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A generic code of urban mobility: how can cities drive future sustainable development?

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Abstract

In order to investigate the drivers of future urban and transport development, we regard cities and their transportation systems as dynamic and complex systems. Therefore a qualitative system model was developed explaining the system's influence factors and their interrelationships. Our theoretical findings were mirrored with an empirical study in 15 cities all over the world. The results show that cities share a "generic code", that is to say, the same components and interdependencies which differ only due to individual framing conditions. Three controlling loops of fundamental significance for driving the future mobility towards a resilient and sustainable development were identified.

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Keywords: System analysis, future mobility, sustainable mobility, urban mobility

1. Introduction

Cities and their transportation systems are subject of enormous challenges: The world population grows rapidly and this growth is concentrated mainly in cities. Today more people live in urban areas than in rural areas. It is estimated that in 2030 about 60% percent of the population will live in urban areas while this percentage will reach more than 75% in 2050 [1]. With the increasing expansion of cities as well as the economic development travel distances are increasing as well. The negative effects of transport, such as air pollution, noise and accidents affect the quality of life. At the global level the impacts of transport are mainly reflected by the increasing consumption of resources and energy as well as the climate related emissions such as carbon dioxide.

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Considering the above mentioned challenges, the search for adequate solutions for sustainable urban mobility remains. Urban and transport planners have to deal with the many challenges mentioned above while keeping the economic and social benefits of mobility. Taking in account the specific framing conditions and development dynamics of each city, it is believed that solutions shall be tailor made for individual problems. At the same time it is forgotten that many cities are very similar in their functioning which is driven by similar processes.

Therefore, this study aims to find out if cities, despite their apparent differences, share in their basics systems a “generic code”. Our hypothesis states that cities have the same components and interrelations among them, which through individual framing conditions finally make a difference in their characteristics. However, the identification of the common interrelations among the basic components of the cities and their transportation system, could allow us to better understand the dynamics of urban mobility and therefore the drivers for sustainable solutions and the barriers that have to be faced.

The variety of framing conditions makes it difficult to determine the essential direction in the development of urban mobility. Many parallel processes are, both in their intention as in their impact, working in opposite directions and hinder the planning power of the cities. Therefore, the holistic understanding of goals and measures of the cities is decisive for the success of sustainable urban development strategies.

Considering the above-mentioned challenges for the urban mobility, the essential specific questions are:

- How does the system of urban mobility work? On which variables is it built and how do those interrelate?
- Does a theoretical system model explain urban mobility? Is it applicable to specific case-study cities?
- What are the visions, strategies and measures of those cities for the future of mobility?
- What strategies for the development of sustainable concepts and implementation of sustainable mobility solutions can be derived?

This papers aims to describe and explain the system of urban mobility and the role of different elements in the system in order to find the triggers that urban and transport planners, authorities and citizens can use to shape the future of urban mobility. We first present our methodology, followed by the results and discussion of the main findings.

2. Methodology

A combination of methods was applied. In a first step, a holistic system model was built on an abstract level using the method of Frederic Vester (sensitivity model) [2] in order to describe and explain the complex interrelations and interdependencies in the system „urban mobility“.

The model was used to generate research questions, which in turn were used to structure the empirical phase of our work.

The empirical phase, as a second step, consisted of research on basic information on the cities using a questionnaire as well as with the active participation of representatives of each city during a workshop.

In the following sections, both the theoretical and the empirical phases are presented.

2.1. System model of urban mobility

A system analysis was conducted with the help of the “sensitivity model of Frederic Vester”. This method allows representing the complex interrelations in dynamic systems. In this case the system “urban mobility” was investigated. The approach of this model allowed the collaboration of the academic project team comprised of the authors together with the company of MAN SE as the sponsor of the study as well as external experts for setting the model basis and creating a common understanding of the system.

An essential advantage of the sensitivity model is the possibility to combine quantitative and qualitative indicators by means of a fuzzy logic approach. Ultimately, the focus of the expected model results is not on the description of specific situations at a given point of time but on behavioral systems analysis over time.

2.1.1. System description and relevant variables

The system modelling approach by Vester starts with a general system description. This is meant to determine the components and the boundaries of the system to be analyzed. The system components describe the inner construction of the system while the system boundaries set the limits of the investigation spectrum and determine which aspects stay out of the system and therefore remain un-investigated.

The system description is created in a previous step without the help of the Vester modelling software (Malik Sensitivity Model® Prof. Vester). A semi-structured discussion process within the research team helped to develop a picture of the system of urban mobility (see Fig. 1).

In the center of this sketch the city, its transport network and different means of transport are recognizable. The core of the system is being framed by many diverse impact factors from different fields such as society, economy, environment and politics, which affect the creation of specific mobility patterns.

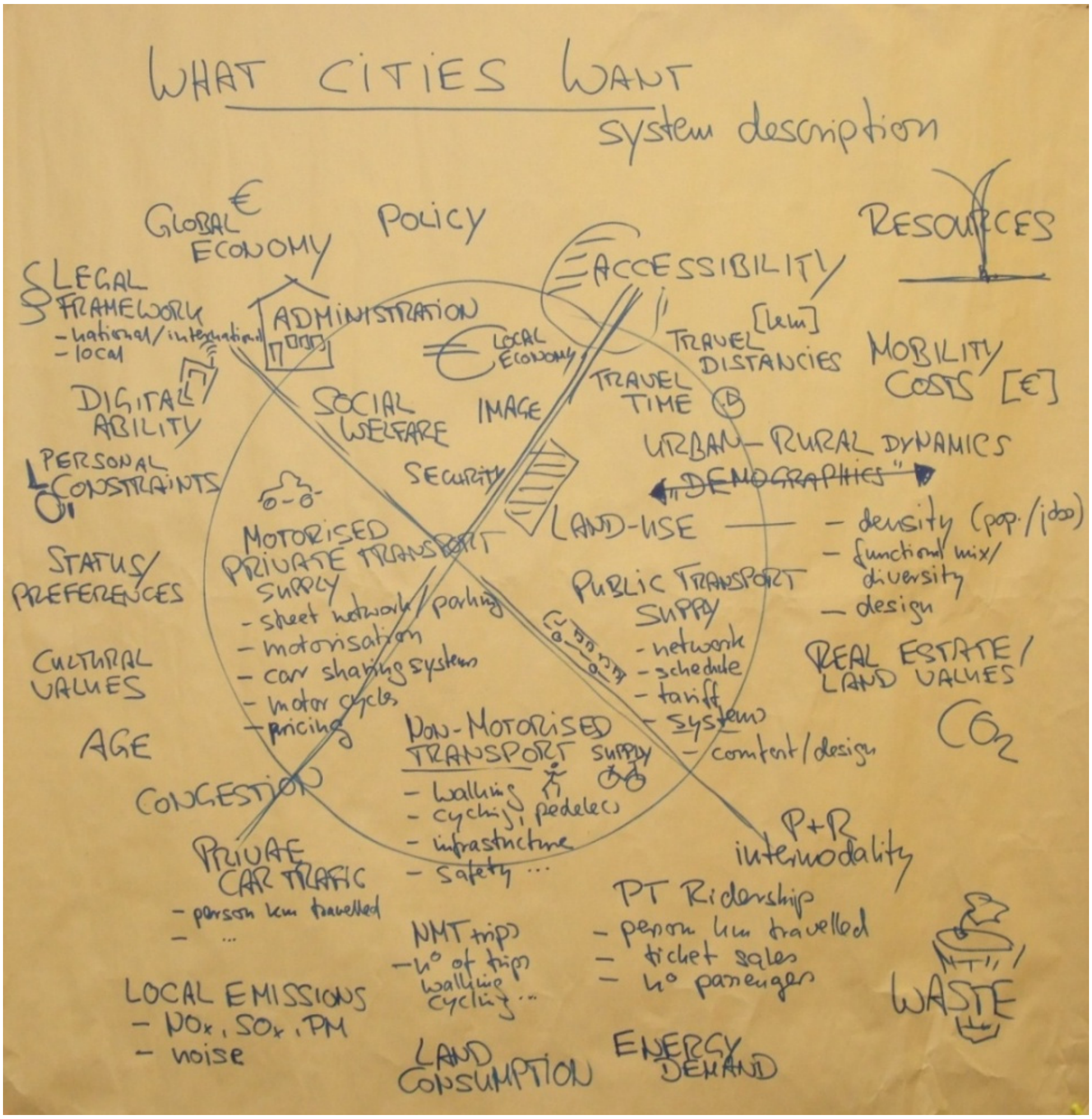

Fig. 1. System picture. Own elaboration.

2.1.2. Set of variables

Based on the system description above the set of relevant system variables was compiled. The sensitivity model software allows checking the selected variables on system relevance by a comprehensive set of criteria. The final adjustment of the variable set as well as the construction of the influence matrix in the following step was done during a workshop with participation of selected experts from different areas including transport operators and consultants, trend research, banking and insurance, among others.

At the end of the workshop with experts, the following list of 29 variables, which sufficiently describe the system of urban mobility, was consolidated:

1. *legal framework*
2. *city policies*
3. *organization & administration*
4. *public budget*
5. *local economy*
6. *urban density*
7. *urban-rural dynamics*
8. *real estate values*
9. *socio-economic population structure*
10. *orientation towards sustainable mobility*
11. *city image*
12. *road infrastructure*
13. *car ownership*
14. *congestion*
15. *trip duration*
16. *PT infrastructure*
17. *PT service quality*
18. *NMT infrastructure*
19. *intermodality*
20. *new mobility services*
21. *ICT for mobility services*
22. *motorized private mode share*
23. *PT mode share*
24. *NMT mode share*
25. *mobility costs*
26. *transport safety and security*
27. *social equity*
28. *transport energy demand*
29. *environmental impacts*

2.1.3. Influence matrix

Once the variables that describe the system are identified, the influence of each variable on all others is determined.

The impact of each variable is evaluated in terms of how strong is the influence to change the other variables. The “Frederic Vester” approach differentiates among four levels of influence, namely:

- 0, negligible influence: a strong change of variable A causes no or hardly a change of variable B
- 1, disproportionately low influence: a strong change of variable A causes only a weak change of variable B
- 2, proportional influence: a change of variable A causes equivalent change of variable B
- 3, disproportionately high influence: a weak change of variable A causes a strong change of variable B

All variables are displayed both in the horizontal and the vertical axis of the matrix in a way that each variable can be positioned against all other variables (See Fig. 2).

Influence by variable ↓ on variable →		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	AS
1	legal framework	X	2	2	1	1	1	1	1	0	1	0	2	1	0	0	2	1	1	0	2	1	0	0	0	2	1	0	0	1	24
2	city policies	1	X	3	2	1	3	1	2	1	1	3	2	0	0	0	3	3	3	2	2	1	1	1	1	1	1	1	1	2	43
3	organisation & administration	1	2	X	1	0	0	1	1	0	1	3	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	0	41
4	public budget	1	3	2	X	0	0	0	0	0	0	0	2	0	0	0	3	3	2	1	1	0	0	0	0	1	1	2	0	0	22
5	local economy	0	1	1	1	X	1	3	2	3	1	0	0	3	0	0	0	0	0	0	1	1	2	2	1	2	0	3	0	0	28
6	urban density	1	1	0	1	0	X	2	3	1	2	2	3	2	2	1	2	2	2	2	2	1	2	2	3	0	1	1	2	1	44
7	urban-rural dynamics	1	1	1	3	3	2	X	2	2	2	1	2	3	3	2	2	1	2	3	2	2	3	2	3	2	0	1	2	2	55
8	real estate values	0	0	0	1	2	3	3	X	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
9	socio-economic pop. structure	1	1	0	2	2	1	2	1	X	1	2	0	2	0	1	0	1	1	0	1	2	2	2	2	0	1	1	0	0	29
10	sustain. mobility orientation	1	1	1	0	0	1	1	0	1	X	3	0	2	1	1	1	2	1	2	2	2	3	3	3	0	1	1	2	2	38
11	city image	0	3	1	0	1	1	1	1	2	1	X	0	1	0	0	0	0	0	0	1	3	1	1	2	1	1	1	0	0	23
12	road infrastructure	2	1	1	2	1	1	3	1	0	1	2	X	1	3	2	2	2	2	1	1	1	3	1	3	1	3	1	0	1	43
13	car ownership	0	1	1	0	0	1	2	3	1	3	1	0	X	1	1	0	0	1	2	2	3	3	3	2	2	0	3	1	1	38
14	(congestion) traffic flow	1	3	2	1	1	0	3	1	0	2	3	3	1	X	3	0	0	0	3	1	3	2	2	1	0	1	1	2	3	43
15	trip duration	0	1	1	1	1	0	2	1	0	1	1	0	1	0	X	1	1	0	1	1	2	2	2	1	0	1	1	2	0	25
16	PT infrastructure	1	1	2	2	1	1	3	2	1	2	3	1	1	1	2	X	3	1	3	2	3	3	3	3	1	2	3	2	0	53
17	PT service quality	0	1	2	1	1	1	2	1	0	2	1	1	1	1	3	2	X	1	2	1	3	1	3	3	1	0	1	2	1	39
18	NMT infrastructure	1	3	1	1	1	2	1	2	1	1	2	3	1	1	1	1	2	X	3	1	1	1	2	3	0	3	1	1	1	42
19	intermodality	0	1	2	1	0	1	1	1	0	1	1	1	1	2	2	0	2	1	X	1	3	2	2	2	1	1	0	1	1	32
20	new mobility services	1	1	2	0	0	1	1	1	1	1	3	0	2	1	2	1	2	1	3	X	2	2	2	2	1	1	1	0	1	36
21	ICT for mobility services	0	0	2	0	1	0	1	1	1	1	1	1	1	1	2	1	2	1	3	3	X	1	2	2	1	1	1	1	0	32
22	mot. private mode share	1	2	2	0	0	0	1	0	1	3	3	2	1	2	0	1	1	1	1	3	2	X	2	3	1	1	0	2	2	38
23	PT mode share	2	2	2	0	0	0	0	0	1	3	3	0	1	2	0	1	2	0	1	3	2	2	X	2	2	1	0	2	2	36
24	NMT mode share	2	2	2	0	0	1	0	0	0	3	3	1	1	2	0	2	1	1	2	1	2	1	1	X	2	1	1	2	2	36
25	mobility costs	1	2	1	1	1	2	3	1	1	1	0	0	2	0	0	0	1	0	0	3	2	2	2	3	X	0	1	0	0	30
26	transport safety and security	2	1	2	1	0	1	1	1	1	0	3	1	2	1	1	1	1	0	1	1	3	2	2	3	0	X	2	0	0	34
27	social equity	2	1	1	1	1	0	3	1	2	0	2	0	1	0	0	1	2	0	0	0	1	0	0	0	1	0	X	0	0	20
28	transport energy demand	2	2	0	1	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	1	1	0	0	0	2	0	0	X	2	15
29	environmental impacts	2	3	0	1	0	0	1	1	1	1	3	0	0	0	0	0	0	0	1	2	1	1	2	2	1	0	2	0	X	25
	PS	27	43	37	26	19	25	43	31	24	37	50	27	34	26	26	30	38	24	39	43	50	44	46	52	28	25	31	26	25	

Fig. 2. Influence matrix. Output of the Vester modelling software.

The evaluation of the level of influence of each variable to the others was done in an iterative, recursive process in which two groups of experts discussed the possible impacts of each variable to the others and agreed on a value that described the level of influence (0, 1, 2 or 3). One group was comprised of the authors while the other group was comprised of experts of MAN, both having deviating assessments for specific influence indeed. The results of each group were discussed again and weighed in order to finally agree on the values assigned to each variable relationship in a final “consensus matrix”. This matrix stayed open for corrections during the time of the study for better understanding of the system, especially during the workshop with external experts

2.1.4. Role assignment

Based on the influence matrix, the “assignment of roles” of the variables is produced in the next step.

The sum of influence values *of* each variable (in a row) is the *active sum* of the variable, meaning how strong the variable for the whole system is. The sum of influence values *to* each variable (in a column) is the *passive sum* of the variable and indicates to what degree the variable is influenced by others in the whole system. Depending on the relative values of the active and the passive sum, the role of the variables is assigned:

- Active: the variable has a high active sum and a low passive sum. The variable has a great influence to other variables while it is hardly affected by other variables within the system.
- Reactive: the variable has a high passive sum and a low active sum. The variable has almost no influence to other variables but if is highly influenced by other variables within the system.

- Buffering: the variable has both a low passive and a low active sum. The variable has almost no influence to other variables and is at the same time hardly affected by other variables within the system.
- Critical: the variable has both a high active and a high passive sum. The variable has a great influence to other variables and it is at the same time highly influenced by other variables within the system.

The role assignment allows understanding how each variable influences the system. Eventually it can help to reflect upon the assignation of influence level in the previous step of building the impact/influence matrix and make corrections if necessary.

2.1.5. Effect system

The effect system of the sensitivity model does not only regard the impact between two selected variables but identifies chains of impacts of several variables. The complete effect system of the system of urban mobility is displayed in Fig. 3

Especially in a complex system it is inevitable to recognize the relevant mechanisms and control loops behind in order to understand the nature of the overall system and its survival capability. Control loops are here defined as links of several single impacts between variables. In contrast to the influence matrix, in this model step also the direction of specific impacts are relevant. This means, i.e. an intensification of variable A could cause variable B to intensify too while a stronger variable B could imply a weakening of variable C.

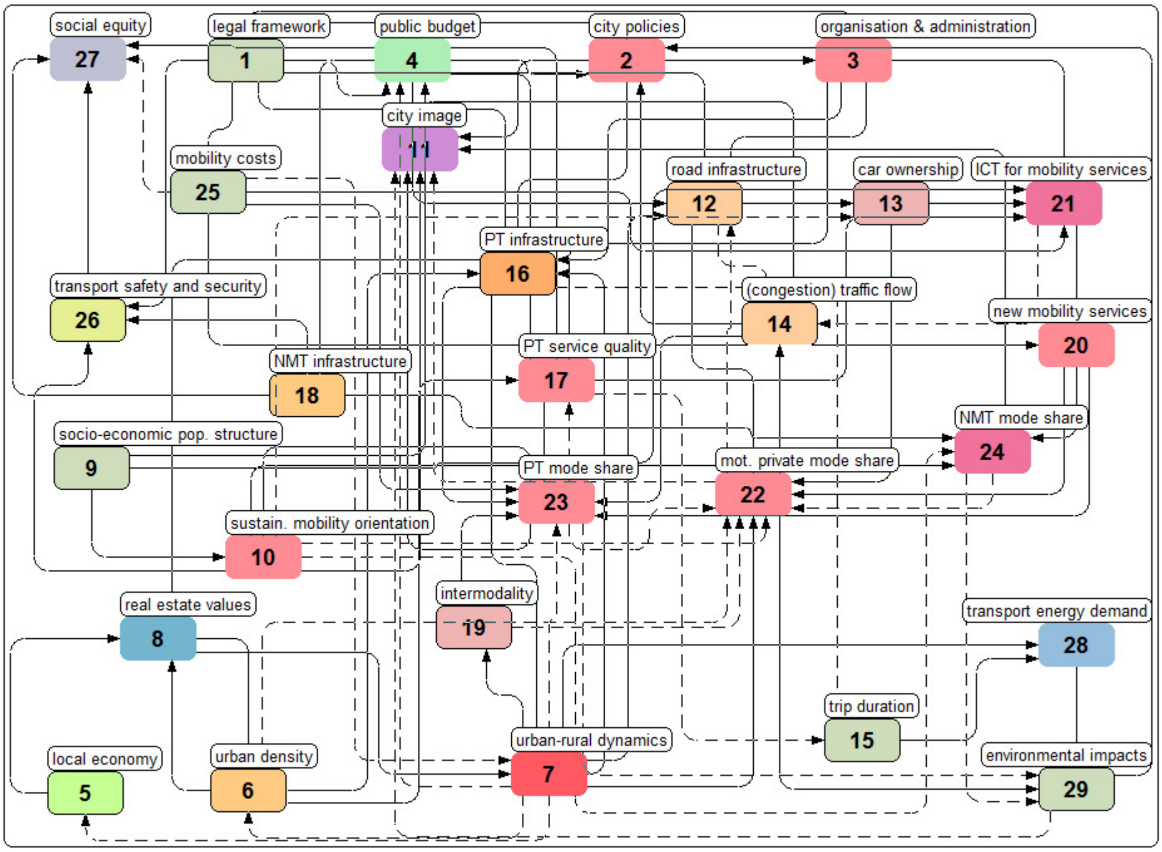

Fig. 3. Effect system. Output of the Vester modelling software.

2.2. Empirical investigation

In order to validate the system model built in the first phase of our investigation, we conducted an empirical study in a wide variety of cities. In our search for the “generic code” of urban mobility, its components and interrelations, we tried to avoid the risk of pushing the hypothesis in one direction, for example by only looking at cities that were similar.

The selection of the cities was done in a way to assure a wide spectrum of characteristics such as population, population growth, population density, urban-rural dynamics, topography, land use patterns, modal split, forms of public transport, environmental aspects, implemented or planned mobility concepts as well as economic and political situation in cities, at least one in each continent.

The fifteen cities selected for the investigation were Ahmedabad, Beirut, Bogotá, Copenhagen, Johannesburg, Istanbul, London, Los Angeles, Lyon, Melbourne, Munich, St. Petersburg, São Paulo, Shanghai and Singapore.

Regarding the number of inhabitants, the selection of cities cover a wide spectrum, from megacities with more than 10 million inhabitants (Shanghai, Istanbul and São Paulo) to those relatively small cities such as Copenhagen and Beirut with a population of about half a million.

3. Preliminary results and model validation

As explained above, the first phase of our investigation consisted in building up a system model. Through internal discussions we assigned levels of influence (0, 1, 2 or 3) to the relations of one variable to another. These values were later validated during workshops with experts in the fields of urban and transport planning. In this way, the most important components or variables of the system “urban mobility” as well as their role were identified.

Among those variables playing an active role are for example the urban density (6), road infrastructure (12), infrastructure for non-motorized modes (18) and congestion (14). Very notable is the active role of public transport infrastructure (16) with one of the highest active sums. Road safety (26) and mobility costs (25) are in comparison less active but have still high active sums within the system. These last two are important, both as a social factor and as the trigger of technological innovations and political decisions. Reactive variables are on the other hand those with less influence to other variables but highly influenced by others within the system. These are for example the city image (11), social equity (27) and real estate values (8).

In Fig. 4 can be observed that most of the variables have a critical role in the system of “urban mobility”. As explained in Chapter 2, critical variables are those that have a great influence on other variables while at the same time are highly influenced by other variables within the system. The most notably critical variables are the urban-rural dynamics (7), the city policies (2), the municipal administration (3) and the share of different modes such as non-motorized-transport (24), private motorized transport (22) and public transport (23). The interpretation of this role assignment tells us that the municipal administration, the motorization rates, the quality of local public transport services, technological innovations and the level of transport interconnections have a considerable influence on the mobility patterns of the inhabitants and the resulting balance in the different modes of transport, but also the other way around: the current modal split and mobility patterns may have an influence on city policies, motorization rates and the urban density, for example.

Finally, buffering variables, those having little influence to others variables and at the same time being hardly influenced by other variables within the system are for example the transport energy demand (28), the public budget (4) and the legal framework (1). The last two may damp down the city’s developmental dynamism. Local economy (5), along with the social, industrial and cultural background of the urban population (9), influence the stability of the system overall to a notable degree. The graphic representation of the active and the passive sums, and therefore their role assignment can be observed in Fig. 4.

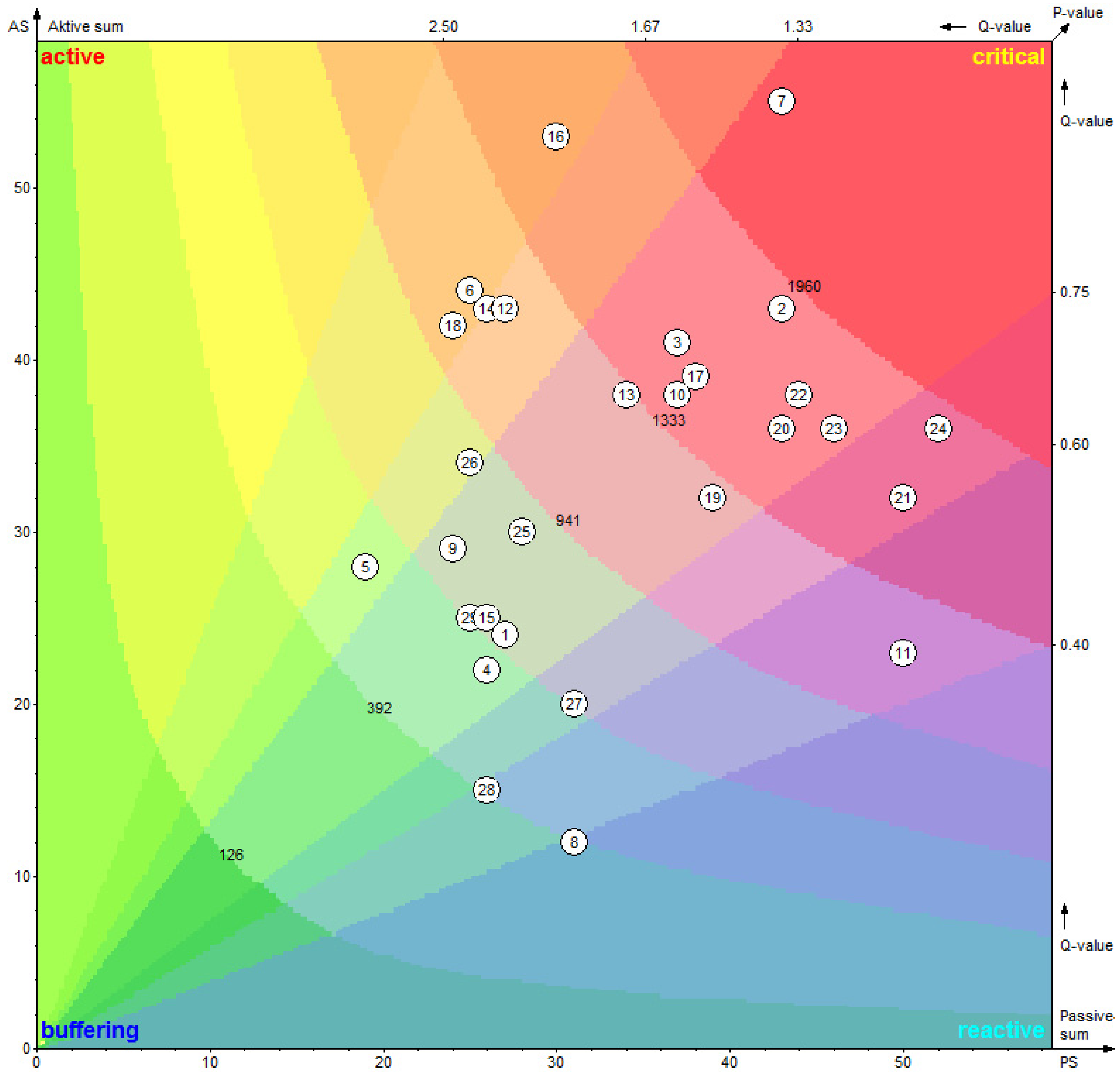

Fig. 4. Role assignment. Output of the Vester modelling software.

3.1. City surveys

On the basis of the "urban mobility" system model presented above we were able to formulate the following questions with a view to investigating the cities taking part in the study:

- How do economic factors affect urbanization and mobility patterns?
- What part is played by energy consumption, climate change and environmental impacts when it comes to local transport policies?
- What concrete challenges are the cities faced with?
- What transport and urban development strategies have the cities adopted?
- How can the players concerned be successful in realizing these ideas?

A questionnaire was developed to inquire about strategies, drivers and obstacles for urban transport policies and mobility planning. Heads of urban and transport and planning authorities as well as experts in these fields were identified and invited to participate in a survey and later on in an international workshop.

3.1.1. Workshop with city representatives

During the international workshop, the results of the theoretical part of the study, the system model of urban mobility built in the first phase of our investigation, were presented to the experts in order to set the basis for discussion.

The experts shared their knowledge about the urban and transport development as well as the strategies for future mobility in their cities through presentations of about 20 minutes followed by questions and discussions for a deeper understanding and analysis.

Finally, starting from the background of the system model developed in the first phase of our investigation and taking in account the challenges for a future sustainable development, with the participation of the city representatives, a common assessment of the future global trends and strategies could be derived.

The strategies observed by the study for the planning of more sustainable mobility are many and varied, and are customized to the different prevailing conditions in the city in question. Taken altogether, we can distinguish between the following approaches to sustainable mobility:

1. Strategies for the integration of urban development and transport planning:
2. Support of local public transport:
3. Support of non-motorized modes of transport
4. Technological approaches
5. Traffic restrictions and financial schemes

Besides the identification of the above-mentioned groups of strategies, the discussion with international experts allowed us to review the system model and validate the mechanisms identified in the last modeling step, the *effect system*.

4. The generic code of urban mobility

Overall, within the effect system more than 600 control loops could be identified. While some them are comprised of only two or three variables and hence are somehow apparent, others are very complex consisting of up to 15 different variables providing detailed effect mechanisms. It was a demanding task to select those, which were of greatest importance for the further outcome of this study. Therefore we selected those that contributed most to the initial research questions. It also became evident that many control loops are similar only differing from each other by one or two specific variables but with a high redundancy in their meaning for the overall system.

At the end, three controlling loops were identified which are of fundamental significance for a sustainable future of urban and transport development. The control loops describe the interrelations of components in three different areas: 1) economic development and urbanization, 2) environmental stress and climate change, and 3) successful implementation of strategies.

4.1. Economic development and urbanization

As observed in most investigated cities, they are the centres of job creation and concentration of activities and services of a national economy attracting people and contributing to urban population growth. The increase in individual affluence that many of these new urban dwellers experience raises their purchasing power and therefore car ownership and car use in a city. In the absence of external intervention, this leads to negative effects such as air pollution, noise and accidents reducing the quality of life within the city. This, together with the increasing demand for space leads to the second effect, suburbanization which has even more extensive impacts for the city and its surrounding environment as it causes traffic to increase further, and the road infrastructure to reach the limits of its capacity. As a consequence, traffic congestion occurs and generates a negative effect on productivity levels of the local economy. See Fig. 5.

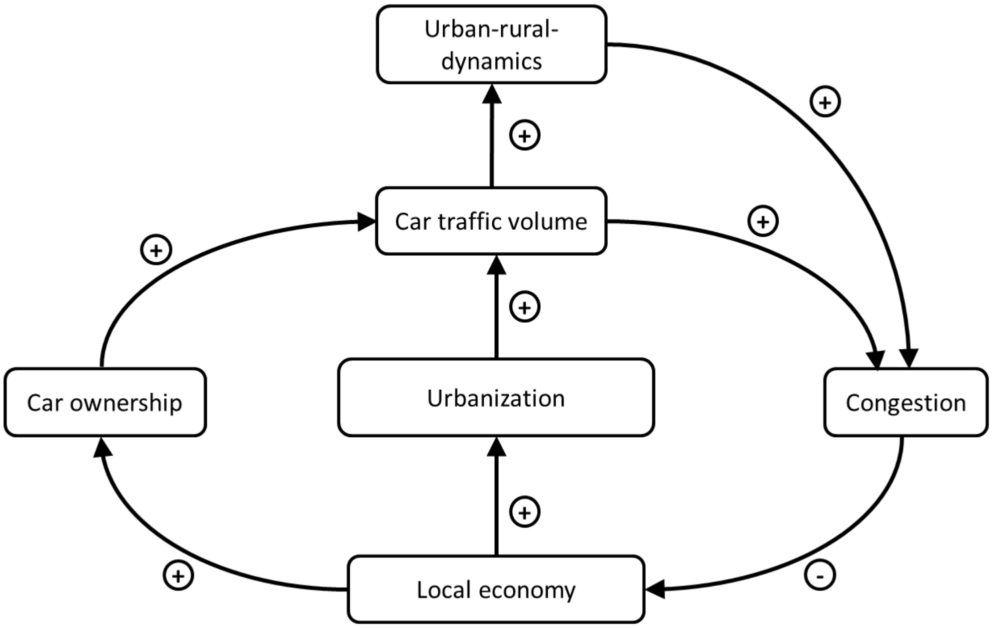

Fig. 5. Controlling loop “Economic development and urbanization”. Own elaboration.

In the empirical part of our study there is a strong support for the findings derived from the system analysis. The importance of both economic development and the volume of motorized vehicles as drivers in the control loop could be found in almost all cities analyzed. Especially in recently fastly developing economies like in Beirut, Bogotá, Istanbul, Johannesburg, São Paulo, Shanghai and St. Petersburg we recognized the classic connection between gross domestic product and the share of cars in transport as a whole. It is only as a result of countermeasures that this presumed automatic mechanism is not or no longer prevalent in cities like Copenhagen, Lyon, Melbourne, Munich and Singapore [3].

4.2. Global climate change and local environmental impacts

In relation to the first control loop, we can recognize other mechanisms related to the increasing demand for mobility. Especially when this is heavily based on private vehicles we can recognize the link between vehicle kilometres travelled and energy consumption, which in turn has two main effects. On the one hand, the emissions of Greenhouse Gases GHG, of which CO_2 is the most representative, contribute to the long-term effect of climate change. On the other hand the emissions of local pollutants and other local environmental impacts such as noise have a negative effect on the quality of life. This last may serve as a trigger for cities to develop sustainable strategies in order to counteract the increasing amount of kilometres travel and thus the entire chain of subsequent effects. The links between all these factors are better explained in Fig. 6, especially on the left side of the loop.

On the right side of the loop we observe how the delayed and less direct impact of CO_2 on climate change may also have an influence on local politics. As previously reported in [3] “the consequences for local quality of life are not yet perceived as serious in the majority of the cities”. However, some cities start to consider the risk of climate change in their planning and some even consider mitigation as part of their mobility strategies. Singapore, for example, is already wondering how to deal with rising sea levels, and Melbourne is concerned with the increasing probability of bush fires.

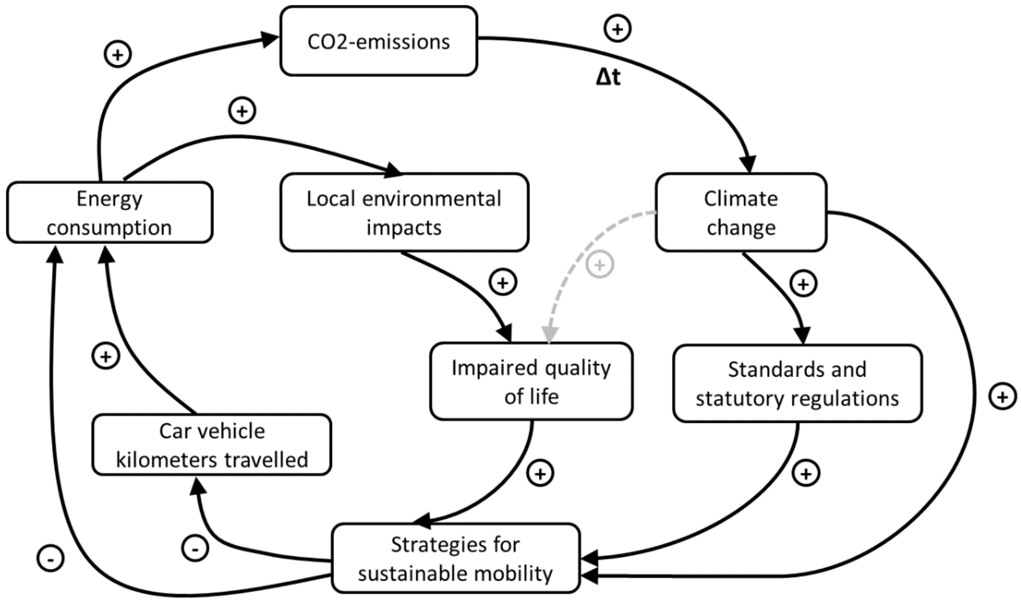

Fig. 6. Controlling loop “Environmental impacts and climate change”. Own elaboration

Many cities are developing climate plans in which sustainable transport plays a major role. Some cities develop such plans in a top-down approach as a result of international agreements in which countries are committed to enact regulations for climate protection, which are then transferred to cities. In other cases though, cities commit themselves to climate change mitigation because they see the co-benefits that sustainable strategies bring for the city such as better air quality, reduced noise levels, less congestion and the subsequent positive effects on public health and the local economy.

A particularly ambitious example is Copenhagen, which has set itself the goal of being CO_2 neutral by the year 2025 even though not all the envisaged measures have the support of the Danish government. Also the cities of Melbourne and Munich are planning to make significant reductions in CO_2 emissions as compared with present day levels [3].

4.3. Successful implementation of strategies for transport and the city

The first control loop explained above allowed us to understand the most important mechanisms between mobility, its impacts on the urban structure and the environment. The second is about those impacts may influence local politics in order to counteract the negative effects. Still, an important question is what the main obstacles in realizing sustainable mobility strategies are and how cities cope with them.

The control loop “Implementation of strategies” (Fig. 7) below illustrates a scenario for the successful shaping of the process. First of all, an effective administration seems to be essential for the implementation of any strategy. The case of Ahmedabad, for example, shows that “the well-organized local planning authority, with its long term development perspective, is principally responsible for what makes the city so different from other cities in India” [3]. While sound planning is the foundation for the successful implementation, this shall be resilient to political changes within the city administration in order to assure a long-term strategy of urban and transport development.

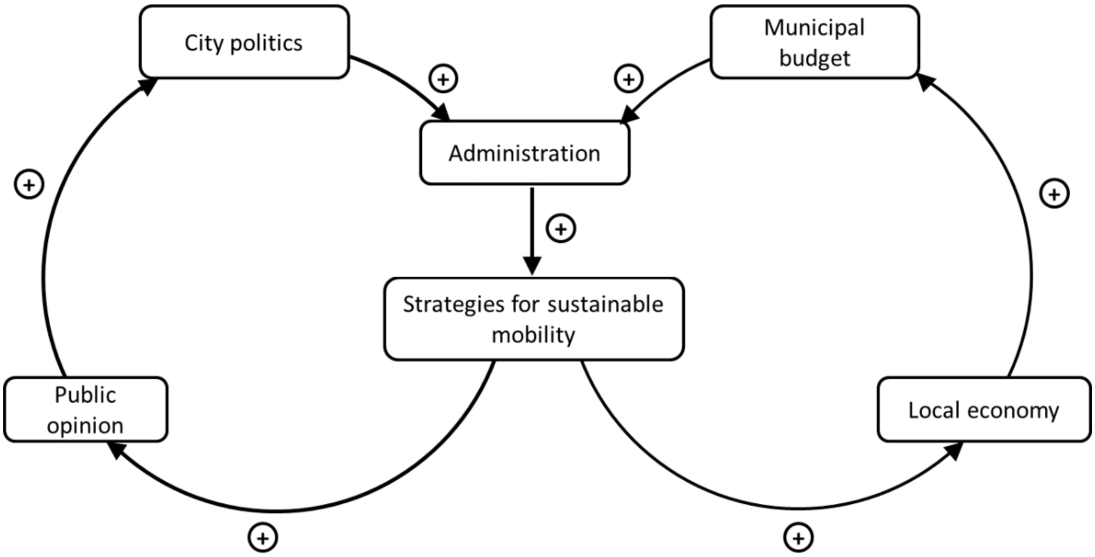

Fig. 7. Controlling loop "Implementation of strategies". Own elaboration

Besides the political support and technical competence within the city's administration, the necessary funding for the implementation of strategies is needed. Given that municipal budgets depend highly on local taxes, it is important to find synergies with the local economy. That means that urban and mobility strategies must be developed in consensus and cooperation with the local and regional industries and services.

5. Conclusions

The study inquired specific local strategies for mobility in selected cities worldwide against the background of global challenges. At the same time, our initial hypothesis that common features between the various cities and generally valid interdependencies of effects do exist could be validated. This is what we call a "generic code" of urban mobility.

The method of system modeling helped us to identify three fundamental controlling loops illustrating and explaining the most important challenges cities are faced with and how they can react. It became apparent that urban mobility is neither a deterministic mechanism, which is not possible to organize, nor independent from the influence of local actors. On the contrary, the analysis of the complex interactions supported by many empirical examples showed the decisive importance of all individual stakeholders such as citizens, entrepreneurs, planners and politicians for setting the course for a more sustainable urban mobility system.

From the methodological point of view of it has to be mentioned that there was a distinctive difficulty in creating a single system model that tries to incorporate the multiple manifestations of urban mobility systems all over the world. As the sensitivity model approach asks for a consolidated determination of the effects between the system variables there might be many examples in reality that show differing results. In the modeling process we were especially confronted with some diverging assumptions on the mechanisms when comparing industrialized countries and recently developing nations. Particularly, when talking about strategies for sustainable urban mobility, most of the model assumptions built upon a properly working relationship between urban local governments, city administration and the private sector. As this is an essential prerequisite, its absence makes it hard to trace the described effects in the individual case.

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