Managing the complexity: decision making process on sustainable mobility

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Abstract

Starting from the literature on decision processes in public choices, aim of the paper is to suggest an integrated methodology to get a choice as much as possible shared and participated joining two different approaches. On one hand there is the "classic" or top-down approach based on statistical data analysis and handling, having as target the definition of some synthetic indicators. On the other hand there is a bottom-up approach based on the Strategic Environment Assessment (SEA) logical framework and on citizens participation. Particularly the paper will apply the above mentioned methodology to face the theme of sustainable mobility showing at the end the results[1] obtained in the analysis of the 13th District of the Municipality of Rome. The choice of sustainable mobility as a target of decision process lies on the fact that actually it is included with a high priority in the agenda of European institutions and (local and national) administrative governments. The proposed model does not provide a solution, but rather defines a process that is able to recognize the particularities of different territorial contexts to yield appropriate, case specific solutions.

1. Decision processes and assessment criteria

The *decision processes*, that is the processes embracing all the steps leading to a choice or an action, are studied in many sectors: sociology, political theory, economy and managerial sciences.

The discipline that is aimed more specifically the study of the decision process, but mainly the development of methodologies to reach rational (or, in a improper way, optimal) choices,

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[1] The application of the methodology to the study case of the XIII District of Rome Municipality has been developed thanks to the participation to the Interreg III B Medocc project "Ville emission zero – Villemizero" where are involved as partners Lazio Region (leader partner), Municipality of Rome, Diputación Provincial de Málaga, Ayuntamiento de Málaga, Prefettura di Atene, AEDA (Development Agency of the Municipality of Athens), Commune Urbaine de Tétouan

internationally known as Operations Research, Management Science[2] or Decision Theory. Such a science can be insert in the sciences of the artificial (Simon, 1981), which are different from the sciences of the nature which object is, in a way, outside to the scientist and independent from him.

By contrast the sciences of the artificial are studying realities that are product of the human being activities. In this case there are not distinctions among the study object and the mental model that represent, describe and explicit it.

A decision process start when there is a need for change or action (Sutton, 1999): as answer to a uneasiness situation or to the feeling that the current state is inadequate in respect to the needs of a specific community, thanks to the action of a person or of a group interested on changing, because new data or research results highlight the need of new policies, etc.

The emerging of changing needs leads to the formulation of a problem that requires a solution. Sometimes the problem will be well defined and will be possible articulate it in targets and constraints, but more often will be expressed in confused terms trough general targets (or even only aspirations).

Starting from these lasts, analyzing context, relative constraints, (active and passive) involved actors, relationship among them and interests, will be possible define more precisely the problem and then to analyze set of possible actions (scenarios) to solve it and finally to realize the chosen solution.

Mental and formal models play a fundamental role in decision processes. It is through our mental models that we interpret the world and give a meaning to it (Forrester, 1975).

The formal models are instruments to improve and strengthen our mental models but also to communicate them to the others. The formalization can be more or less in depth, but a minimum level it's necessary to face the complexity of many problems.

Particularly interesting are the models called policy narratives (Sutton, 1999). Such a narrative is a story with a beginning, a course and a conclusion, in which are represented a specific events sequence that reach the status of "common sense" or "shared truth" within a community or a cultural, scientific or political circle.

In some case are stories deriving from specific experiences but interpreted as general meaning in all of the cases that reproduce similar circumstances.

[2] The two terms, used today as synonymous, have a different meaning: the first one underlines the operative decisions, the second one highlights the strategic and political choices.

In other cases are only artificial realities build in order to highlight or demonstrate the damages or the benefits that some behaviors or actions can imply. A typical example is the story called “The tragedy of the commons”.

This particular models aim to compare and study the effects of cooperative and competitive behaviors. In a decisional process where there are actors with different targets, interests and preferences the problem is how to choice between the possible alternatives.

Decision makers will seek to serve the “public good”. But how are decisions that serve the public good actually identified and distinguished from publicly bad decisions? Traditional planning theories propose that good public decisions are “rational” in the sense that total benefits to society will exceed total societal costs. The idea is that collective choice can and should mirror “rationality” as it applies to individual choice-making behavior. Individuals do not freely make choices whose costs to them exceed the benefits they perceive to be forthcoming. By the same token, traditionalists argue that social groups in a democratic society should be presented with public choices whose collective benefits exceed the collective costs of achieving them.

In the same vein, traditional neo-classical economics teaches that good public choice requires decisions that yield “Pareto improvements” whereby change leaves some individuals better off without leaving others worse off.

There are theories of choice however that do not hold to the traditional model outlined above. James Buchanan, founder of the “public choice” school of economics, and other non-traditionalists such as political scientists David Braybrook and Charles Lindblom (1961), rejects the fundamental premise that “rational” decision making, as it applies to individuals, can logically and reasonably be transferred to a *collection* of individuals (namely, the public) as a basis for public decision making. Buchanan puts it thus:

> “Rationality or irrationality as an attribute of the social group implies the imputation to that group of an organic existence apart from that of its individual components. If the social group is so considered, questions may be raised relative to the wisdom or “unwisdom” of this organic being. But does not the very attempt to examine such rationality in terms of individual values introduce logical inconsistency at the outset? Can the rationality of the social organism be evaluated in accordance with any value ordering *other than its own?*” (Buchanan, 1954)

Each one of the decision makers will rank the alternatives on the base of its own preferences: how to get a common ranking? A typical way it’s to vote. Trough the voting should be chosen the preferred alternative, if not from all at least from the majority of the decision makers.

Buchanan and others of the public choice school argue that it is simply majority decision making in the context of democratic institutions that yields sound social choices. They view majority decision and coalition formation as the key mechanisms through which a social group makes "correct" choices among alternatives.

But, what does it means correct? In fact, as proved from the impossibility theorem (Arrow, 1951), in trying to obtain an integrated social preference (a social welfare function) from diverse individual preferences, it is not in general possible to satisfy simultaneously even mild-looking conditions that would meet the most elementary standards of reasonableness for public choice in a democratic society:

- create a rank ordering of public priorities for every possible combination of individual preferences. ("universal domain")
- allow the ranking of any two social states to depend on peoples' preferences, only over that pair of alternatives, with no dependence on how other, unrelated alternatives, are ranked. ("independence")
- permit no individual or group of individuals to prevail over the social ordering regardless of what others prefer. ("nondictatorship")
- all the group of all individuals, taken together, to prevail over the social ordering. (Pareto optimality);

while still preserving some basic axioms of rationality (transitivity, completeness, reflexivity).

Does this mean that group choices are inherently antidemocratic, or elitist, or irrational?

Buchanan argues that decisions reached through the approval of a majority has never been, and should never be, correctly interpreted as anything other than a provisional choice of the social group. As a tentative choice, the majority-determined policy is held to be preferred to inaction, but it is not to be considered irrevocable. In other words, if the result of a majority decision is ultimately seen by a majority to yield net negative outcomes, the decision will ultimately be reversed.

According with this point of view a decisional process cannot reduced to a linear process aimed to choice of the best alternative in a predefined set. On the contrary can be represented as a "*chaos of purposes and accidents*" (Sutton, 1999) and if target is getting choices related to the original needs, has to be characterized from two fundamental elements: learning and participation.

The analysis of a problem becomes a learning process where the reality (the system) in which the problem has born is understood gradually and where are shared the knowledges of the

various actors. This process implies that the problem and the possible solutions are defined more than one time.

The study of decision processes, the capacity to analyze the mechanism and highlight the actors, is crucial not only to lead to good political decisions (whatever meaning has “good”), but mainly to get to a democratic control of the decisions.

So the decision process has to be also a process of participation that has to involve, not only the decision-makers, but also all those who put into practice the decisions taken and those who will suffer in their lives (in a positive or negative) the effects of such decisions.

Without these features will be difficult the success of the decisional process, both for the lack of cooperation or little motivation of those who have to make the decisions, both for the resistance of those who, even suffering the effects of decisions, don’t are been involved.

In this framework assumes a central role the choice of the methods to use in order to assess alternative decisions, analyzing the effects and the impacts? How to evaluate effects that a set of actions will implies?

Are these the questions object of the so called Decision Support Systems – DSS, those include measurement tools as costs-benefit analysis and related methods of “rational analysis” (i.e. based on multicriteria analysis), that have been devised to help decision makers make good choices (Pareto improvements) and avoid bad ones.

Although this kind of analysis are known to be implemented for any problem, in the last years the democratic and, therefore, political pressure has led to develop decision support systems aimed at specific themes, notably the environment. The reference, from this point of view, is the Strategic Environmental Assessment (SEA).

Conceptually born at the end of the 80’s, the SEA is a systematic process to assess the environmental consequences of planning proposals, having as main goal to consider these at the same level of the economic and social aspects, starting from the beginning of the decisional process. The SEA concerns the elaboration process of the plans rather than the plans themselves. In that way it’s a decision support system rather than a decisional process.

The SEA has to be inserted in the strategic step of the decisional process and has to be applied as soon as possible and along all the path. The consideration of the alternatives, including the “zero option” it’s crucial. Often the plan don’t include this option, that is to don’t act, that on the contrary can be useful compared with the other alternatives.

In a operative way the SEA has to be based on:

- Simple methods oriented specifically on the strategic levels;
- Organized databases, without which it’s impossible any assessment.

Using a such approach in the definition of a sustainable mobility model seems thus the more correct choice even because its compulsory character since the 2004 with the adoption by UE Council of the directive 2001/42/CE.

2. The theoretical framework

The main added value of this approach lies in the decision not to provide a univocal and ready-made solution to the problem, but rather to identify a cohesive process able to assist the policy makers in finding solutions that best respond to local needs, in order to support, reinforce and best utilize the various territorial stakeholders.

In general terms the procedure/model has the following characteristics:

- interactive – various territorial actors work closly with the authorities responsible for planning, facilitating a continuous exchange of information;
- iterative – the choices, subjected to constant refining, are considered as alternative hypotheses;
- participatory – the request of the resident population affect the corpus of judgment criteria and project choices;
- systemic – the various components are analyzed according their mutual interactions in relation to the established objectives;
- evaluative – the alternative scenarios are assessed in comparison with four different situations (ideal status, actual status, preferred status by institution, preferred status by local community).

The resulting conceptual framework (

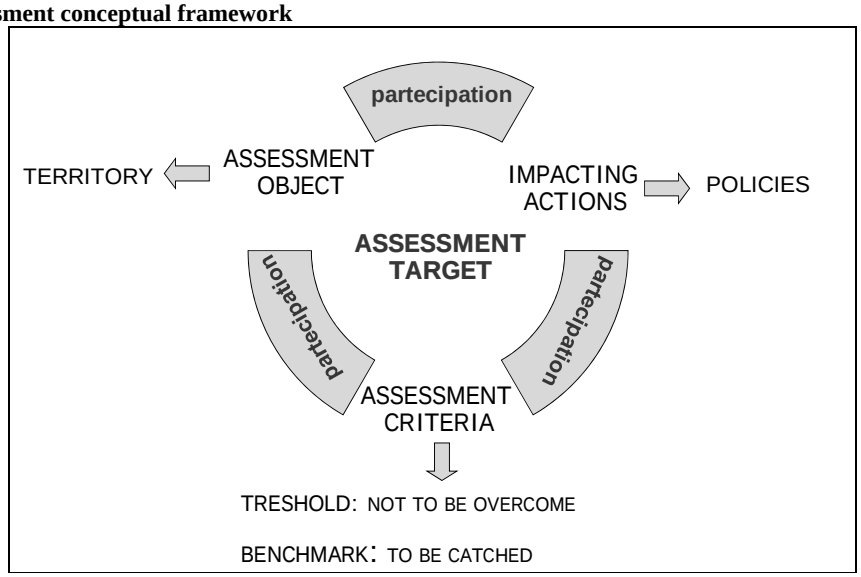
Figure 1) has as main elements the concept of assessment that implies first to define the assessment target (the theme) and then the assessment object (the territorial context), the assessment criteria (the benchmark to be catch or the threshold not to be overcome) and the impacting actions (the alternative scenarios).

Applying this definition to the operational sphere, has been defined a logical outline of the process (Figure 2) that foresees four main groups of action that operate according to a non-sequential dynamic and reciprocal relationship:

- cognitive frame

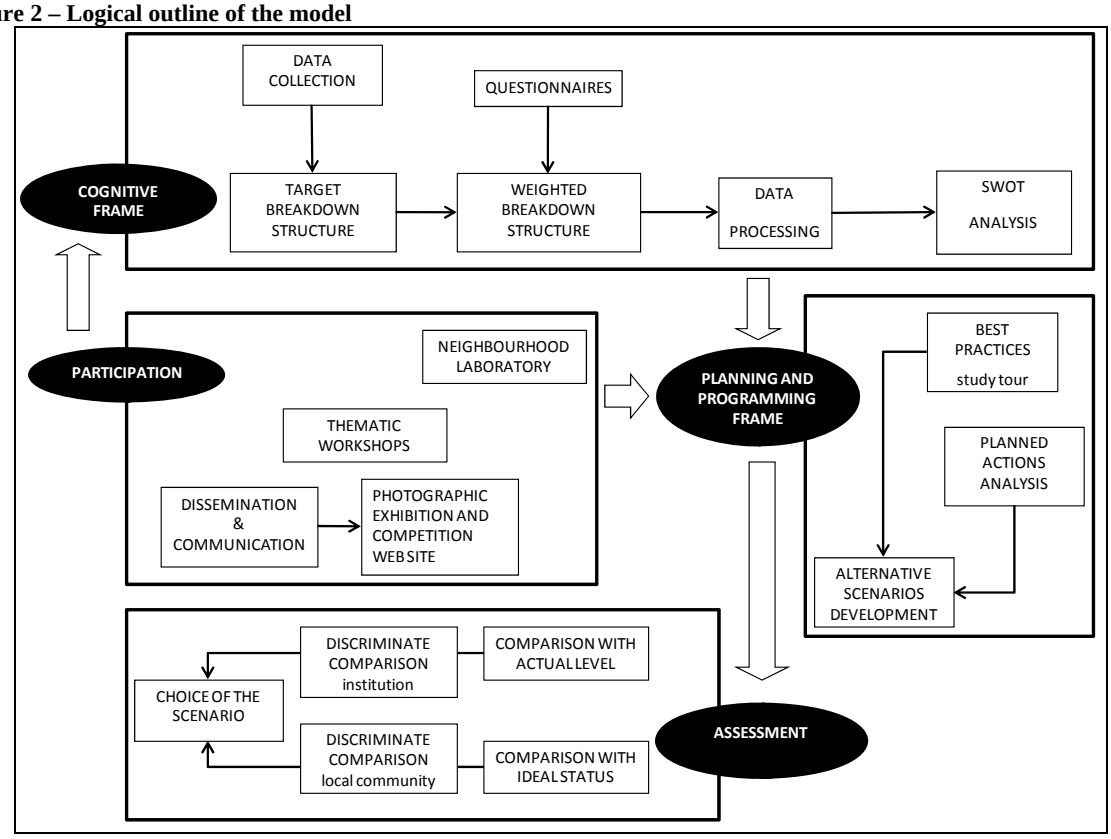
- participation
- planning and programming framework
- assessment

Figure 1 – Assessment conceptual framework



Source:our elaboration

Figure 2 – Logical outline of the model



Source:our elaboration

The individual components of this logical outline are then recomposed into working phases to assure its operability: building the Target Breakdown Structure; measuring the Status quo, defining the alternative scenarios, assessment and choice.

3. Application of the methodology to the theme of the sustainable mobility

Due the fact that the sustainable mobility is today a focus point in the agenda of the development policies, the procedure above mentioned has been concretized in a model which allows for the adoption of common strategies to reduce emissions caused by traffic, such as the development of intermodality, improvement of infrastructure and existent transportation services, also trough improved relations between the various institutional levels.

The conclusions of the Johannesburg Earth Summit (2002) and the recent version of the Aalborg Charter "Charter of European Cities & Towns Towards Sustainability" (June 2004) highlights on the commitments that have to be assumed by the local authorities to develop their territories according to the principles of the sustainability. One of the themes is that one of the mobility:

> *"We, cities & towns, shall strive to improve accessibility and sustain social welfare and urban lifestyles with less transport. We know that it is imperative for a sustainable city to reduce en-forced mobility and stop promoting and supporting the unnecessary use of motorised vehicles. We shall give priority to ecologically sound means of transport (in particular walking, cycling, public transport) and make a combination of these means the centre of our planning efforts. Motorised individual means of urban transport ought to have the subsidiary function of facilitating access to local services and maintaining the economic activity of the city."*

The objective of European sustainable transportation policy is to provide a transport system that addresses economic, social and environmental needs of society. To ensure its own prosperity, Europe must possess efficient transport systems that account for the strong impact that transportation has on economic growth on social development and on the environment. One of the main target is so to prevent and reduce the pollution caused by the street traffic, especially in urban and peripheral areas in a integrated perspective: social, economic and environmental.

Even if the final objective is clear, there is no universally accepted definition of sustainable transport and of the related terms: sustainable transportation and sustainable mobility.

Box 1: Definitions of sustainable mobility

European Conference of Ministers of Transport (ECMT 2004)

A sustainable transport system is one that is accessible, safe, environmentally-friendly, and affordable.

Transport Canada (1999)

"The goal of sustainable transportation is to ensure that environment, social and economic considerations are factored into decisions affecting transportation activity."

Richardson (1999)

A sustainable transportation system is "one in which fuel consumption, vehicle emissions, safety, congestion, and social and economic access are of such levels that they can be sustained into the indefinite future without causing great or irreparable harm to future generations of people throughout the world."

Transportation Research Board (TRB, 1997)

"…sustainability is not about threat analysis; sustainability is about systems analysis. Specifically, it is about how environmental, economic, and social systems interact to their mutual advantage or disadvantage at various space-based scales of operation."

Organization for Economic Co-operation and Development (OECD)

The Environmental Directorate of the OECD defines environmentally sustainable transportation as, "transportation that does not endanger public health or ecosystems and that meets needs for access consistent with (a) use of renewable resources that are below their rates of regeneration, and (b) use of non-renewable resources below the rates of development of renewable substitutes."

European Union Council of Ministers of Transport

A sustainable transportation system is one that:

- allows the basic access and development needs of individuals, companies and society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations;
- is affordable, operates fairly and efficiently, offers a choice of transport mode, and supports a competitive economy, as well as balanced regional development;
- limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise.

Transportation Association of Canada (TAC)

The Transportation Association of Canada proposes that a sustainable transportation system has the following characteristics:

a) in the natural environment:
- limit emissions and waste (that pollute air, soil and water) within the urban area's ability to absorb/recycle/cleanse;
- provide power to vehicles from renewable or inexhaustible energy sources. This implies solar power over the long run; and
- recycle natural resources used in vehicles and infrastructure (such as steel, plastic, etc.).

b) In society:
- provide equity of access for people and their goods, in this generation and in all future generations;
- enhance human health;
- help support the highest quality of life compatible with available wealth;
- facilitate urban development at the human scale;
- limit noise intrusion below levels accepted by communities; and
- be safe for people and their property.

c) In the economy:
- be financially affordable in each generation;
- be designed and operated to maximize economic efficiency and minimize economic costs;
- help support a strong, vibrant and diverse economy.

In the application of the model, among the different definitions has been chosen the one advanced by the Sustainable Mobility Working Group of the World Business Council for Sustainable Development (http://www.wbcsd.org/): *Sustainable Mobility is the ability to meet the needs of society to move freely, gain access, communicate, trade, and establish relationships without sacrificing other essential human or ecological values today or in the future.*

According with this definition has been identified four major challenges;

- reduce carbon emission (CO, CO2);
- build institutional capacity;
- address the problem of traffic congestion;
- reinvent current processes of planning, development and management of mobility infrastructures.

3.1. Building the Target Breakdown Structure

Coherently with the challenges above mentioned that describe in a more detailed way the assessment target, the subsequent phase is the definition of a indicators set in order to describes the phenomenon and able to give a quantitative measure of its value.

To catch this goal has been used a hierarchical framework typical of the Project Management theory (usually known as Work Breakdown Structure - WBS), renamed as Target Breakdown Structure (TBS), that is articulated in themes, subthemes and indicators describing the phenomenon. The first choice of the indicators generally requires an adjustment (by proxies) because of the lack of available indicators, especially when the study is conducted at local level.

The resulting framework in the case of the sustainable mobility (Figure 3) shows 4 policies (or determinants), 16 themes and 25 indicators.

Specifically the four policies identified are:

- accessibility, meaning a transport system that protects and guarantees the right of movement, its accessibility and safety;
- economic development, meaning a transport system mainly oriented to the economic development in respect for environmental laws;
- territory, meaning a transport system that favors "soft" mobility;
- innovation, meaning a transport system oriented towards new research findings and opportunities.

To characterize each element of the framework in a clear and unambiguous manner has to be defined the related metadata that in the case of the sustainable mobility are shown in the Figure 3.

The first version of the TBS (the theoretical version) has to be thus specified according to the available statistical data without modify the original meaning. Where elementary data are no available, specific estimation models could be used to delineate the characteristics of the phenomenon (in particular for air pollution and noise pollution).

To complete the theoretical framework the last step is to define the mutual relationships (vertical relations) between the indicators in order to capture the complexity of the phenomenon. A such evaluation, with classical criteria or with statistical independence tests, allows for the creation of a classic correlation matrix.

3.2. Measuring the "status quo"

In order to get a synthetic measure of the phenomenon the final TBS has to be more specified in terms of relative performance.

In fact if the process stopped there, it would be a simple top-down analysis. Considering that different territorial contexts could have different priority, the methodology foresee to use a weighting process, coherently with a bottom-up approach, to specify the relative importance levels of the different aspects of the phenomenon, trough a sample investigation by means of questionnaires submitted to a population sample on the relevance perceived of the indicators groups above defined. That add a subjective and qualitative component to a objective and quantitative measures.

It must be underlined that to better capture the perceptions of the different stakeholders, the weighting process considered separately the answers of the politicians and of the citizens.

Another point that helps to get relative results, concerns the data collection process that has not be restricted to the target area, but has to be extend to the near local administrative units, which, possibly, also belong to the same vaster study area. To compare the results of the data collection of the set of n areas, these has to be then standardized in a new scale according, for example, to a 0-1 range.

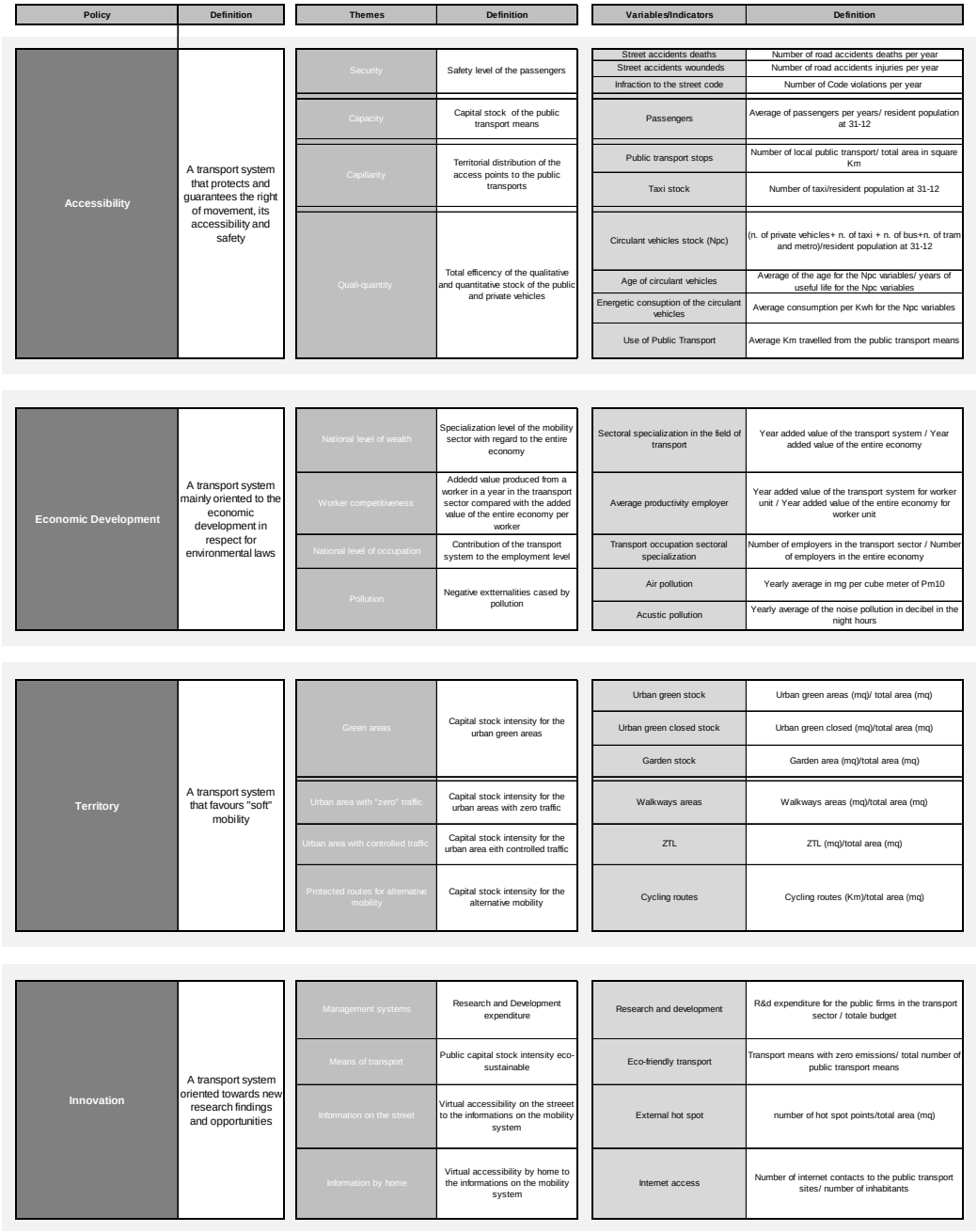
This process leads to the definition of a spatial matrix X_{np}, with *n* indicators and *p* territories and two weight vectors w_1 and w_2 representing the priorities of the generic interviewed subject (politician rather than citizen).

This phase ends with a SWOT analysis (Strengths, Weakness, Opportunities and Threats) that is able to summarize the main issues of the target area in order to be presented in interactive and iterative way to the main territorial stakeholders enriching thus their informative background.

3.1. Definition of the alternative scenarios

An impact assessment requires two fundamental elements: the object of impact and the impacting agent. The first element is the TBS or better, the indicators of the TBS.

Figure 3 – The target breakdown structure (the theoretical version)



Policy	Definition	Themes	Definition	Variables/Indicators	Definition
Accessibility	A transport system that protects and guarantees the right of movement, its accessibility and safety	Security	Safety level of the passengers	Street accidents deaths	Number of road accidents deaths per year
				Street accidents woundeds	Number of road accidents injuries per year
				Infraction to the street code	Number of Code violations per year
		Capacity	Capital stock of the public transport means	Passengers	Average of passengers per years/ resident population at 31-12
		Capillarity	Territorial distribution of the access points to the public transports	Public transport stops	Number of local public transport/ total area in square Km
				Taxi stock	Number of taxi/resident population at 31-12
		Quali-quantity	Total efficency of the qualitative and quantitative stock of the public and private vehicles	Circulant vehicles stock (Npc)	(n. of private vehicles+ n. of taxi + n. of bus+n. of tram and metro)/resident population at 31-12
				Age of circulant vehicles	Average of the age for the Npc variables/ years of useful life for the Npc variables
				Energetic consuption of the circulant vehicles	Average consumption per Kwh for the Npc variables
				Use of Public Transport	Average Km travelled from the public transport means
Economic Development	A transport system mainly oriented to the economic development in respect for environmental laws	National level of wealth	Specialization level of the mobility sector with regard to the entire economy	Sectoral specialization in the field of transport	Year added value of the transport system / Year added value of the entire economy
		Worker competitiveness	Addedd value produced from a worker in a year in the traansport sector compared with the added value of the entire economy per worker	Average productivity employer	Year added value of the transport system for worker unit / Year added value of the entire economy for worker unit
		National level of occupation	Contribution of the transport system to the employment level	Transport occupation sectoral specialization	Number of employers in the transport sector / Number of employers in the entire economy
		Pollution	Negative extternalities cased by pollution	Air pollution	Yearly average in mg per cube meter of Pm10
				Acustic pollution	Yearly average of the noise pollution in decibel in the night hours
Territory	A transport system that favours "soft" mobility	Green areas	Capital stock intensity for the urban green areas	Urban green stock	Urban green areas (mq)/ total area (mq)
				Urban green closed stock	Urban green closed (mq)/total area (mq)
				Garden stock	Garden area (mq)/total area (mq)
		Urban area with "zero" traffic	Capital stock intensity for the urban areas with zero traffic	Walkways areas	Walkways areas (mq)/total area (mq)
		Urban area with controlled traffic	Capital stock intensity for the urban area eith controlled traffic	ZTL	ZTL (mq)/total area (mq)
		Protected routes for alternative mobility	Capital stock intensity for the alternative mobility	Cycling routes	Cycling routes (Km)/total area (mq)
Innovation	A transport system oriented towards new research findings and opportunities	Management systems	Research and Development expenditure	Research and development	R&d expenditure for the public firms in the transport sector / totale budget
		Means of transport	Public capital stock intensity eco-sustainable	Eco-friendly transport	Transport means with zero emissions/ total number of public transport means
		Information on the street	Virtual accessibility on the streeet to the informations on the mobility system	External hot spot	number of hot spot points/total area (mq)
		Information by home	Virtual accessibility by home to the informations on the mobility system	Internet access	Number of internet contacts to the public transport sites/ number of inhabitants

Source: our elaboration

To define the second element a list of territorial policy measures has to be created for the focus area and issue in question. Main actors in this activity will be local governance authorities, contributing to the model with sustainable measures already contained in regional and municipal strategic plans, as well as citizens who will express their priorities trough the neighborhoods laboratories, the forum and all the possible means of communications.

The definition of the alternative actions at this stage can be supported through activities such as workshops of experts, analysis of specific literature, analysis of experiences in other contexts (benchmark analysis), visits to other contexts (study tours).

The activities described above are prerequisite to the evaluation phase.

The scenario is created by using a quali-quantitative logic. Firstly, the impact of a determined action, when implemented, could impact on more indicators (and consequently on more determinants) of the TBS, so has to be build two impact matrices (*n* x *m*, where *n* is the number of the indicators and *m* is the number of impacting actions) according to the different weighting vector defined by politicians and citizenships, that shows the relationship between actions and indicators in order to define the functional relation between actions and indicators. The scenario, as subset of the available actions, impacting the indicators that define the initial state of the system (sustainable mobility), transforms the indicators into receptors, altering them and defining a new system status through the application of the relation (1):

(1) $R_i = f(A_{j\ (j= 1\ to\ m)}; w_{i,k\ (k= 1\ to\ 2)} * I_i)$

where

R= receptor, value of the indicators after the impact of the action
A= policy action
I= value of the indicator
w = weight attributed by politicians (k=1) or citizens (k=2) to the *i*-indicator
i = generic indicator/receptor
j = generic impacting action

The impact of the policy on the entire system finally depends of the correlations (vertical relations) between the indicators, as previously defined. This process allows to produce three different representation of the focus area:

- status quo (hypothesis of zero level or scenario without any news);
- planned scenario (top-down hypothesis or scenario defined by local administrators);
- wished scenario (bottom-up hypothesis or scenario imagined by citizenship);

3.2. The assessment

The main outputs of the previous steps are three different weighted scenarios: actual, whished and planned. These lasts, finally, have to be assess on the base of four comparison criteria:

1) comparison between the “value” of sustainable mobility based on the performance of the actions related to the defined scenarios (ex-post) and the “value” of sustainable mobility in a no-action situation (i.e. the “current state scenario” or ex-ante scenario);

2) comparison between the “value” of sustainable mobility based on the implementation of the actions related to the examined scenario and the “value” capable of maximising the value of the indicators, i.e. the “ideal value” (“non-discriminate maximisation”);

3) comparison between the “value” of sustainable mobility based on the implementation of the actions related to the examined scenario and the value deemed the ideal value for the local/regional authority (“discriminate maximisation”);
4) comparison between the “value” of sustainable mobility based on the implementation of the actions related to the examined scenario and the “value” deemed the ideal value for the community (“discriminate maximisation”).

Particularly could be elaborated concise quantitative judgment, with regard to:

- citizen perceptions of the current states of their district in comparison with several other areas;
- policy makers' perceptions on the current state of their territory of competency in comparison with several other territories;
- redefinition of the new state of the system and a new evaluation of citizens' perceptions following the pro-sustainable mobility activities that were based on their own requests;
- redefinition of the new state of the system and a new evaluation of local policy actors';
- perceptions following the pro-sustainability activities that they planned.

The sustainable mobility model is such that its maximum value for each neighborhood area is equal to 4 for every scenario considered (current state, planned scenario and desired state). Thus, the numerical threshold, equal to 4, also represents the identifiable benchmark of the ideal situation.
Representing the model as a black box in which to input information such as:

- variables of its state (the system of indicators selected to describe the mobility phenomenon);
- perceptions of residents and local development actors (questionnaires and semi-structured interviews);
- possible territorial activities as envisioned by public administration and private stakeholders (citizens' associations and more generally all stakeholders involved in the local forums phase - and with the neighborhood laboratory, in particular);

the output of the model is constituted by a set of values on a scale between 0 (which represent the minimum value) and 4 (representing the maximum value), which constitute a summary evaluation of the state of the sustainable mobility system.

The model moreover allow for a synthetic evaluation of the effectiveness of a scenario, in other words, what we can define is an overall evaluation of the state of the art, as well as a focus on determinants of the system itself, which represent groups of indicators of the information system on which the model is based (in fact, the labels of disaggregated factors represent the groups of indicators of the information system).

Based on this assessment, the local/regional authorities acquires the information for making an informed choice about the actions to be implemented.

4. Evidences from the study case: the sustainable mobility in the XIII District of Rome Municipality

The model above described has been tested on the territory of the XIII District of Rome. To evaluate the citizen opinions on sustainable mobility as defined in the previous paragraph, has been interviewed a questionnaire to a sample of 400 individuals, 200 of which were interviewed at stops along the Roma-Lido train line, while the other 200 were interviewed by telephone. Sample quotas for gender and age group were calculated on the basis of census data for the 13th Municipal district. In addition to the questionnaires for the citizens, a questionnaire was also designed for a specially chosen panel of public decision makers and technical experts in order to compare actual mobility policymaking in the 13th district, with the analysis of responses of the resident population. The objective of this comparison study was to estimate the gap between the public wishes for the future and the policies already planned (or in the planning stages). The panel was formed by figures in the relevant local offices that play a key role in deciding how to implement policy choices which are finally adopted by political decision makers. With regard to citizen opinions it’s to note that the guarantee of accessibility is the main priority for the public, followed by the implementation of innovative systems. The right to movement (accessibility) translates essentially in a greater frequency of public transportation, followed by request for greater security, as it pertains to cleanliness, decorum and public order. In the use of innovative systems, the preferred choice is the investment in eco-sustainable means of transportation and the management of traffic to avoid delays; in third place is the option of investing in informative panels on the streets and on train and metro platforms; and far behind was the possibility of receiving information through the most advanced systems. As far as foot and bicycle traffic, the first priority for citizens of the 13th district was the construction of green areas, while next came the construction of foot paths and finally, in third place was the construction of bicycle paths. The

organization of traffic in ZTL - Limited Traffic Zones, was the least preferred option in the sample interviewed, as it was seen as a mere limitation rather than a solution.

Box 2: Analysis of citizen-types

The analysis of sample data in the 400 interviews depended on an appropriate sampling of both those who use public transport as well as those who mainly use polluting private transport. In fact, it was inevitable to encounter more users of public transport during the administration of questionnaires since those interviewed were contacted on the platforms of the Roma-Lido train line. Given the importance of evaluating the mobility desiderata and opinions on challenges land potential solutions to sustainable mobility, has been used a categorization of the citizens interviewed (unsustainable, intermodal, sustainable) on the basis of their mobility orientation choosing as criterion (specifically stated during the interview) the main means of transport utilized. Among the most common means of transport, those that represent an unsustainable style of mobility are single-passenger automobiles, motorcycles and scooters. For 35.5% of respondents, the automobile was the most frequently-used form of transport; 29.3% use a two-wheeled means of transport. The intersection set of private transport (automobiles and scooters) is limited to 62 cases 115.5%1. while the union set equals 49.25%, or 197 cases. If we consider the least-frequently used means of transport, we see that 22% use their automobile for less frequent trips; while 29.3% use motorcycles as their secondary means of transport. The intersection set of this case is very similar to the preceding one (59 cases), while the union set amounted to 146 cases, equal to 36.5%. This simple operation regarding the most frequently-used means of transport can only be partially used as variable in other analyses. We must clarify that this indicator - denoted ins1 - is still imprecise for estimations of sustainable behavior, because frequent use of an automobile or scooter might easily converge with intermodality strategies which can be considered sustainable behaviors both from environmental and traffic standpoints. To better consider the issue of intermodality we can use a certain symbol to signify sustainable transport (travelling on foot, by metro, train, urban and extra-urban buses, bicycle, in short any means of transport that releases zero emissions or which would emit the same amount of pollutants even if no one took them); no sign (zero) would signify transport that is in and of itself neither sustainable, nor patently unsustainable (such as car sharing or taxis), and finally the opposite symbol to the first combination of the two categories of polluting vehicles (single-passenger automobiles and motorcycles). Addition of the responses of each subject meaning that every case corresponds to single interview subject - will thus yield either positive, negative or neutral values (equal to 0). We would then have a tri-partition (variable ins2) which can easily be the fruit of compensations of polluting private transport, public transport, or for a private citizen who uses private automobile to arrive at the metro (indicating intermodal behavior). Following this reasoning, with regard to data on the most frequent movements has been developed a synthetic indicator of good use to guide a more in-depth analysis. Established in this manner, indicators reveal that 59% of the population has sustainable habits (which does not absolutely preclude a partial use of polluting transport, nor the possession of such transport in the family); 14.5% have mixed habits, thus definable as intermodal; and 26.5% have unsustainable habits, where the use of single passenger automobiles and/or scooters exceeds the use of public and/or sustainable transport.

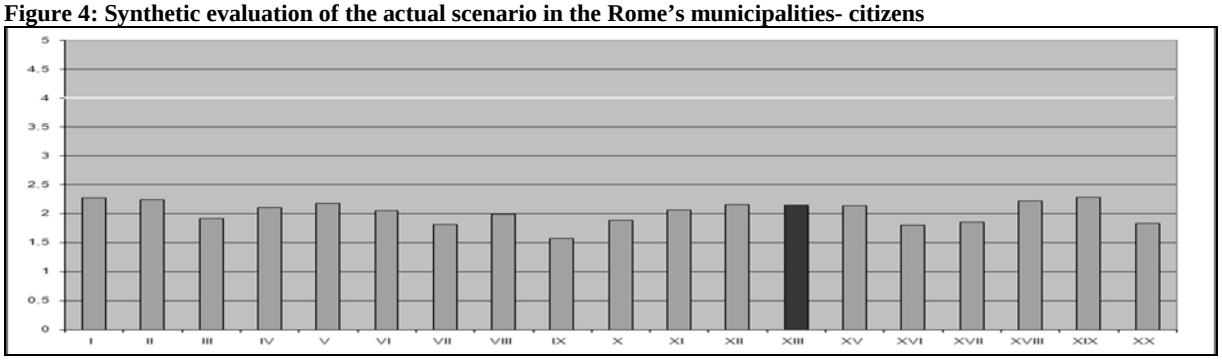
Among the many other findings of the study, it’s interesting to note the overall satisfaction with regard to the transport system and mobility in the 13th District. Taking the arithmetic average of the questions regarding the level of satisfaction (scale of 1-10), the satisfaction with the system of mobility is considerably higher in those with sustainable behaviors, while it is lower by more than 2 points for those with unsustainable habits, with an intermediate position for those labeled intermodal. This result can be interpreted as follows: those with sustainable habits tend to use mostly public transportation and non-polluting vehicles and therefore make their evaluation on the basis of their own life experience. The same observation can be made for those categorized unsustainable and intermodal.

Regarding the implementation of the model in the study case it’s to note that two other activities become entwined. One the one hand, the knowledge of the issues was broadened through study tours carried out in a variety of European cities the aim of which is to bring examples of best practices into discussions and roundtables, gain inspirations and potentially adopt successful solutions once adopting them to local contexts. On the other the creation of neighborhood laboratories (in the specific case called Villemizero Lab), integrating the results

of the study tours, allowed to discuss and define policies and activities to be inserted in a scenario. To standardize the values of the different indicators are used territorial series regarding all the Districts of Rome. Finally the results of the evaluation process of the alternative scenarios on the sustainable mobility system that emerged in Rome's 13th Municipal district following the application of the method has been based on a comparative analysis between the existing state of the focus area, the existing programming framework and the desiderata of the local population. In particular the main results of the model can be summarized in the following points:

1. The overall evaluation of the scenario of the 13th district, as perceived by its residents (Figure 4) and determined by algorithms of the model, is 2.14, in seventh place among the 19 other Roman Municipal districts, where values range from 2.28 in the 19th district and 1.57 in the 9th district;

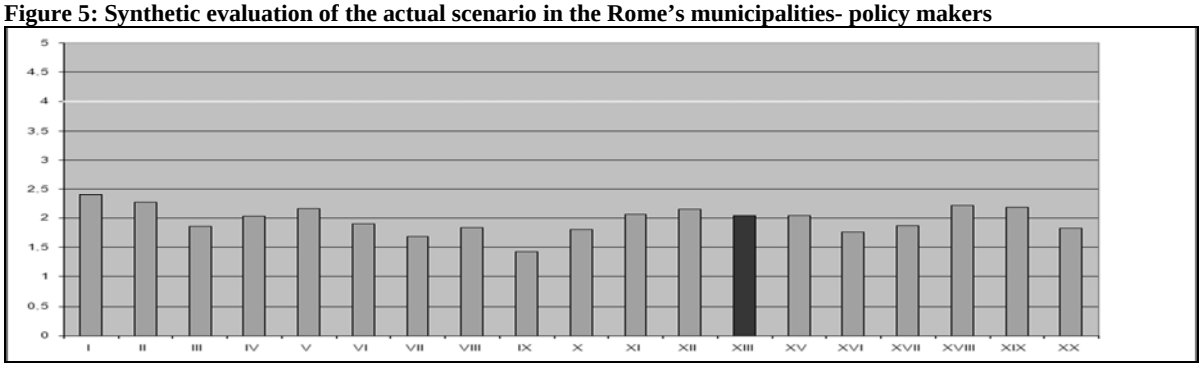
Figure 4: Synthetic evaluation of the actual scenario in the Rome's municipalities- citizens



Source: our elaboration

2. The evaluation of the current state, as perceived by political actors (Figure 5), varies only slightly from the evaluation made by the citizens. The overall evaluation of the state of the sustainable mobility system is equal to 2.04, just below the citizens' evaluation, which puts the 13th district in eighth position among the 19 Roman Municipal districts;

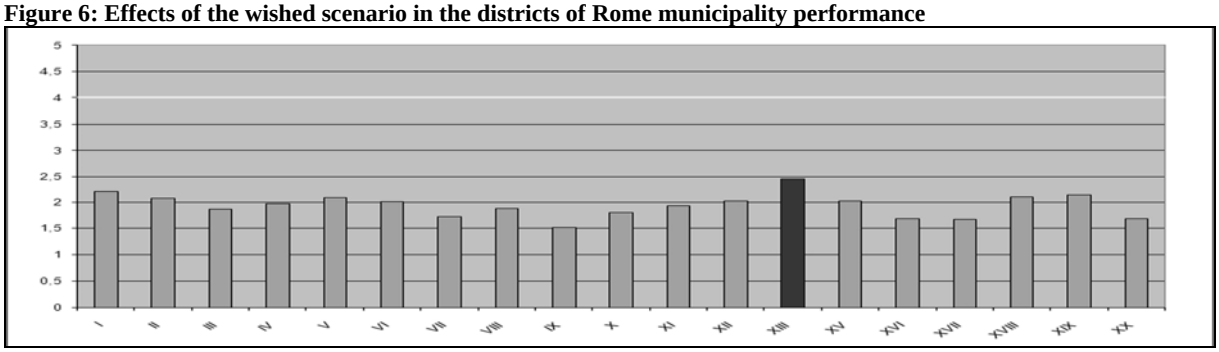
Figure 5: Synthetic evaluation of the actual scenario in the Rome's municipalities- policy makers



Source: our elaboration

3. The evaluation of the scenario related to the impact of the activities desired by the citizens (the wished scenario) earns a value of 2.46. This value moves the 13th district from seventh to first place in the ideal scale of the positions among all Roman Municipal districts (Figure 6);

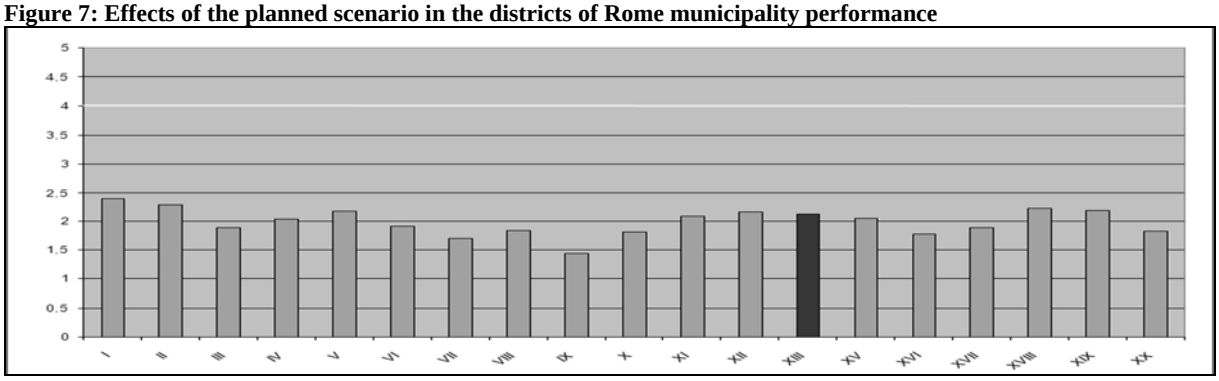
Figure 6: Effects of the wished scenario in the districts of Rome municipality performance



Source: our elaboration

4. The evaluation of the scenario relative to the impacts of the activities planned by local policy makers (the planned scenario) results in a value of 2.11. This value takes the 13th district from eighth to seventh place on the ideal scale of the positions of all Roman Municipal districts, representing only a relative unitary increment greatly inferior, in absolute value and in relative comparison, with residents' perceptions of the new state of the system in relation to their specific requests (Figure 7).

Figure 7: Effects of the planned scenario in the districts of Rome municipality performance



Source: our elaboration

This results highlights as a more participative process could lead to a better results. Finally the evaluation of the different scenarios has been ended analyzing the role of each determinant (accessibility, territory, innovation, economic development) and of each indicator with which the phenomenon of the sustainable mobility has been described, thus allowing better understand on which elements focus attention to maximize the intended effects. In facts, as mentioned, the main aspect of this procedure is to give to decision makers a decision support system allowing a more aware decision.

5. Conclusions

The proposed model does not provide a set of predefined actions in order to solve the sustainable mobility issue and to be used indifferently in various contexts, but rather defines a general procedure, applicable to different cases, that recognizing the particularities of different territorial contexts, allows to yield specific (thus each time different) solutions.

From this point of view the fundamental characteristics of the procedure/model developed, which can constitutes reference to define sustainable mobility projects in different urban realities are essentially:

- the capacity to integrate the desk informations (on and off-line data) with field investigation. Past experience demonstrates the importance of analyses founded on informational inputs from variety of entities (interviews with local agencies and "field experts", from whom obtain useful and accurate information on the mobility situation in the area);
- the creation of a matrix of qualitative and quantitative indicators to ensure the maximum coverage of the multiple aspects of mobility; this matrix essentially includes indicators of stock, use, negative externalities and measures of the innovative character of the initiatives. The breadth of variables included in the informative matrix allows one to choose the available indicators maintaining the integrity of the established procedure;
- the choice to collect data on several different territories - focus area and contiguous territories – allows for the definition of a relative measure of comparison for the various scenarios and thus more clearly rendered the potential strengths and weaknesses in each territorial area considered;
- the involvement of the stakeholders at various levels enhances the final scenario acknowledging not only importance of planned policy activities, but also of the desiderata of the citizens;
- the use of a composite evaluation based on different sources of information (statistical data, questionnaires, etc.) and on the horizontal and vertical correlation between the indicators provides the local territorial administration the necessary elements to define set of specific actions, with a greater awareness of the effects of their choices;
- the dynamic nature of the procedure allows for continual monitoring of chosen solutions, provided that info points (or neighborhood laboratories) remain operational; these facilities thus become vital points of encounter between territorial actors, of information updating and territorial observation.

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