative.

The drawing of boundaries is a crucial parameter in the evaluation, as is the choice of indicators [6]. E.g. the appropriate indicators can change when enlarging the observed system (from the PCU – passenger car unit – using a car-oriented approach to the number of people when including all modes).

On principle, it is necessary to include mobility indicators because of the huge share of mobility in the total energy consumption and its dependency on the settlement structure (density) and the location in space.

References

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