Smart City and the effects of the Paradigm Shift in Transportation on Spatial and Urban Planning in Times of Climate Change

Hermann Knoflacher
Em. o.Univ. Prof. Dipl. Ing. Dr. techn.
Vienna University of Technology
Institute of Transportation
Research Unit Transport Planning and Traffic Engineering
E-mail: hermann.knoflacher@tuwien.ac.at Web: http://www.fvv.tuwien.ac.at

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***Abstract*— Between 1970 and 1982 the essential foundations for a scientific foundation of transport planning with the inclusion of evolutionary theory and evolutionary epistemology were developed in Vienna and adopted in teaching, but also integrated into the practice of urban and transport planning, where administration and politics implement it. As the core hypotheses of the traditional disciplines are replaced by the new ones, well-known phenomena, such as urban sprawl, the death of inner cities, the dominance of Corporation or the problems of new housing developments can now be explained in a comprehensible way. This makes it possible to treat the causes and not the symptoms. Practical experience of four decades shows that quantification in urban planning is necessary, but not sufficient, and that the quality of the built environment must once again be the objective of the work. the priority given to the technical transport systems of the last century must also be abandoned in the concept of smart cities in favor of a harmonious integration of the city, the environment, the economy and transport. The report presents fundamentals and effects of the experience gained so far, as well as the problems encountered in implementation.**

***Index Terms*— concept of smart cities, death of inner cities, dominance of Corporations, fundamentals and effects of the experience, evolutionary theory and evolutionary epistemology, harmonious integration of the city, practice of urban and transport planning, quality of built environment, scientific foundation of transport planning, urban sprawl**

I. INTRODUCTION

THE term "smart city" originates neither from the relevant sciences nor from urban planning practice, but from the technology corporations; in Austria, it was introduced by the Siemens corporation[1]. the emphasis of this proposal is on electronic methods, voice activation methods, and sensors to collect specific data to be used to efficiently manage assets, resources, and services and to use this data to improve operations throughout the city. The promise is to enhance quality, performance and interactivity of urban services, to reduce costs and resource consumption and to increase contact between citizens and government. Smart city applications are developed to manage urban flows and allow for real-time responses.[2] In the German version, the smart city, as advertised especially in Vienna, appears in a more innocuous guise: Smart City is a collective term for holistic development concepts that aim to make cities more efficient, technologically advanced, greener and socially inclusive. These concepts incorporate technical, economic, and social innovations.[3] Here, the intent of the corporations is attempted to be hidden behind general terms from planning, technology and economics.

The documentable history of cities goes back more than 8000 years, which suggests that it is quite a smart organism, built and operated by smart human species, as a place where knowledge and culture developed, but also material wealth. Cities were therefore also always the target of exploitation and conquest. In the Middle Ages, cities were smart to assert their rights for independent development. Within their walls, they defended their independence and developed orderly structures of economy and coexistence. Today, the invisible firewall would be comparable to the situation at that time. Only this is not subject to municipal sovereignty, but is usually a "platform" of international corporations. The technical development has overrun the comprehension of the consequences.

II. PARADIGM AND PARADIGM SHIFT

Paradigms are scientific methods, ways of thinking, and norms that researchers generally accept as the basis for their research at a given point in time. Researchers build their research on these prevailing paradigms for new insights and new knowledge. Thomas Kuhn[4] refers to this as "normal science"[5]. The term paradigm shift was coined by Thomas S. Kuhn in 1962, and in his writings on the theory and history of science it refers, among other things, to the change in fundamental framework conditions for individual scientific

1 https://new.siemens.com/global/en/company/topic-areas/smart-infrastructure/smart-cities.html
2 https://de.wikipedia.org/wiki/Smart_City
3 https://de.wikipedia.org/wiki/Smart_City
4 https://en.wikipedia.org/wiki/Thomas_Kuhn
5 Thomas S. Kuhn, The Structure of Scientific Revolution. Chicago and London: University of Chicago Press, 1970

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theories[6]. In analogy to the above description of the paradigm as a normal science, a paradigm shift means a scientific revolution[7]. According to Wolfgang Stegmüller[8], the core hypotheses, which are no longer suitable for providing correct forecasts and can also no longer be supported by auxiliary hypotheses, are replaced by new hypotheses with a more far-reaching or more precise forecasting capability.

Paradigms do not emerge suddenly, but develop over more or less long periods of time. And with them also structures of thinking and all resulting actions. These actions can lead to powerful political, economic, religious structures and also create as well as change the structures of the universities. "A new scientific truth does not establish itself in such a way that its opponents are convinced and declare themselves to have been taught, but rather by the fact that its opponents gradually die out and that the rising generation is familiarized with the truth from the outset". (Max Planck[9])

Doubts about the fundamentals of transportation engineering at that time began with the Highway Capacity Manual from 1950[10] Mobility was driving and the task of education was to remove all obstacles to this mobility growth. In Vienna, a historic church, which also formed the cityscape of the 4th district, was moved out of the way to make way for the car. The unit of measurement in traffic and urban planning was (and still is) the car, the Passenger Car Unit.

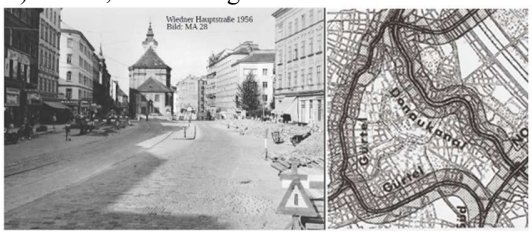

Fig. 1. The “smart city” of the 1960s was the motor city with highways.

The width of the lanes what 3.75 m, much more than the car width. Doubts increased after almost twice the number of vehicles were counted on the Mittlerer Ring in Munich, with lanes of 2.05 m and 2.20 m, then was theoretically impossible according to the HCM principles[11]. The relationship between lane width and speed was discovered for the first time[12]. In the process, it is shown that the oversizing of roadways tempts motorists to speed. The professional community take no note of these research results; but it occurred much later in Germany with recommendations for the design of urban roads[13].

The experience of the traffic organization for the pedestrian zones in the center of Vienna in 1969 - 1971, closing roads carrying 120.000 car trips through the center of the city, had no negative impact on the business community. The remaining network of roads could be prepared for traffic calming in the following decades[14]. A measure against all the principles and the value system of transport planners at the time. In 1972, when the city government stopped the urban highway projects under citizen resistance, a new traffic concept had to be developed. In retrospect, it can be said that this decision was a major contribution to the paradigm shift in traffic planning.

Between 1975 and 1979, the city had the foundations for a new traffic concept drawn up, in which two essential parts of the new paradigm were obtained from the analysis and processing of the issues of pedestrians, bicycle traffic, public traffic in the street space, parking and the reorganization of traffic signals:

1) the unit of measurement for transportation planning is people, not drivers or cars. This was also the basis for the planning condition "priority is given to the transport modes with the highest efficiency"[15]. From this alone, it can be seen that the car or passenger vehicle cannot claim priority in public space. This means a fundamental change in policies and methods in transportation, urban and regional planning.

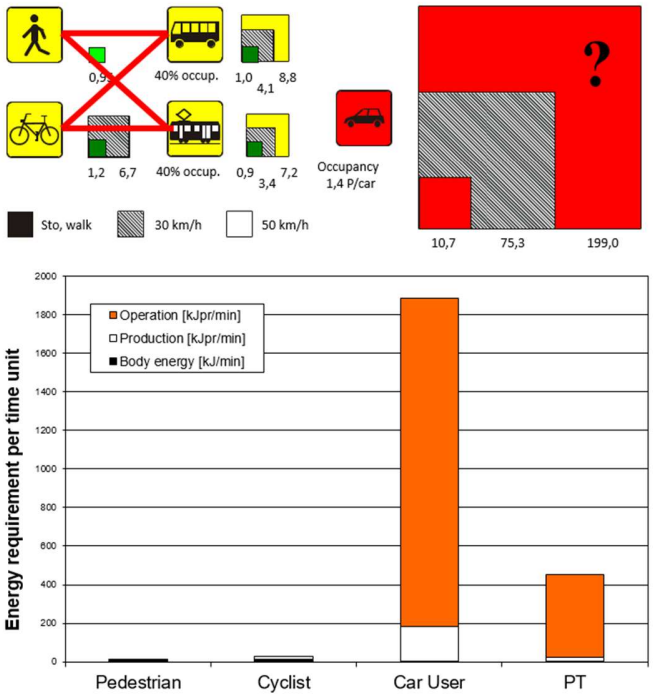

Fig. 2. Land use (above) and energy use (below) of urban transport modes provide clear priorities for rational planning.

2) The concept of mobility, formerly known as driving, needs to be redefined.

6 https://de.wikipedia.org/wiki/Paradigmenwechsel

7 https://www.philoclopedia.de/2019/11/10/thomas-kuhn-wissenschaftliche-revolution/

8 https://en.wikipedia.org/wiki/Wolfgang_Stegm%C3%BCller

9 Max Karl Ernst Ludwig Planck (1858 - 1947) German theoretical physicist.

10 Highway Capacity Manual. Published by US Dept of Commerce. 1950

11 Knoflacher H. "MARKIERTE VERKEHRSSPUREN MIT EINER GERINGEREN BREITE ALS 3 m" Österreichische Gemeindezeitung, Offizielle Zeitschrift des Österreichischen Städtebundes, Heft 18/1968

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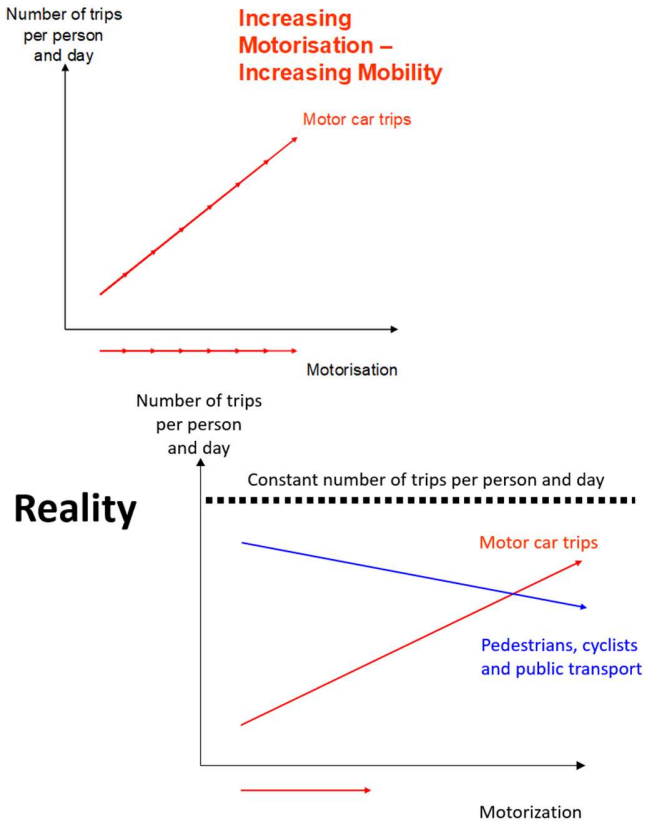

Fig. 3 Both diagrams only count trips and do not ask about the purpose, which, however, underlies every local movement. Therefore, the increase of one mode always means the decrease of the others. There is no “Growth of Mobility in the System”. The increase in automobility reduces the mobility of all other modes. The average number of daily trips is about 3 trips per person per day.

This also makes traffic forecasts obsolete. Planners and politicians have to decide on the choice of means of transport, on which planning has to be based. They must therefore know what kind of city they want and are responsible for. One cannot invoke mysterious growth or the will of the citizens without considering the consequences for it.[16]

3) In 1975 from the research work of Karl von Frisch about the bee language and a dissertation about the time evaluation of the passengers of Walther[17] the mathematically identical functions were determined, so that a homology could be assumed. Likewise, the relationship to the inverse function of psychophysiology, the Weber-Fechner law was also recognized and thus one had an approach to the causes of our behavior in the technical environment of today. Parallel to this, the empirical falsification or validation of the theory was checked with diploma theses[18]. The results can be summarized in the following points:

- The auto-dependency of humans is due to an energetic bond at the level of clearing the body's energy. It is a physical bond that can only be broken by a physically effective action.
- The cause of this binding is the proximity of car parking to human activities. A consequence of § 2 of the Reichsgaragenordnung from 1939.
- The acceptance of footpaths depends on their length and the quality of the surroundings.

This places urban planning, architecture and spatial planning at the center of possible solutions not only to traffic problems. It turned out that the quality of the environment and the beauty of public spaces have an impact on people's behavior, which is crucial for the choice of transport, the local economy and city finances. At least to the same extent as the then all-determining traffic planning with its ill-considered structural destruction.

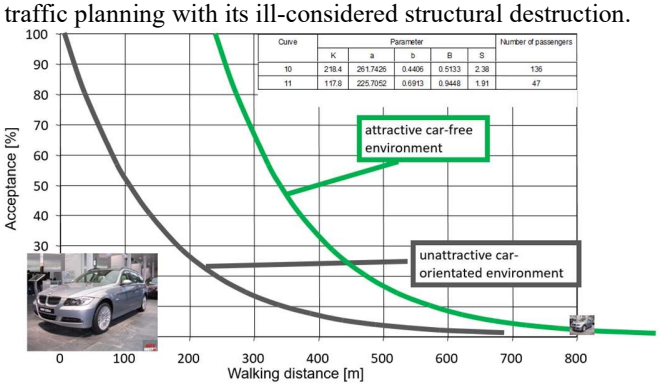

Fig. 4 Acceptance functions of footpaths to public transport stops in a car-oriented environment and in an environment without cars.

The consequence of this theoretically substantiated and empirically confirmed behavior of the people requires the change of the building regulations in such a way that cars must be parked outside the cities, if one wants to avoid their further destruction from the inside and outside. This requires not only smart experts, but also politicians with courage and responsibility for the city, its economy and inhabitants. No matter how much IT is used, these cannot be replaced.

4) The last pillar of the old paradigm, "saving time through speed" is also the basis for justifying investment in rapid transport systems. It is based on assumption that at higher speed takes less time to cover a distance, i.e. a static notion of the space in which the parameters of the transport system change without any effect on the space and its Structure. Thus, spatial planning determines the places where space is used and transportation planning provides the connections. As early as the late 1960s, it was hypothesized that travel speeds in cities would not have changed in a hundred years. Findings from household surveys also showed that different speeds of modes did not reveal analogous travel time changes. The study "Spatial Effectiveness of Transportation Systems" showed an increasing mean speed of the population with motorization and roadway expansion, but no change in travel times. The effect of higher speeds manifests itself in a lengthening of trips. Fast transport systems change spatial structures.

16 Knoflacher H. "ZUR FRAGE DES MODAL SPLIT" Straßenverkehrstechnik, Heft 5/1981, Sept./Okt. 1981

17 Walther K. Nachfrageorientierte Bewertung der Linienführung des ÖPNV, Diss. TH Aachen. 1973

18 Peperna O. Die Einzugsbereiche von Haltestellen öffentlicher Nahverkehrsmittel im Straßenbahn- und Busverkehr, Diplomarbeit TU Wien. 1982

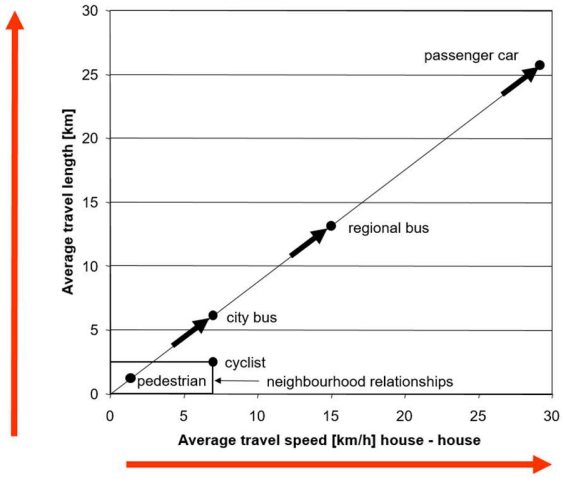

Fig. 5 Increasing the speed of individual modes of transport does not lead to time savings as in the old paradigm, but always to the lengthening of distances.

This can explain the dynamic change in existing settlement and economic structures caused by automobile traffic, as well as the urban sprawl caused by residential areas and concentration in shopping centers outside cities and towns along highways and bypasses. Commuting is on the increase, as is environmental pollution and congestion on motorways, which can now be predicted and calculated.

This was finally confirmed worldwide by a study in the year 2000, in which the evaluations of the mobility surveys over the entire width of the annual income found no differences in the mobility time budget.[19] The conclusion that one can therefore not calculate time benefits from fast traffic systems from a quantity that does not exist, was published in 1986[20].

III. SUMMARY AND CONSEQUENCES OF THE PARADIGM SHIFT

The insights into human behavior in this new technical environment of high speeds, far outside the evolutionary endowment of humans, and the effects of automobile traffic were not gained within the planning and engineering sciences, but by incorporating scientific principles from psychology, physiology, biology, system dynamics, and evolutionary theory. Translating this into planning practice is not easy for several reasons:

- A paradigm shift is a rare and unusual event and is particularly problematic in disciplines with strong practical and economic impact.
- Most of the new transport- and urban structures from the 20th century were planned and built under the paradigm with the core hypotheses of *mobility growth, time savings through speed, and freedom of transportation choice* determining the existing system dynamics. The hypotheses are alternately self-reinforcing because of the lack of system-maintaining dampening feedback.
- Planning methods followed demand by adapting to the inherent dynamics of automobile traffic, from building codes to guidelines to justifying investment decisions by extrapolating individual experience to system behavior.
- The result of this paradigm are traffic safety-, environmental-, financial-, and organizational problems in communities, states, and countries.
- The separation of the system-relevant disciplines of urban planning, engineering, economics, to name only the most important, in teaching and research, hinders the view of the interactions on the one hand and leads to the assumption "the others will already know what is right" on the other hand. The synthesis is missing.
- The immediate and individual benefits of car traffic are perceived, but not the slow changes in the overall system of city, traffic and economy and the numerous interdependencies that have arisen from them. These are taken as given.

The results resulting from scientific research and empirically confirmed, called paradigm shifts change the core hypotheses, concepts but also their contents, planning methods and evaluations and lead to a new self-understanding.

- The core hypotheses consist of the realization that there is no mobility growth if the mobility concept is reduced to the mobility purpose.
- Time saving through speed in the transport system is not found in the analysis of local surveys, nor worldwide.
- Freedom of transport choice is always structurally determined.

This has far-reaching consequences for teaching and practice:

- It is no longer the inherent dynamics of a transport mode and its forecast that is the orientation variable, but the desired modal split, which is to be derived from external goals, such as energy minimization, land conservation, climate goals, strengthening of the local economy and local jobs, and which city one wants to have. The responsibility for this must be assumed by the designers of the system and can no longer be left to "growth" that cannot be influenced.
- Since there is no benefit from a quantity that does not exist in the system, such as the time saved by speed, investment decisions for public infrastructure can no longer be economically justified by it. With this core hypothesis, however, phenomena that could not be explained in the previous paradigm can be comprehended, such as urban sprawl, the concentration of economic structures and their separation from settlement

19 Schaeffer . et al. Tehr future Mobility of the world population. Transp. Res. Part A. 2000

20 Knoflacher H. "KANN MAN STRASSENBAUTEN MIT ZEITEINSPARUNGEN BEGRÜNDEN?" Internationales Verkehrswesen 38, Heft 6/1986, Nov./Dez.

areas, the decline of the public transport share in passenger and freight transport, to name but a few.

- Since the "freedom of choice of means of transport" as presupposed in the old paradigm does not exist, but is determined by the internal structures of people and the external structures of our artificial environment, planning determines this behavior through its structures. In order for it to do so, the characteristics, capabilities, and limitations of people must be included as a basis in teaching and training. The choice of means of transport, as the research results show, is made primarily by the organization and thus binding of people to the means of transport at the sources and destinations of the routes. Measures of Flow traffic, the center of efforts for solutions in the old paradigm, are therefore only symptoms of failures at the origins and ends of paths.

The paradigm shift therefore also impacts governance structures, money flows, the legal system, and enables problem-avoiding objectives that align with all climate, environmental, local economic, and social goals.

IV. What does this mean for the smart city?

The Smart City concept means practically the retention of the existing spatial, organizational and financial structures, equipped with IT technology that promises to solve the social, financial, economic problems of a city and also the traffic problems without touching the car. A very tempting prospect for those who want to avoid the causes that lie in the laws, policies, the training of professionals, the financial flows, the confrontation with the habitual and power structures and finally the people. A clever business model of IT corporations to get access to all the data of society and its organism of the city, but ineffective. It misses the core of the problems that lies in the deep layers of human brains. This is what the cover of a booklet published by in 1985 entitled "Catalysts for the Non-Motorized" is supposed to express.

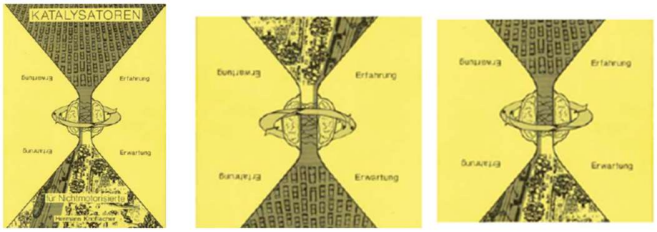

Fig. 6 Front cover "Catalytic converters for non-motorized", and right the representation of the human brain that has turned the world of nature and beauty into a gray desert of car cities and the solution (right).

Fig. 7 The consequence of the paradigm shift in transportation for the city. (Vienna "Graben")

What kind of city do we want? Is the question. The city should not be smart by IT, but beautiful by itself, by its own power, and a living space in which one feels safe because people, not cameras, animate it and can develop their social relations undisturbed without their evolution being threatened by the greed for power of corporations. We find the yardstick for this in the old medieval centers and districts, not only of our European cities. when people were still clever enough to defend them and themselves from outside access by means of a "firewall" of the mind. Whether the current model cities such as Masdar City[21] or Tsukuba Science City[22] can deliver on the promise is more than doubtful, at least from a transportation perspective, knowing the organism of a vital living city.

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22 https://en.wikipedia.org/wiki/Tsukuba