# TeMA

## Journal of Land Use, Mobility and Environment

Cities need to modify and/or adapt their urban form, the distribution and location of services and learn how to handle the increasing complexity to face the most pressing challenges of this century. The scientific community is working in order to minimise negative effects on the environment, social and economic issues and people's health. The three issues of the 14th volume will collect articles concerning the topics addressed in 2020 and also the effects on the urban areas related to the spread Covid-19 pandemic.

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# THE CITY CHALLENGES AND EXTERNAL AGENTS. METHODS, TOOLS AND BEST PRACTICES

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The cover image is Rue de Rivoli - an emblematic street of Paris connecting Bastille to Concorde – that since May 2020 has been reserved for bicycles and pedestrians, Paris, France, Saturday, Nov. 6, 2021.

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# EDITORIAL PREFACE: TEMA JOURNAL OF LAND USE MOBILITY AND ENVIRONMENT 3(2021)

The city challenges and external agents. Methods, tools and best practices

ROCCO PAPA
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Cities need to modify and/or adapt their urban form, the distribution and location of services and learn how to handle the increasing complexity to face the most pressing challenges of this century. On these topics and the ones arisen during the last year, the scientific community is working in order to minimize adverse effects on the environment, social and economic issues and people's health.
The three issues of the 14th volume collect articles concerning the effects of climate change, the ageing of the population, the reduction of energy consumptions from fossil fuels, immigration flows from disadvantaged regions, innovation technology, the optimization of land use and the impacts, in the short and long period, with innovative methods, tools, techniques and practices.
For this Issue, the section "Focus" contains three contributes. The first article of the section is titled "Sustainable urban mobility plan and the electric mobility challenge", by Ilaria Delponte (University of Genova, Italy) deals with the step-wise project of new four trolleybus lines in Genoa, as an initial application of metropolitan "Rapid Mass Transport - TRM" systems in Italy. The authors provide the assessment of the electrification project adopted in the city of Genoa and also the first results from the case-study planning process.
The second article, titled "Co-creation of green smart city concept" by Ewa Łaźniewska, Izabela Janicka, Tomasz Górecki (Poznan University, Poland), discusses the results of a research conducted in the Polish-German borderland region, concerning the ecological maturity of municipalities in 2020.
The last paper, "Mobility scooters in Italy: the reason of a missed revolution", by Giuseppe Cannata, Marialisa Nigro, Concetta Ljoka, Mihaela Murè, Guerino Coluccia, Laura Giordani, Umberto Crisalli, Calogero Foti (Tor Vergata and Roma Tre University, Italy), proposes a classification of mobility scooters as "motor vehicles" for both able and disabled persons and specific regulation of their characteristics and circulation.
The section "LUME" (Land Use, Mobility and Environment) contains five contributions. The first is titled "The River Contract in urban context as a new network of experiences" by Donatella Cialdea (University of Molise, Italy) and Chiara Pompei (Sapienza University of Rome, Italy). The contribution proposes a methodology to compare River Contract applications in European Union by combining considerations related to theoretical issues and practical interventions, carried out on waterways by different natural processes.
The second article, titled "Investigating the side-effects and consequences of the formation of second homes in Alamut rural areas, Central Alborz of Iran" by Reza Kheyroddin, Sepideh Momeni, Mojtaba Palouj, Abdolhadi Daneshpour (Tehran University, Iran) deepens the "second home" phenomenon in the Alamut region in central Alborz of Iran using surveys method from locals and field observation in eight villages of the eastern Alamut area and highlights positive and negative effects.
The third contribution, titled "Public space and 15-minute city", by Antonio Bocca (Gabriele d'Annunzio University, Italy) highlights how urban planning is aiming towards a city model that can be reached 15 within minutes, which promotes the proximity of services on a local scale and the improvement of public space and access to places and activities, thus emphasizing the need to interpret coordinated actions aimed at making our neighbourhoods self-sufficient in the first place.

The fourth article, titled "Characterization of drivers of agricultural land use change" by Akeem Olawale Olaniyi and Ahmad Makmom Abdullah (Kaduna State University and Putra University, Malaysia), proposes a useful method to identify and characterize important factors driving agricultural land use with a view to gain deeper understanding of the process, the drivers, the dynamics and the potential implications for attaining sustainable development in the Malaysian state of Selangor.

The last paper of the section, titled "Logit and probit models explaining perceived cycling motives, barriers, and biking trip generation in Lahore, Pakistan" by Izza Answer, Houshmand Masoumi, Atif Bilal Aslam, Muhammad Asim (University of Engineering and Technology, Lahore, Pakistan; Technische Universität Berlin, Germany; and University of Johannesburg, South Africa), answers two research questions based on the perceptions of the people of Lahore. The first research question addresses the perceived motives of everyday biking trip generation, and the latter addresses the perceived barriers in biking in Lahore.

Finally, the Evergreen section drawing the attention of the international scientific community to papers that, despite the passing of time, still present elements of significative scientific interest – insights, anticipations and reflections – enough to deserve careful read back. The paper - published in Italian in 1995 with the title "La città come sistema complesso in crisi strutturale" as a contribution in the volume Bertuglia, S.C., Fuccella, R. & Sartorio, G. (eds), "La città come sistema complesso in crisi strutturale: strumenti e tecniche per il governo metropolitano", Giuffrè, Milano – is published again in this section of TeMA Journal, Evergreen, in its literal English translation.

The Review Notes section proposes four insights on the themes of the TeMA Journal. The first research "Ecological Transition: innovation in cities", by Carmen Guida proposes an insight into the central role of cities in promoting technological and social innovations to improve citizens' quality of life and trigger a profound ecological transition.

The second research "Resilience as an urban strategy: a comparison of resources and interventions in the European Recovery Plans for the green transition" examines the green transition strategies highlighting the relationship between energy policy and physical and functional organization of urban systems. In addition, the resources and interventions of the recovery plans of Spain and Ireland are examined in comparison with Italy and Germany.

The third research "Toward greener and pandemic-proof cities: policy responses to Covid-19 outbreak in four global cities" by Gennaro Angiello. The section provides an overview of the policies and initiatives undertaken by four major global cities in response to the Covid-19 outbreak: Madrid (ES) London (UK), Brussels; (BE) and Milan (IT). The contribution employs a cross-city analysis to derive a taxonomy of urban policy measures and discusses their effectiveness for the sustainability and resilience of urban communities.

The last research "Sustainable development in cities: a review of frameworks and indexes" is by Stefano Franco. The contribution clarifies the concept of sustainable city from a practical point of view, by describing some of the most widespread framework in defining urban sustainability.

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# Sustainable Urban Mobility Plan and the electric mobility challenge. First results of the planning process in Genoa

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**Abstract**
An increased use of local public transport (LPT) is often proposed as an essential contribution to the overall response to the environmental challenges. The major changes in the urban layout are accompanied by an adaptation of the infrastructural settings, necessary so that the movements can take place quickly, safely and efficiently, following to the main exigencies of its citizens. For this purpose, in accordance with the European Directive 2014/94 on alternative fuels, in Italy, the coordinated action at national level supports electricity and other fuels (such as liquefied and compressed natural gas and hydrogen) as priority fields of interventions for the entire supply of the transportation sector. Aware of the current state of Italian urban mobility, in August 2017 the Ministry of Infrastructure and Transport (MIT) introduced a planning tool dedicated to the 14 Metropolitan Cities, the Sustainable Urban Mobility Plan (SUMP) with the crucial objective of the electrification of "Rapid Mass Transport - TRM" systems. In particular, only TRM interventions that create a zero-emission are eligible for funding. Precisely in relation to sustainable electric mobility, this contribution deals with the step-wise project of new 4 trolleybus lines in Genoa, as an initial application of metropolitan TRM systems in Italy. In the paper, author provides the assessment of the electrification project adopted in Genoa and also first results from the case-study planning process.

**Keywords**
Sustainable urban mobility plan; Electric mobility; Public transport service.

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# 1. Introduction

Reducing private transport and making urban transport systems greener and more efficient has important benefits: for the health, climate and prosperity of cities. Even today, many of the daily journeys depend on cars and other private motorized vehicles, with a strong impact in terms of air pollution, noise and climate change as in the European Union transport is responsible for a quarter of greenhouse gas emissions. Therefore, new models of transport and urban accessibility, increasingly oriented towards environmental sustainability, must be adopted. The issue of urban mobility is a current issue and is particularly important in European countries where over 75% of the population is concentrated in urban areas and, furthermore, in a moment of growing concern about global warming and other environmental problems, an increased use of local public transport (LPT) is often proposed as an essential contribution to a complex solution (Holmgren, 2013; Mugion et al., 2018).

The choice of the transport solution must be made in relation to not only technical but also economic, social and environmental feasibility. Furthermore, the recent pandemic emergency is influencing mobility attitude and modal choices connected with public transportation (Al-Rashid et al., 2021; Campisi et al., 2020; Tirachini & Cats, 2020; EU Com, 2020).

At European level, Commission indicates the subscription of a planning tool, the Sustainable Urban Mobility Plan (SUMP), which explicitly referred to the policy documents of the sector and in particular in the Action Plan on Urban Mobility of 2009, among the priority actions. Many initiatives have already taken by European cities and the scientific literature about is getting more and more solid Europe-wide (Diez et al., 2018; Campisi et al., 2020; Pisoni et al., 2019).

As known, SUMP was defined as a strategic planning tool (Okraszewska et al., 2018) that, over a medium-long term time horizon (10 years), develops a system vision of urban mobility proposing the achievement of environmental, social and economic sustainability objectives, through the definition of actions aimed at improving the effectiveness and efficiency of the mobility system and its integration with the urban and territorial structure and developments. Evidently, mobility integration does not mean only cars and trains, but also commonly used solutions, meaningfully contributing to sustainable urban mobility goals like bike-sharing or park and ride systems (Macioszek et al., 2020; Politis et al., 2020; Nikiforiadis et al., 2020).

It is therefore evident that the traditional approaches to urban mobility are now outdated and with the SUMP a new concept of mobility has been introduced, with more emphasis on the involvement of citizens and stakeholders (Lindenau & Bohler-Baedeker, 2014), on the coordination of policies and planning tools and integration with various sectors: transport, urban planning, environment, economic activities, social services, health, safety, energy, etc. The main merit of the SUMP was in fact that of not promoting the idea of improving transport through the fluidification of traffic, but of putting at the center the quality of life perceived by citizens: in this sense, participation is not just a duty, but focuses on the sphere of values indicated by the citizens themselves, which is in fact detected by surveys in the first phase of SUMP (Maltese & Mariotti, 2011). The SUMP is also a fundamental tool for the integration into urban policies oriented towards the "smart city", supported in the European framework of Sustainable Urban Development. It intends to favor actions to combat climate change, production of clean energy, risk prevention, accessibility with a view to social and economic inclusion, safety and health, entrusting a new role to communities as real actors in urban transformation processes.

Many cities Europewide have already adopted a SUMP, as a coordinate way to organize internal transportation (Mozos-Blanco et al., 2018) but also to be competitive in a wider scene for obtaining UE funds, according to communitarian rules, which strongly suggest to adopt the plan. Around the tool, a meaningful debate arose, too (Niglio & Comitale, 2015; Arsenio et al., 2016; May et al., 2017; Jordova et al., 2021).

The SUMP is a strategic superordinate tool, hierarchically binding in respect to the other planning tools of the transport sector, because it takes into consideration all the needs of the core city and its hinterland, overcoming municipal administrative boundaries.

It is a dynamic tool, not limited to providing a list of interventions but it defines also measurable objectives, types of actions and proposes a program. On the basis of the objectives set, a two-year monitoring process and regular evaluation of the results are activated and, therefore, of the ongoing review of the measures adopted. Best cases can be represented by Manchester, Bilbao, Dresda, Grenoble, to cite a few. In particolar, SUMP Guidelines underlined how comprehensive sustainable urban mobility planning has proven to be an effective way to tackle the climate, energy and environmental challenges that cities face in relation to transport, giving also a greater emphasis on participatory process; in fact, in the document, SUMP concepts were explained to readers who are not necessarily professional planners, but want to understand the principles and basic elements for an active role during the drafting.

The Ministerial Decree 4 August 2017 of the Ministry of Infrastructure and Transport "Identification of guidelines for Sustainable Urban Mobility Plans-SUMP entrusts the Italian Metropolitan Cities with the drawing up their plans, as a condition to have access to State funding. They were specifically devoted to new interventions for Rapid Mass Transport-TRM, such as metropolitan rail systems, metro and trams.

The Decree starts from an assumption: the travel speed of the Italian metropolitan LPT is about half that of the large European metropolitan areas. The Italian anomaly compared to other European countries is especially visible in the undersizing of the rail mobility network (trains, trams, subways): in Italy the number stops at 3.8 km per million inhabitants of the underground network, half of that of Germany and a third of Spain. Therefore, political priority is assigned to the investment in infrastructures which favor electric transition: they must have an impact on the city as to considerably reduce gas pollution, to allow an increasingly decisive modal shift towards collective transport and to justify heavy costs in the long-medium term (Gargiulo et al., 2012; Ghosh & Schot, 2019; Guno et al., 2021; Ryghaug & Toftaker, 2016; Yao et al., 2020; Bakker & Konings, 2018).

The main target areas of this initiative are, as mentioned, the metropolitan cities, because they are places in which pollution levels are most critic. In relation to sustainable mobility in the Italian context, the paper deals with the assessment of the project of new trolleybus lines (as an application of the TRM system) in the Metropolitan City of Genoa, designed in accordance with Ministerial Decree and SUMP EU Guidelines.

Genoa is a densely populated area located at the center of the Liguria coast, where a complex geomorphological situation forces the urban mobility system to be extremely diversified: so that, it is an ideal test-bed for the application of the Italian and European regulatory apparatus in the field of transport of great interest. LPT service has buses, trolley buses, vertical and horizontal lifts, funiculars, racks, underground and marine transport. More specifically, Genoa has the lowest density of cars in Italy, compared to other metropolitan cities and a quite high share of non-motorized internal movements; for that, the increase in the use of the LPT is even more challenging.

The work is structured as follows: section 2 briefly outlines the planning process which boost electric mobility within the Italian context, trying to explain peculiar elements of the "Italian way to transport electrification process" (in accordance to the EU one); section 3 describes the project of Rapid Mass Transport system conceived in Genoa and its SUMP. Sections 4 is dedicated to the process' results and the assessment of the electrification projects adopted in Genoa, while section 5 is devoted to general conclusive remarks where also critical points from the Genoa case are summarized.

## 2. Electric mobility planning process in the Italian context: a brief review

In recent years, many Western European urban public transport systems have undergone major reorganisation. While organisational forms differ between cities, there are common features that can examine as structural changes in urban public transport.

Within changes of this magnitude, *electric traction* is one of the most promising technologies, capable of improving the quality of life in metropolitan contexts, reducing emissions -that alter the climate- and dependence on fossil fuels (Chowdhury et al., 2019; Jorgensen, 2008; Drofenik & Canales, 2014).
The paradigm shift in Italy is not so timely for now: at the close of 2018, with 14,000 electric cars in use, the peninsula ranks among the tail-lights of Europe, even if the technology providers are gearing up to respond to the demand and the tendency to promote electric mobility in urban areas, starting from a not good position.
It is interesting to investigate how and from what basis the introduction of electric mobility is evolving In Italy. Economic and Financial Planning Document (DPEF) of 2016 mentions the major criticalities of the Italian transport system and starts from there to propose solutions.
In particular:

- modal imbalance;
- reduced road capacity;
- insufficient last mile connection;
- reduced accessibility to main nodes.

The Annex of the same Document integrates, in 2017, its objectives and strategies with the analysis of medium/long-term infrastructure needs, identifying interventions and programs of significant national interest: it represents the document of "synergy" between the Italian infrastructure planning and the EU strategies, with which it shares the time horizon to 2030. As far as the completion of the EU Core network challenge is concerned, to better understand the logical steps in the adoption of electric mobility in Italy, a conceptual milestone is represented by the implementation of the EU Directive 2014/94 into the National Decree n. 257/2016. If the shared goal is to mitigate the effects of greenhouse gases and other pollutant components' concentration, the question is how to ensure that this cultural change takes place with the inclusion of everyone and contributes to an increased competitiveness of the transport system of the Country.
The IT Legislative Decree 2016/257 gives the precise definitions of what is meant by alternative fuels and allocates targeted funding to them: according to it, "alternative" are fuels or energy sources which serve, at least in part, as substitutes for fossil fuels in the supply of energy for transport and which can contribute to its decarbonisation and improve the environmental performance of the transport sector. Alternative fuels include:

- electric energy;
- hydrogen;
- biofuels;
- synthetic and paraffinic fuels;
- natural gas, including biomethane, in gaseous form, called compressed natural gas (CNG) and liquefied, called liquefied natural gas (LNG);
- liquefied petroleum gas (LPG).

Furthermore, the Decree instituted the so-called PNIRE (National Plan for the recharging of vehicles powered by electricity), that is finally more specifically related to the electric topic (IT Transport Ministry, 2020).
The National Plan concerns the creation of infrastructural networks for the recharging of vehicles powered by electricity as well as interventions for the recovery of the building stock aimed at the development of the same networks. The Plan supports the policies that incentivize the development of electric mobility by monitoring and / or promoting involvement in the following areas:

- revision of SUMPs;
- participation in European projects;
- involvement of end users through information campaigns and policies sharing of national and regional strategies of the sector.

But not only. Further measures, for the private sector, are:

- development of a national electric charging network, both in terms of quantity and location of the *charging infrastructures*, their characteristics and development trends, including public and private fleets, two-wheeled vehicles and residential areas;
- reference models on which to base the spread of electric charging infrastructures;
- minimum *standard characteristics* of the components of the charging process mainly constituted from sockets and charging methods, communication protocols and forms / tools for accessing infrastructures.

To better implement a dissemination model whose criteria are guaranteed by standards decided at national level, the Decree also establishes the PUN (United National Platform) which therefore has the objective of ensuring, throughout the national territory, uniformity and homogeneity of the information relating to the contents of the National Infrastructure Plan for the recharging of vehicles powered by electricity.

This Platform is exactly in line with the European initiative of DG Move and in particular of the European Electro-mobility Observatory (HyER), which provides for the establishment of a single platform for the control and monitoring of public charging infrastructures aimed at control (for managing bodies) and the provision of information (for end users) as well as integration with mobility policies sustainable to be developed locally and nationally.

Moreover, the National Decree of 257/2016 builds an "ideal bridge" between the PNIRE and SUMPs. This peculiar "graft" of electric mobility plans on SUMPs, in addition to the TRM systems promoted by the 2017 MIT Decree, has ensured that the main "room" in which the national electricity grid (and related services) is developed are the SUMPs drawn up on a metropolitan scale, combining in an overall vision private and public sectors' investments for electrification. Fig.2 shows the archipelago of regulatory references and related policies that make up the peculiar architecture of "sustainable mobility transition in Italy". As better explained in section 3, this "way" was crucial in the case of Genoa transport service design, so that can be considered as a methodological starting point.

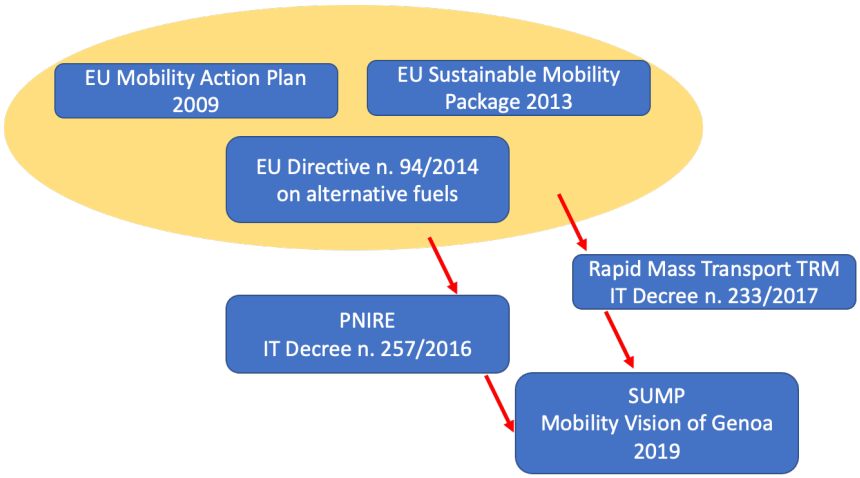



**Fig.1 Main legislative pillars in the EU and IT planning process for electrification of transport sector which lead to Genoa SUMP**

In the PNIRE, there are many national and local measures active in the transport sector and aimed at reducing consumption and emissions. Preliminary estimates about the impact of these measures lead to a total of 12.1 cumulative Mtoe of final energy in the period 2021-2030. These are (Fig.2):

Finally, to fully understand the legislative and planning framework it is still necessary to include a further document which refers to the diffusion of electric mobility: PNIEC - Energy and Climate Plan 2030, which final version of which was released at the end of 2020 (IT Economic Development Ministry, 2020).

The PNIEC foresees 5 lines of intervention - decarbonisation; efficiency; energy security; development of the internal energy market; research, innovation and competitiveness - which should guarantee a 56% decrease in emissions in the large industry sector, a 35% reduction in the tertiary sector and transport and bringing the share of energy from RES in Gross Final Energy Consumption to 30%.

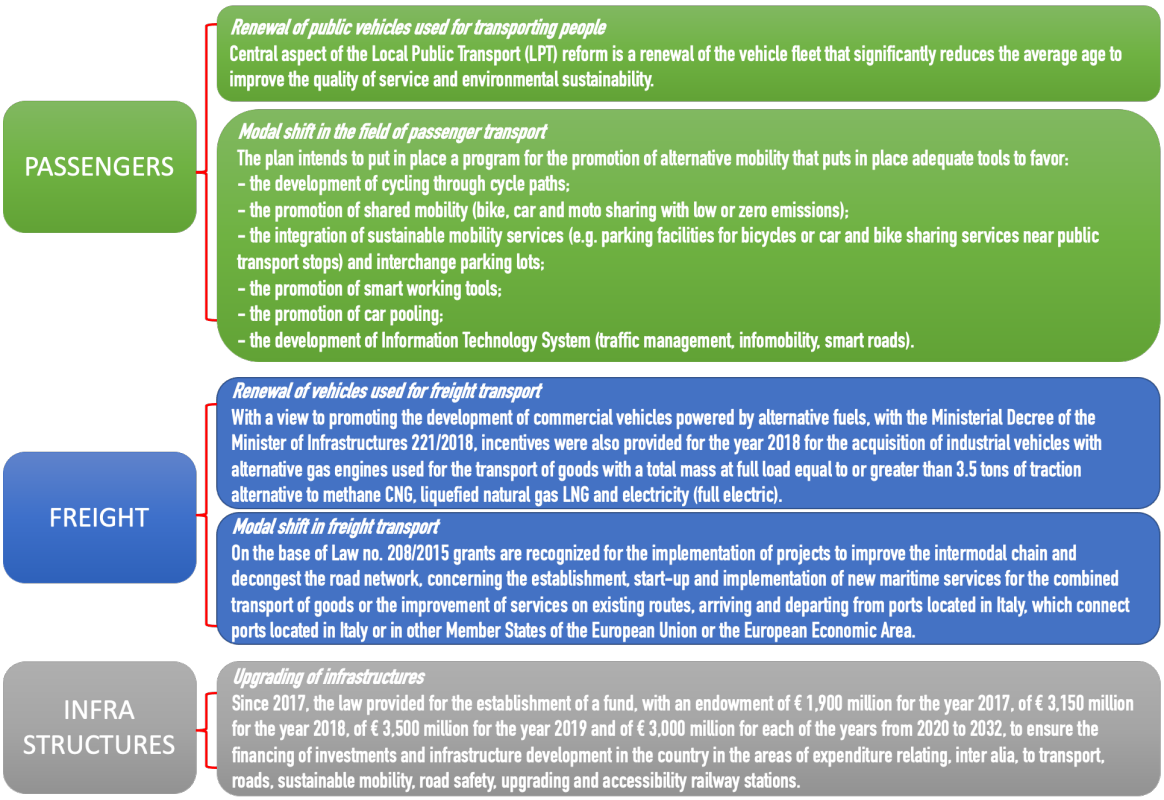



**Fig.2 List of measures contained in PNIRE (Piano nazionale infrastrutturale per la ricarica dei veicoli alimentati ad energia elettrica, 2020)**

Italy intends to accelerate the energy transition from traditional fuels to renewable sources, promoting the gradual abandonment of coal for electricity generation, in favor of an electricity mix based on a growing share of renewables and, for the residual part, on gas. The document states that the realization of this transition requires the planning of the plants' replacement and the construction of necessary infrastructural network.

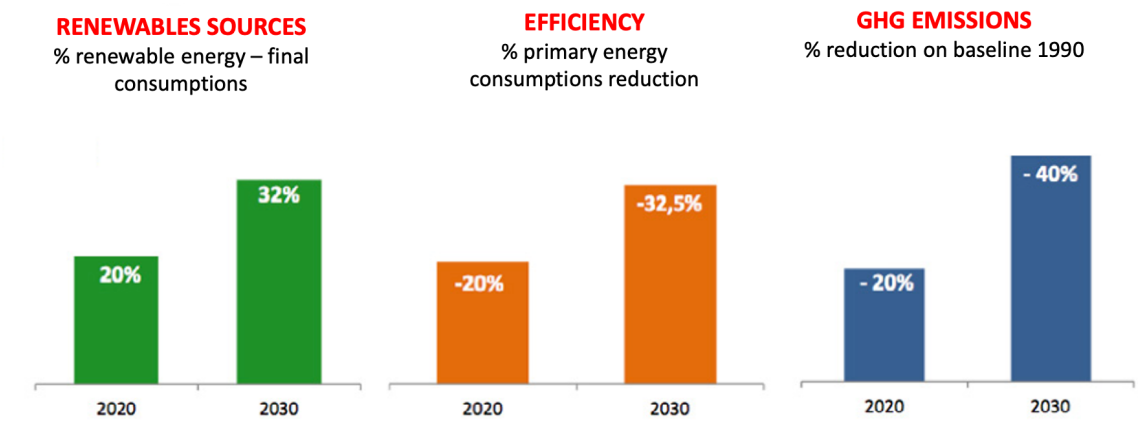



**Fig.3 PNIEC - Energy and Climate Plan 2030 Reduction Goals (Source: elaboration from PNIEC, 2020)**

According to the PNIEC's objectives -which targets are represented in Figg.3 and 4-, the power generation park undergoes an important transformation thanks to the objective of phase-out of coal generation by 2025 and the promotion of the extensive use of renewable energy sources.

The increasing contribution to the renewables derives from the growth of electricity sector, which by 2030 reaches 16 Mtoe of generation from RES, equal to 187 TWh. The strong penetration of renewable electricity production technologies, mainly photovoltaic and wind, allows the sector to cover 55.4% of Gross Final Electricity Consumption with renewable energy -all sectors-, compared to 34.1% in 2017.

| Trajectory of Renewable Energy Sources share in the Transport Sector (recorded and projected) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
| 4,6 | 5,6 | 4,8 | 4,3 | 5,7 | 6,5 | 5,5 | 6,7 | 7,8 | 8,9 | 9,9 | 11 | 12,1 | 13,2 | 14,4 | 15,8 | 17,2 | 18,6 | 20,1 | 22 |

**Tab.1 Increase of Renewables in energy consumptions in the Transport Sector (recorded and projected)**

This last objective is directly linked to the SUMPs and attributes to this kind of plans the driver role in the planning process, both from the transport and environmental point of view.

## 3. The project of the trolleybus lines in Genoa: materials and methods

In this paper, the materials and methodology refer to what has been done in the planning process of the city of Genoa, as a reference example for the planning of sustainable mobility supported by the Directives.

Genoa adopted its SUMP in August 2019, after a long period of discussion around alternative solutions for a better mobility in the city. Focusing on the case-study, Genoa is a densely populated area, but only 30% anthropized: the rest of the municipal area is not accessible and is covered by uncultivated vegetation and is characterized by steep slopes.

Evident is the morphological uniqueness that characterizes the city: it is precisely this complexity that forces the urban mobility system to be extremely diversified. In order to meet passenger demand, the LPT service has buses, trolley buses, vertical and horizontal lifts, funiculars, racks, underground and marine transport. These factors significantly affect the way people move around the city. In fact, the data reported on the Municipality of Genoa show how the rate of use of LPT by residents is 32%, a rather high percentage for the Italian scenario and also the share of non-motorized internal movements, i.e. on foot or by bike, is 22%, an extremely high score for a city that is not exactly flat, third only after Turin (32%) and Bologna (28.2%) in which the contribution is made by bicycles, not by pedestrians. However, an emblematic data for Genoa is the density of cars (car fleet per 1,000 inhabitants) of 492.94, the lowest compared to other metropolitan cities.

Starting from an accurate knowledge of the territorial contest, basically the SUMP of the Metropolitan City of Genoa proposes 4 LPT "core routes" (mainly on a dedicated lane) that unfold on the municipal area, intercepting the most important directions of city mobility, as showed in Figure 5. Then, it, leveraging on "mass" transport and on speed and punctuality by ensuring the protected lane along almost the entire route. Basically, the SUMP prioritizes LPT over private transport, intercepting the greatest number of users on the entire area.

Considering the experiences underway in other European cities that are dealing with the same problems and the same SUMP tool, it can be noted that Genoa, through its transport vision, is in line with the major European cities, reaching a hypothesized target of pollution reduction within a range of 5-10%. However, differently from other cases, Genoa has not focused its strategy of change either exclusively on the technological upgrade, nor on the push to intermodality, nor on the realization of missing infrastructures. It proposed an organic idea in which the design of the new public transport framework did not concern a particular aspect or place, but reached all the places of greatest demand, promoting a strategical and not a tactical approach. This fact underlines once again that the focus is on the quality of life of metropolitan citizens and not only on the technical choice of a particular technology.

At this point, however, the technological choice of "how" and "with what" to equip the lanes arises: Genoa decided to invest, according to the SUMP objectives and the TRM funding, in the building up of 4 trolleybus lines in reserved lanes, as an infrastructural intervention that best matches the urban situation.

The goal was to realize a set of axes (therefore not a single line, like Bologna, Firenze, Brescia proposed), but using a less impactful technology from the point of view of times and costs. With the same investment, it would have been possible to build a tramway, but only along 2 lines and not 4. The "systemic" choice was the crucial point on which the political and technical side of the research team involved found a meeting point.

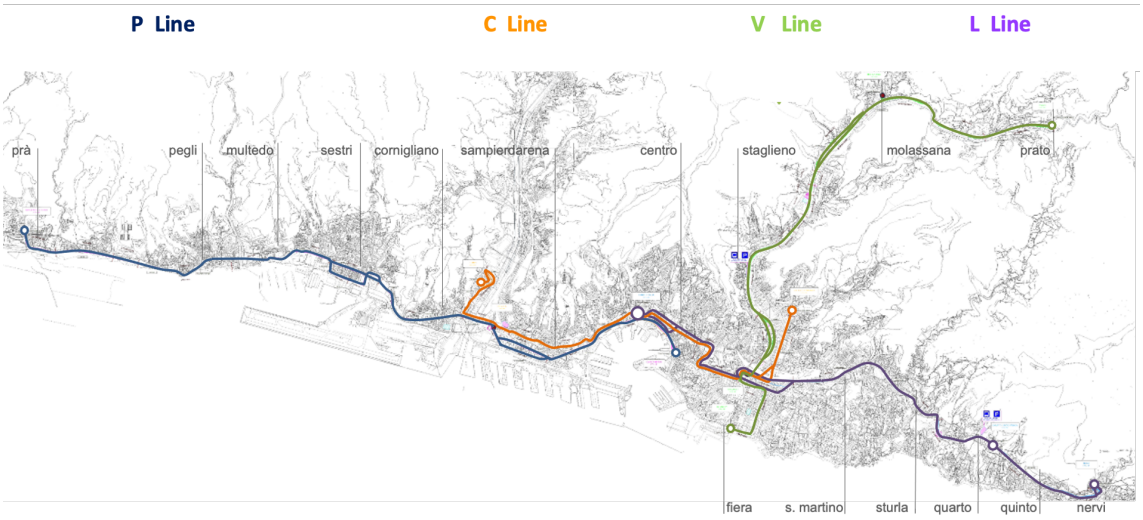



**Fig.5 Map of the 4 priority LPT lines (P, C, V, L) crossing all districts of Genoa conurbation (Source: elaboration from SUMP 2019)**

The target is to achieve, in the long term, the official type approval of trolley buses on three carriages, 24 m. long, already present in other countries of Europe but which in Italy currently cannot circulate. In this sense, Genoa acted as a frontrunner: the pushing force of Municipality and Liguria Region contributed decisively to the circulation permission to the 24m long buses, accorded by the Ministry in 2021.

Specifically, the LPT lines must have characteristics of high hour capacity (3000 pax / h per direction) and excellent interconnection with the rest of the public network (train and metro), with private traffic (interchange parkings with cars and two wheels). In addition, in support of the design of the 4 lines, an overall rationalization of the city LPT supply will also be carried out, with reorganization of the hilly lines, in addiction to priority axes. In this regard, it should be noted that the technologies existing to date, capable of providing a reliable, punctual service (and electrified) are numerous and in continuous evolution.

The solutions considered valid today could quickly lose their competitive advantage with the arrival of new decisive improvements in the offer of new vehicles and infrastructure. In order to be able to evaluate the different alternatives offered by today's market, a multi-criteria evaluation[1] was used in which the construction of an "all trolleybus", "all tramway" and network organized on "thermal buses" scenarios were compared (on 15 selected criteria). The results show better advantages - not only economic - in the choice of trolleybus (Hamacek, 2014; Mwambeleko et al., 2015; Borowik & Cywinski, 2016): a simplified comparison between tramway and trolleybus is reported in Figure 6. The "thermal bus" scenario was immediately set aside as it cannot be financed as TRM.

The complete conversion of all urban public transport to electric traction will represent, in the near future, the most visible sign of sustainable urban transformation and, at the same time, will drastically reduce air and noise pollution (Pisoni et al., 2019); but the Plan provides a gradual conversion of collective urban transport to electric traction. The next generation of buses will be predominantly electrified.

The technologies for recharging and storing electricity are rapidly evolving. Currently, if the relatively low volume of traffic does not justify the infrastructural cost of a power supply such as the overhead line (catenary), the most important alternatives are:

- the night-time or fast-charging electric vehicle;

[1] Criteria used for the evaluation were: costs of investment, times of realization, impact in phase of construction site, urban redevelopment involved sites, impact on management, minimum frequency in operation, capacity of vehicles, distance between stops, travel comfort, impact on the city centre, impact on the roads hierarchy, environmental benefits, interactions with the ordinary roads (overlapping), flexibility of the management, intermodality ed expandability.

- the "classic" hybrid vehicle (thermal engine and electric motor);
- the plug-in hybrid (the electric motor can operate either by a thermal engine or by a rechargeable battery).

In the Genoese metropolitan area, the Plan assumes the gradual replacement of the entire fleet by 2025 (reference year is 2019). At present, the replacement of the existing fleet can be around 500-550 vehicles. The replacement must therefore be gradual and prudent, for obvious financial reasons (operating costs), and in order not to expose the transport company to high risks due to rapidly evolving technologies. These aspects will be studied in depth in the following stages of elaboration of the SUMP and during its biennial monitoring process which is expected for the end of 2021.

For better organizing the electric transition and providing a structured manner to control results of strategic choices, SUMP procedure implies the building up of a set of scenarios in which alternative solution are represented and evaluated by a traffic simulator (Lindenau & Bohker-Baedeker, 2014).

These scenarios must include an economic-financial plan that supports their programmatic sustainability in terms of investment and management costs. Each alternative has to be evaluated with respect to the "reference scenario", which includes all the interventions under construction or already financed, which will be completed within 2028.

The identification of the best scenario has been carried out through the comparative assessment of the economic, financial and managerial sustainability of the proposed interventions and the synergies generated by all the strategies implemented by the SUMP. The way in which strategic options affect performance, scope, safety, investment costs, operating/maintenance costs, urban planning and aesthetic impact depends crucially on ongoing and rapid technological evolution. The comparison between different transport systems must therefore take these aspects into account.

In particular, the SUMP of the Metropolitan City of Genoa presents 3 alternative scenarios -modal shift performances are showed in Fig.7- which, starting from the comparison with the reference scenario by means of a core of selected indicators, allowed the identification of the selected scenario.

- Scenario 1 includes the almost complete list of interventions considered as a priority by the Administration. They include both works to be developed in the capital and in the metropolitan area and refer to multimodal actions (LPT on rail and road, private traffic, pedestrian and cycling, sharing and pooling) and intermodal ones (interchange parking lots, LPT terminals organization) (see Fig.8).
- Scenario 2 presents the same interventions as scenario 1, but with the exclusion of the LPT lines of Center C and Ponente P. This scenario was constructed in order to assess the impact on the total of the sole two lines and to verify the added value resulting from the synergy of the LPT system if fully realized.
- Scenario 3 proposes the construction of the 4 lines, but unlike scenario 1, it does not consider new interchange parking lots in the metropolitan area, an essential part of the mobility system. Scenario 3 was built to identify the contribution of the interchange system of the metropolitan area and to evaluate the differences between its actual and non-realization.

The little difference among scenarios is due to the strategical vision adopted which was articulated in many aspects: the scenarios showed that if a tessera of the mosaic is changed, the same benefits that would be obtained with synergistic actions could not be achieved.

The scenarios differ from each other not so much in terms of number of interventions, but they intend to simulate, on the one hand, the contributions of each intervention on the overall system, so that to provide elements for the political decision.

## 4. First results: electric mobility choices and scenarios assessment

Genoa started its planning process just after the legislative update reported in section2. According to that, the electric mobility "architecture" of Genoa is substantially composed by the TRM system, equipped with

trolleybuses -for the public sector- (and financed by MIT, according to 2017 Decree) and by the investments for the construction of recharging infrastructure -for the private sector-, as envisaged by the Government in the PNIRE.

Focusing on public transport service, two important motivations in support to the extension of the LPT lines along the coast (L, P, C) and the principal valley (V) are confirmed in the Regulatory Master Plan of the Municipality of Genoa: first of all, the morphology of the conurbation which implies the river implies a high population density (about 300-400 inhabitants per hectare), with a road network converging on a single direction "west-east". Secondly, the importance of a reserved LPT lanes, characterized by a high users' attractiveness, which is therefore considered as the ideal solution to satisfy significant amounts of demand.

The technological choice on the type of vehicles used and their characteristics was not trivial and accompanied by a broad citizen debate and a careful evaluation of the various solutions.

As known, trolleybus systems are based on the use of electrically-propelled road vehicles (Brunton, 1992), which are powered by an electrical energy distribution infrastructure. Generally, the collection of electricity takes place through electrical conductors by means of devices called "trolley rods" or "collection rods".

The trolleybus network has the following advantages:

- it integrates the existing trolleybus section in the city center (C), which, however, will need to be improved by implementing, where possible, further portions of reserved lanes;
- it takes full advantage of the existing axis in the eastern part of the city (L), minimizing the impact during the construction phase in this portion of the city;
- allows a high flexibility in operation.

Furthermore, the implementation of the routes dedicated to LPT crosses prestigious squares and boulevards, connecting them in a branding new way, as an important landmark for urban regeneration actions.

The overhead line consists of a two-wire: it is a double wire hung by a system of tension cables that allow the overhead line to remain in the assigned position even under the strain of its own weight or other climatic conditions, such as the presence of wind. As known, the need to have a two-wire and not a single wire, as occurs in trams or trains, derives from a question of the composition of the electrical supply circuit system. In fact, vehicles such as trams or railway engines have a circuit formed not only by the overhead line, but also by the metallic track with which they are in contact via the wheels. In the case of a trolley-bus, this is not possible because the line does not has rails.

The overhead line is positioned at a height of about 5-6 meters from the roadway, so as not to hinder the normal circulation of other vehicles (such as trucks or vehicles with particular vertical protrusions) and to ensure greater safety of the entire plant.

The definition of a trolleybus, as it was introduced before, has been undergoing a transformation of concept in recent years, abandoning the close link with the term "wire", towards new innovative technologies in the field of sustainability and environmental protection.

For now, the regulatory reference is the Italian Decree no. 238 of 10/07/2003 "Provisions concerning the homologation procedures for trolleybuses for the transport of people" (IT Dec., 2003), which contains rules to which new trolleybuses and those still in use must refer and, where missing, adapt to the current law.

The selected technical solution for Genoa was the "In Motion Charging-IMC" Trolleybus System (Wolek et al., 2021), a system with free-driving cars all electric, able to travel up to 45% of the route without power supply from overhead contact line (the above mentioned two-wire system). According to Bartłomiejczyk (2017), point-to-point contact charging or induction charging at the station or stops are the two most common systems for charging electric buses, but they extend the stopping: the alternative which combines the advantages of trolleybus transport and of electric buses is to charge vehicles in motion: the main supply source are traction batteries and the charging is performed in motion, without the necessity of stopping the vehicle. This system allows short realization times with a medium-low impact in terms of possible inconvenience during the construction phase. When fully operational, it allows sufficient frequencies, compensated by the absence of

constraints on the distance of the stops and a high flexibility. Positive is the physical impact of the system (visual of the overhead line where present, practically no impacts due to noise and vibrations) and interactions with the ordinary roads (no rails) and good travel comfort.
As for investment costs are concerned, the trolleybus solution is decidedly inferior to the other technological options and high possibility of both integration with other systems and expandability later in other directions. The economic framework provides, as a first approximation, an amount overall equal to 450-500 million / euro.

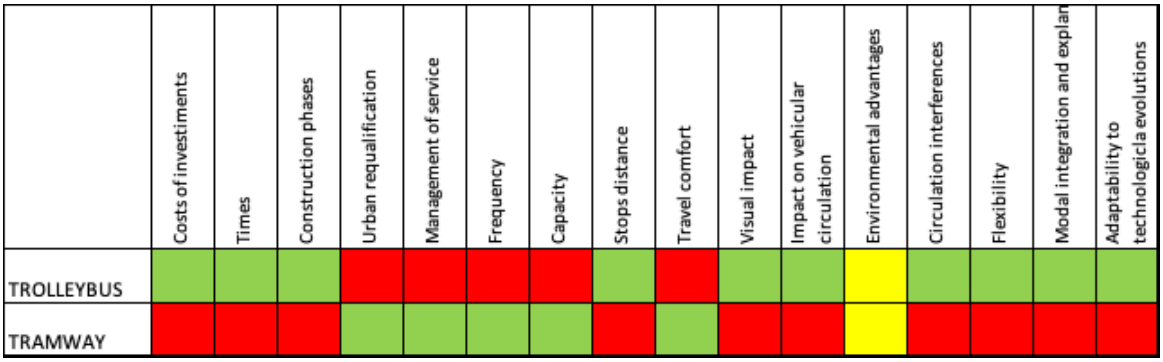



**Fig.6 Performances of tramway and trolleybus, in an intuitive comparative framework (Source: PUMS, 2019) Legend: reds are the disadvantaged aspects of the solution, greens advantaged ones**

As shown in Fig.8, scenario 1 shows comparatively better performing modal share than alternative scenarios. In the table, it is also possible to appreciate the improvement compared to the reference scenario "business as usual" to 2028 (scenario 0). In this regard, scenario 1 demonstrates a strong acceptance of citizens: the scenario proposes a strong identity, clearly characterized and complete in all its parts, in accordance with the strategic guidelines of the Administration and the results of the participation process.

| Modal Share | 0 Scenario (business as usual) | 1 Scenario (all interventions) | 2 Scenario (without P and C lines) | 3 Scenario (without interchange parkings) |
|---|---|---|---|---|
| % cars | 44.8 | 39.4 | 40.6 | 40.5 |
| % LPT | 25.4 | 31.4 | 30.0 | 30.3 |
| % bike or foot | 23.2 | 23.2 | 23.1 | 23.0 |

**Fig.7 Comparison among performance indicators related to Reference Scenario, Scenario 1, 2, 3**

Moreover, for the scenario 1, the benefits that can be quantified through the simulation show, with respect to the reference scenario:

- an increase in local public transport users of approximately 52 thousand people / day (+ 22.5%);
- a reduction of over 511 thousand km / day in private journeys.

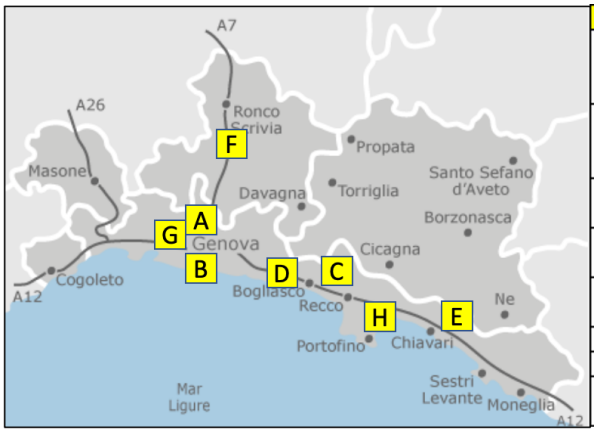
These forecasts allow to estimate the following environmental effects:

- a decrease in $CO_2$ emissions in public transport estimated at about 8,700 tons per year1 with consequent savings in external costs of the order of 780,000 euros per year;
- a decrease in polluting emissions in public transport with consequent savings on external costs of the order of 87,000 euros per year;
- a decrease in noise emissions in public transport with consequent savings on external costs of the order of 450,000 euros per year;

- a decrease in $CO_2$ emissions resulting from the reduction of kilometers traveled by private vehicles, estimated at about 15,000 tons per year with consequent savings on external costs of the order of 1,350,000 euros per year;
- a decrease in polluting emissions resulting from the reduction of kilometers traveled by private vehicles, with consequent savings on external costs of the order of 750,000 euros per year;
- a decrease in noise emissions resulting from the reduction of kilometers traveled by private vehicles, with consequent savings on external costs of the order of 2,300,000 euros per year.

Estimates are based on the Handbook on external cost of transportation, available at the link of DG-MOVE, MOVE Directorate-General for Mobility of the European Union (EU Com DG Move, 2014).

To sum up, considering the inevitable uncertainty existing in the external cost estimation models, it can be concluded that the benefits for the community generated by the implementation of scenario 1 are in the order of € 5.7 million per year.




| MAIN INTERVENTIONS SCENARIO 1 |
|---|
| A) extension of the Brin-Brignole underground line with the construction of three new stations; to the east: Terralba; to the west: Pallavicini and new Corvetto station (LINE "M") |
| B) four axes of force of the TPL electrified: VB, C, L, P large interchange car parks (Levante, Val Bisagno, Sampierdarena, Val Polcevera, Ponente) |
| C) new interchange car park in Recco near the A12 exit new interchange parking near the Rapallo tollgate A12 |
| D) new interchange car park near the railway stations of Bogliasco and Pieve L. |
| E) new Chiavari / Carasco interchange car park new Cogoleto interchange car parks |
| F) new interchange car parks in Busalla and Ronco Scrivia |
| G) TPL connection Erzelli's technological hub |
| H) TPL Rapallo - SML - Portofino realization of networks for urban mobility infomobility interventions |

**Fig.8 List and map of the main interventions of Scenario 1 (dark grey: Genoa Metropolitan Area)**

## 5. Discussion and conclusions

What can be seen from the significant example of Genoa is that a TRM system, that constitutes the general architecture of public transport influences the modal choice and generates effects from the point of view of vehicular congestion and - above all - from the point of view of concentrations of harmful gases, which was the main ambition of the Alternative Fuels Directive. As told in the paper, the planning of sustainable mobility through a dedicated tool, such as the SUMP, strategic, updatable and common throughout Europe, is certainly a positive aspect in urban governance, as well as being a point of comparison between the different experiences of European cities.

The capacity of Genoese governance was to have correctly interpreted the process of SUMP (as a strategic element of the city and not just as a sector plan), and to have it correlated with the opportunities offered by national funding. Often, especially in terms of energy planning, these elements are reported as conflicting, especially for electricity and the use of renewables (about, see Joint Research Centers publications).

Considering the initial application of a metropolitan TRM system in Genoa, first elements of discussion can be shared, in order to support urban policies' applications that are still reflecting on their electric transition model (or developing it):

- for a successful planning, capable of being effective in responding to the electric mobility challenge, a commitment is also required in setting up a series of boundary conditions that can favor the change of the mobility paradigm, as all international policies in the field hope. A systematic approach to electric mobility, testified by the union of European Directives and National Plans as PNIRE and PNIEC, is very important, but it must also be inserted within a city vision that involves other related aspects. In this perspective, SUMP is crucial to implement policies to a lower scale;

- taking into account practical implications, the increasing public service and electric private mobility systems encourages sharing mobility and puts the user in a position to have other needs: for example, knowing the localisation of recharging points and the time needed for it. For this reason, it is essential to advance the design of the electrification of the LPT lines, in parallel with the application of the concept of MaaS (Mobility as a Service) which provides information and integrates the services to users. This also involves a parallel evolution of the ITS (Information Technology System) architecture;
- as showed, the traffic simulation is quite central in the assessment of the benefits generated by the selected scenario and its results claim to strongly guide choices. Nevertheless, the results obtained through the simulation are only one of the parameters used in the SUMPs Guidelines and contented in the National Decree. This means that, even today, the plan objectives are usually focused on the fluidification or mitigation of congestion and not, for example, on the number and surface of urban regeneration spaces that such a transformation brings with it. In other words, the parameters not deriving from the simulation are in any case considered but are not considered rights: that is, the final decision is not played on them;
- nevertheless, it must not be forgot that the lowering of the concentrations of polluting emissions and greenhouse gases also passes through the reduction of the demand for vehicles' parking and therefore how the planning of quality cycle-and-pedestrian routes encourages the demand for sustainable mobility (which is currently growing all over the world). These long-term objectives place SUMP within the most innovative actions carried out by metropolitan areas in favor of sustainability and attribute to it a pivotal role from the point of view of strategic planning;
- the results of a plan such as the SUMP cannot be parameterized only through the reduction of emissions: to change the face of the urban mobility system, other improvements and innovations are clearly needed and this is only the first step. This opens up new spaces for discussion on other solutions that have only been hinted at in this paper and which constitute just as many new directions of investigation and research.

To briefly report main points underlined in the paper, the great originality of the Genoese choice in the drafting of its SUMP were:

- the attention paid to the city context, such as described in section 3, and focused on mobility attitudes (strong propension towards LPT, difficulties in infrastructures building up, consolidated tradition in pedestrian mode for interchange,…): starting from the social terrain is a good point for successful initiatives that have solid acceptance; in this case, the design of the 4 LPT lines sounded on this robust base, so that to facilitate ecological transition and urban transformation but according to shared social assumptions;
- the overall design of an interconnected network of service, which is not linked "a posteriori" but conceived "a priori" as unitarian; the 4 lines were thought as a unique system like a skeleton in which all other modes are added. The strong meaning attributed by the SUMP strategy to the public service wanted also to induce a mind-shift, limiting the demand of private cars;
- as reported before, the SUMP Guidelines stressed a lot on the strategical contents of the plan; nevertheless, SUMP is considered an "enlarged Traffic Plan": that strategical orientation is sometimes neglected or juxtaposed. In this case, the choices are derived by a unique methodological choice: not to invest in single interventions, but in a general revision of the LPT network, which is be able to reach important ecological targets, expected by the metropolitan population and demonstrated by the computer-science simulation of congestion and pollution production;
- the SUMP is not centered in a technological choice, but in a strategy that can be supported -at this particular stage- by a functional way of transport. The choice of the electric buses is related to the boundary conditions (accessibility to funds, market, technicalities, competences) but the technological

choice is not considered as the unique solution; actually, the trolleybus were selected from their flexibility and because they allow Administration to equip the LPT lines in a different way, if conditions were to change;

- Genoa followed the strategy carried out by PNIRE and TRM systems orientations, in order to think about the transformation of the urban area from the mobility point of view. Metropolitan governance did not ground on its own perspective to build up a new vision, but follow the Italian way to ecological transition, giving also a contribution to it as a frontrunner (in many aspects, as the often used expression "Genoa Method" contributes to underline). In this sense, it is a best-case not only from the transport point of view but also from the multilevel governance angle.

The present article therefore intended to show a practical application of electric mobility planning at a local level, in accordance with the regulatory framework, whose decisions have been illustrated and argued. It revealed how both the current moment of great economic support for ecological transition, and the consideration of the geographic constraints of the place, were the "guide" for the realization of an all-encompassing project.

The urban transport planning, in fact, nowadays cannot ignore urban regeneration as one of the main challenges that all cities in the world have to face: the need of conversion of ex-industrial spaces that quickly become inadequate and obsolete, the simultaneous creation of "full spaces" in which urban expansion is concentrated and that of "empty spaces" in which it progressively goes towards depopulation and decay, the modern "design for all" policies that largely involve the transport systems' project for an increasingly accessible and inclusive city.

Transport planning will increasingly have to go hand in hand with the urban regeneration of metropolitan cities to be truly effective: the merge of these two aspects - although desired by many - is not so taken into consideration by current research. In this sense, this vision that brings the two elements together in an effective way - and not only programmatic - will clearly be a very prosperous line of research in the future, in accordance with the goals of Agenda 2030.

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## Image Sources

Fig.2: Elaboration from PNIRE (Piano nazionale infrastrutturale per la ricarica dei veicoli alimentati ad energia elettrica, 2020);

Fig.3: Elaboration from PNIEC (Piano Nazionale Energia e Clima , 2020);

Fig.4: PNIEC (Piano Nazionale Energia e Clima, 2020);

Fig.5: SUMP-Sustainable Urban Mobility Plan, Genoa, 2019;

Fig.6: SUMP-Sustainable Urban Mobility Plan, Genoa, 2019;

Fig.7: Elaboration from SUMP-Sustainable Urban Mobility Plan, Genoa, 2019.

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# Co-creation of the green smart city concept. Analysis of the maturity of municipalities in the Polish-German borderland region

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**Abstract**
This article discusses the results of research conducted in the Polish-German borderland region regarding the ecological maturity of municipalities in 2020. Our main thesis is that the ecological strength of municipalities lies in the diversity of approaches taken towards solving problems related to environmental protection, and in the continuous activation of municipalities in their pursuit of the "green smart city" model, which in turn contributes to raising the standard of living for the residents. The aim of the study is an attempt to assess the activity of municipalities in the Polish-German borderland region via a tool for studying the ecological maturity of municipalities. The following milestones were adopted in the research: surveying municipalities in the Polish-German borderland area in terms of their ecological maturity, conducting a comparative analysis of the survey results, and formulating recommendations for the further development of municipalities and ecological policy.

**Keywords**
Local development; Sustainable development; Smart cities; Green smart city.

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# 1. Introduction

The project also yielded other articles that concern the theoretical aspect and criteria for assessing municipalities in terms of ecological activity and ecological maturity, which may be of interest to the current reader. This article presents the results obtained as a result of the study and demonstrates a practical approach to the application of the concept in order to study the ecological maturity of municipalities and to evaluate the eco-transformational processes.

The study provides an analytical framework within which to expand the emerging debates on supporting municipalities in their pursuit of the "green smart city" model, the various dynamics of sustainable development of municipalities, and the diversified development paths by comparing and contrasting many local eco-developmental routes for sustainable development taken by border municipalities using modern technological and other solutions in the Polish-German border area (Cappellano & Kurowska-Pysz, 2020; Kurowska-Pysz, 2018; Kurowska-Pysz, 2020). The literature does not contain broader debates regarding the concept of a "green smart city". It should be underlined that the concept of a smart and sustainable city was popularised in the mid-2010s by Höjer and Wangel (Höjer & Wangel, 2014) who identified five projects. These issues include: the globalisation of environmental problems and sustainable development, urbanisation and urban development, sustainable urban development and sustainable cities, information and communication technologies and smart cities (Fagiewicz et al., 2021; Jankowska et al., 2021; Peña et al., 2020). Extending the conventional perspective to include the eco-transformation of municipalities along with a fresh look at the processes of activating municipalities by developing various interesting developmental paths that a municipality may work into a harmonious model, offers a new perspective of recommendations for further research and conclusions for climate policy. Regional policy should focus on monitoring the progress of municipalities in the eco-development process and support various individual concepts arising from the project.

There are three key terms in the considerations, which are synthetically presented here. The first is ecological activity. A necessary condition for communes to achieve new goals and move to higher levels of eco-transformation is, on the one hand, supporting communes with specialist counseling services, e.g. in terms of new technological solutions available on the market, on the other hand – due to the high dynamics of economic and social changes – monitoring optional activities of municipalities that strengthen their pro-ecological image. The developed tool is a useful, but probably not the only possible solution to assess the ecological maturity of communes. Polish and German communes carry out numerous municipal tasks, directly or indirectly related to ecological goals, but also take initiatives beyond these borders. This article shows what can be called optional activity of municipalities. Maturity ecological is achieved when the commune does not violate the ecological balance, combining economic and technological while maintaining sustainable development. It is a permanent process that will last forever. Remember that technologies are only a tool for improvement, not an end in itself. Synthetically speaking, the presented subject of the article fits into the broadly understood issues sustainable and smart local development. The added value of the study is expressed through the described concept of the green smart city model, which may become a new development paradigm for municipalities, as well as the introduction to economic terminology of the concept of eco-transformation and the concept of green smart city. A "digital tool for measuring the ecological activity of municipalities" was also proposed in the pursuit of its ecological maturity. The ecological activity of municipalities may be accompanied by synergistic effects in the form of increased benefits from joint actions, coopetition, cooperation and strengthening competitiveness (Gargiulo et al., 2020; Kurowska-Pysz, 2020; Makkonen & Rohde, 2016; Moreno et al., 2021; Papa et al., 2015).

Unfortunately, as the research shows, cross-border character in the case of communes located on the Polish-German border it is often related to their location in the border zone, and has little to do with cooperation ecological environment of municipalities. While there are interesting projects, they are unfortunately not properly promoted. An example is the heating project from 2015, connecting Słubice with Frankfurt (Oder).

In the short history of their cooperation, which is only 30 years old, border communes experienced already that resistance to various crises, including ecological ones, is very important. As an example you can cite the current pandemic, flood or contamination from industrial or storage activities toxic waste. The examples developed by both of you may be interesting cooperation in the field of public services. European Union funds (currently Interreg) that support and create new ideas for cooperation (Ulrich, 2020; Ulrich et al., 2020; Ulrich & Scott, 2021). Border universities play a significant role in initiating projects – Collegium Polonicum (branch of Adam Mickiewicz University) and the University of Viadrina (Elbel & Ulrich, 2021). The communes in the Polish-German borderland, like others, strive to raise the level lives of their inhabitants and consider this task to be one of the most important (Churski, 2018; Churski et al., 2018). Their attractiveness results mainly from the richness of nature (reserves, parks, areas protected, forests, mountains, access to the Baltic Sea). There are many paths for transformation these municipalities, but ultimately they should seek to strengthen their most valuable resources and their protection, to build the image of communes attractive to investors and residents and small cross-border traffic, which is mainly Saturday-Sunday.

As a result of the preparatory work undertaken, two separate digital questionnaires were developed to assess municipalities on the Polish and German side. These surveys were based on face-to-face interviews, which at the outset demonstrated quite significant differentiation in areas of activity due to different approaches to problem solving or different stages of eco-development already attained by given municipalities. Furthermore, a supplementary questionnaire was created to verify the ecological activity of the residents. As a result, 11 German and 43 Polish questionnaires were analyzed. In total, 48 communes were included in the study.

The analytical work deals with several perspectives: classical, innovative and model. All these perspectives show the diverse involvement of municipalities in environmental protection processes, and thus in preventing the effects of climate change. The article ends with recommendations for further research and climate policy.

## 2. Method of analysis

The analytical research was based on a desire to explore the involvement of Polish-German borderland municipalities in the eco-transformation processes. Taking into account the accelerated pace of digitisation caused, *inter alia*, by the Covid-19 pandemic, the results of research on the ecological activity of several dozen municipalities in the Polish-German borderland may turn out to be interesting in this context, and may already provide a credible picture for analyses related to the ecological maturity of municipalities and their involvement in climate protection processes. However, as authors and researchers, we are aware that in order to obtain in-depth results, the entire borderland, which is highly diverse, would have to be included in the study. Due to the relatively slim budget of the project and the short implementation period (three months), it was possible to cover only 1/3 of the municipalities along the belt within four Euroregions: Pomerania, Pro-Europa Viadrina, Nysa-Szprewa Bóbr and Nysy. Unfortunately, the investigation of the German municipalities turned out to be extremely complicated for technical reasons.

It should be stated that the contact areas are economically and socially specific, and their development has often been historically inhibited. The state border in the west of Poland, after the Second World War, was a barrier that prevented the free movement of people and cross-border cooperation. This situation has changed over the last thirty years. Municipalities on the Polish-German border make use of green resources and develop tourism in many directions. This steers municipalities towards pro-ecological and infrastructural activities that strengthen the possibilities of cross-border communication. In this context, it should be recognised that this analysis has specific values, taking into account the uneven social and economic development, and in general the specificity of border municipalities as contact municipalities.

The article adopts the following analytical scheme:

- research issue: lack of knowledge about the ecological maturity of municipalities in the Polish-German borderland area;

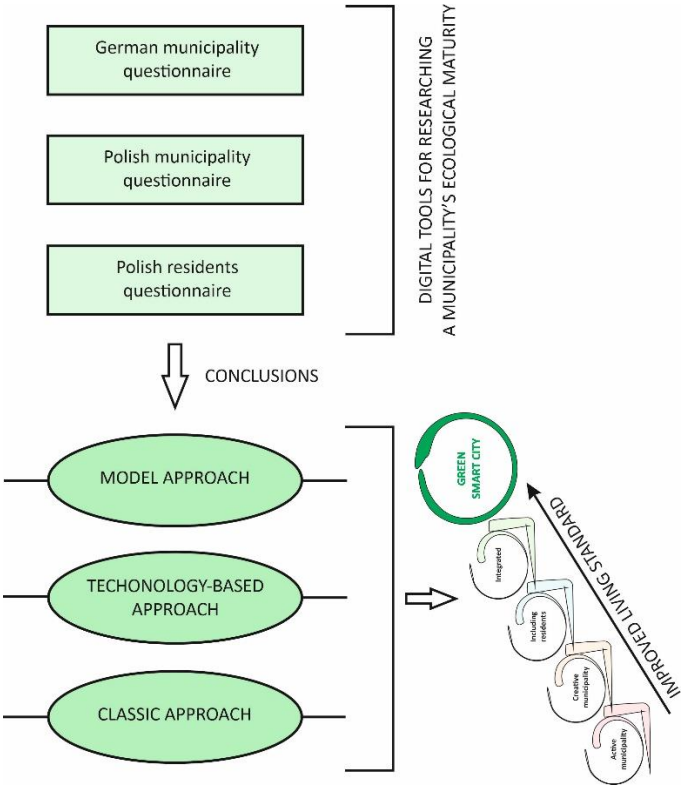



**Fig.1 Research procedure. Source: Own study**

- research goal: to investigate the activity of municipalities in four Euroregions towards their ecological maturity;
- research hypothesis: The eco-transformation process undertaken by municipalities is defined as their action taken towards a "green smart city", which creates real opportunities for strengthening all areas of a model approach towards a municipality's ecological maturity;
- the considerations are based on the concepts of smart city development as well as a range of concepts related to sustainable development. By critically analysing related concepts, the authors created the concept of a "green smart city" municipality, which closely links eco-development with smart development. The overall concept was adapted to the specificity of the development of border municipalities;
- the research method was tailored to the needs of the hypothesis and objective. Three different digital tools were proposed to study the action taken by municipalities towards ecological maturity. The study encompassed municipalities within the Polish-German borderland region. Due to extenuating circumstances, very little representative research was carried out among the municipality residents, which was mainly caused by limited financial resources and restricted time frames. Fig. 1 details the research procedure, which includes three stages: questionnaire research, conclusions drawn through three separate evaluation criteria and an indication of at which stage the municipalities found themselves along the eco-transformation process;
- the adopted assumption regarding the research tool. Due to the differences in the level of needs as well as the regional policy in Poland and Germany, and as a result of consultations with German partners, two different questionnaires were developed, which create varied criteria for evaluating processes, conditioned, inter alia, by legal conditions. These differences are shown in Table 1.

It should be underlined that the effects of eco-transformation should be considered in terms of measures and indicators that capture improvement in the quality of life.

| Research themes | PL | DE |
|---|---|---|
| Waste management | x | Recycling since the 1970s, deposit system since 2003 |
| E-communication by the municipality | x | x |
| Promotion of eco action | x | x |
| Care for biodiversity | x | x |
| Sustainable public transport | x | x |
| Green cross-boarder cooperation | x | x |
| Renewable energy | x | x |
| Inclusive growth | x | x |
| Water management | x | x |
| Air quality | x | x |
| Noise reduction | x | x |
| Eco education for the residents | x | Education is provided at schools |
| Thermal comfort | x | x |
| Smart technologies | x | x |

**Tab.1 Similarities and differences in the Polish and German questionnaires. "X" indicates compliance of the questionnaire in both cases. Source: own study based on surveys for German and Polish border municipalities**

The questionnaire topics included in Tab.1 illustrate the fundamental issues concerning the "green smart city" actions undertaken by border municipalities. 20 questions were devised for the Polish, and 15 for the German, municipalities. In the interviews with the German side, some issues were omitted because they seemed obvious and had already been implemented a long time ago. The resulting differences result from the legal situation, the government system, the citizens' environmental awareness and the wealth of the state. Due to the long-standing "green" traditions in German policy, the extent to which the principles of sustainable development have been implemented may be higher and might not arouse any particularly social controversy. The Polish side is struggling to a greater extent with poor segregation of municipal waste or its environmentally hazardous disposal in home furnaces or illegal storage. There are many similarities, although they may differ in detail in selected research topics. One example would be e-communication. On both sides of the border it is possible to correspond with the municipal administrations, but the range of possibilities is much wider on the German side, which can be seen in the layouts of the German border municipalities' websites.

The drafting of the questionnaires was preceded by in-depth interviews with the Polish and German side. As a result of these interviews, the research technique established a priori based on the questionnaire could not remain identical in terms of quantity or quality, and clearly had to be modified. Closed questions contained technologically selected options that could be applied in the cross-border area under research. Some were intentionally cognitive and could serve as an indication of possible directions for solutions. From the point of view of the statistical evaluation criterion, the questions included some stimulant and destimulant explanatory variables. Filling out the questionnaire, besides the feedback given, was a kind of educational activity for the municipalities.

## 3. Ecological maturity map of the municipalities included in Polish-German borderland research

At the outset, one should note that the study included mainly small municipalities rather than large cities, which are characteristically unrelated to the type of municipality referred to by the smart city phenomenon (Drobniak, 2019). The study did not incorporate large cities where the level of pro-ecological action would

certainly be higher (one exception may be the medium-sized city of Frankfurt (Oder), but the digital tool would also have to be adapted to the city size.

The analysis of the obtained material, which is presented in map 1, gives a clear picture of the relatively low variation in the results, which is certainly influenced by the small share of German municipalities in the study, where we suppose that the main difference could occur. The differentiation appears greater when we look at individual criteria, which is discussed in the subsequent sections of this article. It should also be recognised that the municipalities revealed an average level of activity, which is the starting point for a discussion on the level of eco-transformation in the process of striving for a "green smart city".

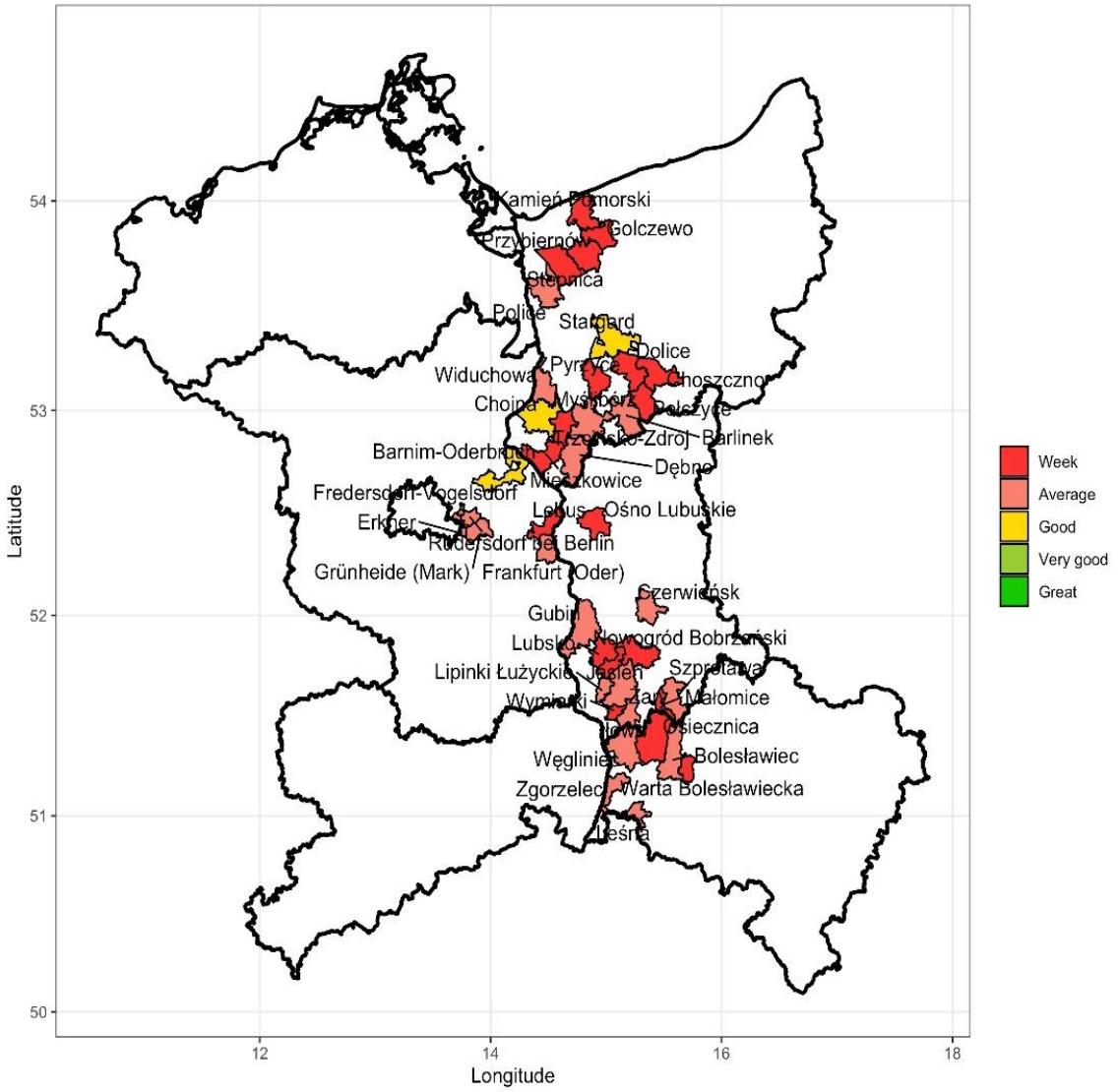



**Fig.2 Activity of municipalities in the Polish-German borderland region. Source: Own study**

## 4. Maturity analysis from the "smart city" perspective

The effects of climate change can broadly be divided into three groups: ecological, social and economic. The ecological effects of climate change include changes in vegetation types and the associated impacts on biodiversity; changes in afforestation density and agricultural production; expansion of dry areas; decrease in the quantity and quality of water; and risks related to pests, diseases and fires, a decline in water quantity and quality, and risks related to pests, diseases and fires. Social impacts can include changes in employment, equity, risk distribution and human health, as well as displacement of populations. Economic and economic effects include increased risk and uncertainty with regard to forestry and agricultural production, changes in

the productivity of crops and forest products, reduced supply of ecosystem goods and services, increased costs of utilities and services, and changed energy demand (Francini et al., 2020).

Due to the purpose of the study, the most important criterion when assessing the activity are digital technologies that municipalities propose to solve their own problems. In the literature on the subject, there are numerous critical discussions around the "smart city" of great diversity in understanding this phenomenon. and Smart City practitioners got involved in considering it through the prism of criticism. Criticism of "smart city" in the literature is noticeable on five levels: (a) conceptual methodological ambiguity, (b) utopian visions driven by ICT and corporations, (c) ignoring the potential of citizens and others, (d) "splintering urbanism", unequal representation , concerns about privacy and security, and the lack of a long-term vision for sustainable urban development adapted to local needs (Angelidou et al., 2017; Capasso & Mazzeo, 2020).

The *technological criterion* is the first to be analysed when assessing the activity of municipalities. First of all, from the point of view of economic practice and the observation of, for example, other entities, municipalities also need time to implement new technologies. Even in the case of large cities, these processes take place with a certain time delay. It should also be remembered that the processes of investment in innovative solutions are very expensive, which does not allow municipalities to reap benefits in a short period of time. Such investments should be seen as a long-term venture. Secondly, thanks to modern technologies, municipalities open up their "realm of possibilities" much further in various fields, e.g. economic, social and organisational.

Investments in information technology often require the introduction of changes in the municipality in terms of work organisation, communication, etc. These are expensive processes and, at the same time, do not always translate into boosting the municipality's competitiveness and improving the quality of life for its residents.

Thirdly, the implementation of digital technologies by municipalities may enhance some area of municipal activity, while not necessarily benefitting the functioning of the entire organism. It should be remembered that the analysed area of municipal activity in terms of the natural environment, is larger and more complex, in direct proportion to the size of the municipality. Fortunately, computerisation does not significantly affect rent dissipation, nor do the benefits grow at the expense of other municipalities. Here, a certain analogy can be made to competitiveness, which in the case of municipalities too does not directly arise from taking benefits from other municipalities, but these phenomena are much more complex. Finally, we can underline that decisions related to various solutions may turn out to be wrong. Lack of transformations in other areas of municipality management may reduce the overall benefits.

It is obvious that there will be more and less active innovators throughout the municipalities. The analysis of municipalities through research of action undertaken has yielded some highly interesting results. Four areas were taken into account in the analysis. In terms of "green" aspects, the following areas were selected to evaluate the activity of municipalities in borderland regions: smart management, smart living, smart environment, smart people. These are critical areas from the point of view of improving quality of life for the residents, as they all involve measures taken by the municipality to eliminate the negative consequences of climate change.

- In the *smart management* (Anthopoulos & Fitsilis, 2014; Janc, 2019; Sharifi, 2019) category, the active use of information and communication technologies in public services, which motivate residents to participate in eco action in the municipality, was studied. This category also includes economic waste management, which takes into account the requirements of the circular economy (Henry et al., 2020; Moraga et al., 2019; Vence & Pereira, 2019). Also of relevance is the activeness of municipal authorities in acquiring external funds for ecological projects, training municipal administration employees in the field of ecology, as well as regular cooperation with environmental organisations and specialists in the field of sustainable development. An efficient system of municipality management is based on co-governance and cooperation between residents and other city users, establishing appropriate procedures

that require cooperation between citizens and local authorities, and the willingness to use innovative technologies that help a given town function.

- *Smart living* (Anthopoulos & Fitsilis, 2013; Sharifi, 2019; Tokody & Mezei, 2017) includes all action taken to create a friendly climate for people and improve their quality of life, taking into account ecological balance. In this category, the municipality's endeavours regarding sustainable transport, diversification of energy sources, including renewable ones, and the introduction of modern architectural solutions in the biophilic design style (Kellert et al., 2008), also known as low environmental impact design (Kellert et al., 2008).
- The municipality's concern to reduce the level of carbon dioxide emitted to the atmosphere, expand green areas and guarantee clean water supplies and protect its resources fall within the *smart environment* category (Camarinha-Matos et al., 2019; Castanho, 2019; Gajdová et al., 2016). This area also encompasses all operations undertaken by the authorities, in cooperation with the residents, to reintroduce native species of animals and plants and protect endangered species. The systems used to reduce water consumption, the respect of natural resources and the use of renewable energy sources as well as the optimisation of energy consumption via modern technologies and the promotion of environmental education are all evaluated here.
- The final model category, referred to as *smart people* (Aletà et al., 2017; Sharifi, 2019; Tokody & Mezei, 2017) concerns the municipality residents who become conscious participants in ecological transformation through the process of their activation and education. Given appropriate technical facilities, they are able to reduce excessive energy consumption and environmental pollution and strive to improve their quality of life. Lifelong learning becomes an immanent feature of smart people, as "that kind of learning will define the twenty first century and is not taking place in a classroom" (Jessen, 2011). Educational endeavours to raise a "young green generation" are also assessed.

Figg. 3a and 3b show how active the Polish and German municipalities have been in relation to the four smart categories. In the case of Polish municipalities, one general conclusion can be drawn: as the overall activity of municipalities increases, the share of individual categories increases.

Most municipalities are entering into a phase of using smart solutions to protect the environment at their own pace or they simply lack the courage and creativity to make decisions. In the case of small municipalities, the lack of advisory institutions and academic centres in the immediate vicinity may also be a relatively tough obstacle to overcome.

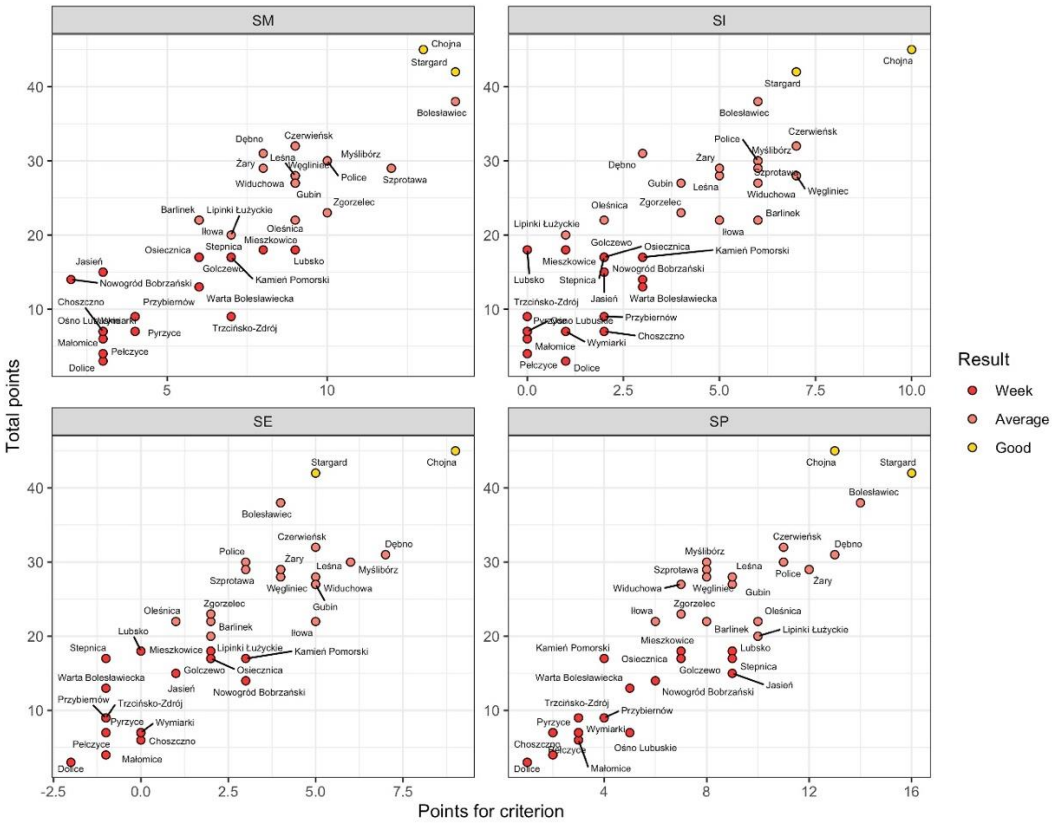
It is observable that all the solutions that are universally discussed as being standard for cities, for smaller municipalities still remain in the realm of plans, and maybe even are not considered for implementation in the long term.

Only two municipalities were included in the third group. One might note that they are not similar when it comes to implementing solutions in terms of the four categories under consideration. In the case of German municipalities (cf. Fig.3b), we take into account a far smaller group. Most municipalities manifest similar activeness, while the municipality of Borken, which is significantly more active, is an outlier. Its actions may be considered as exemplary. The municipality Borken took part in the survey as a municipality lying on the western border of Germany.

The activity of communes was divided into four categories, according to the percentage criterion, as indicated by the communes in their responses.

The weak ones were those that showed activity up to 25% of the answers proposed in the questionnaire; average are those which showed activity in the range from 25%÷50%; good from 50%÷75% and very good above 75%.

(a)




(b)

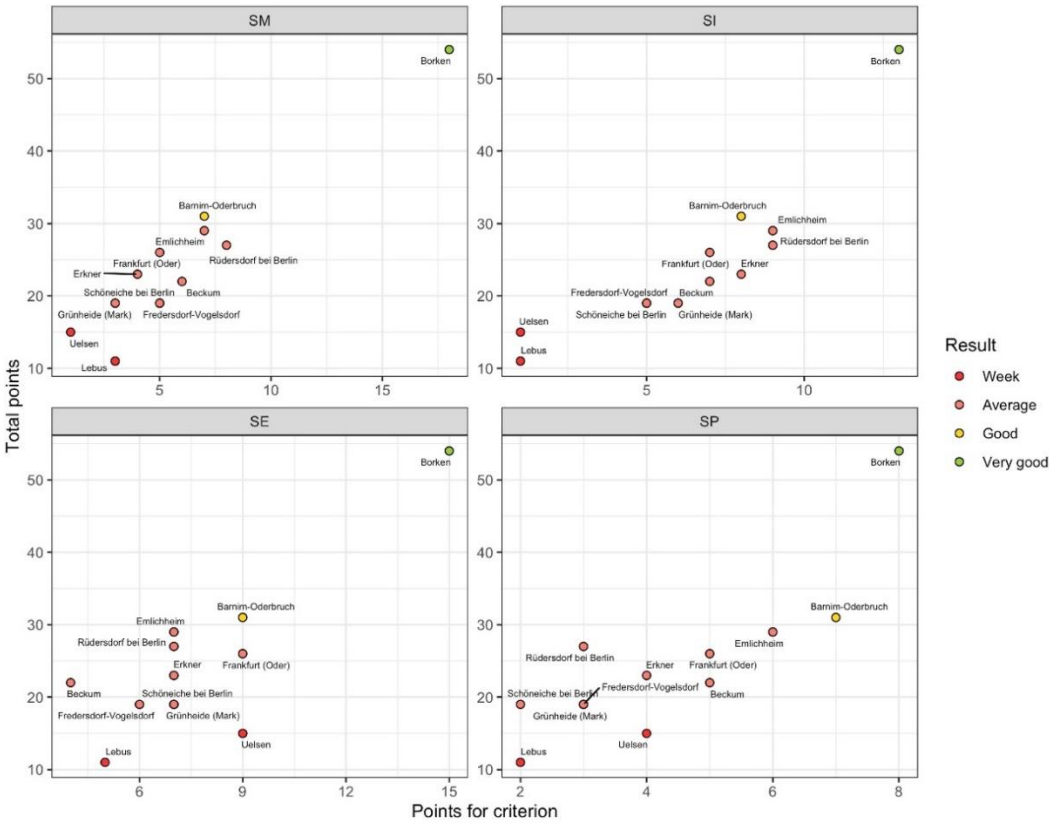



**Fig.3 Number of activities undertaken by municipalities in relation to smart cities (a) Polish municipalities (b) German municipalities. Source: Own study**

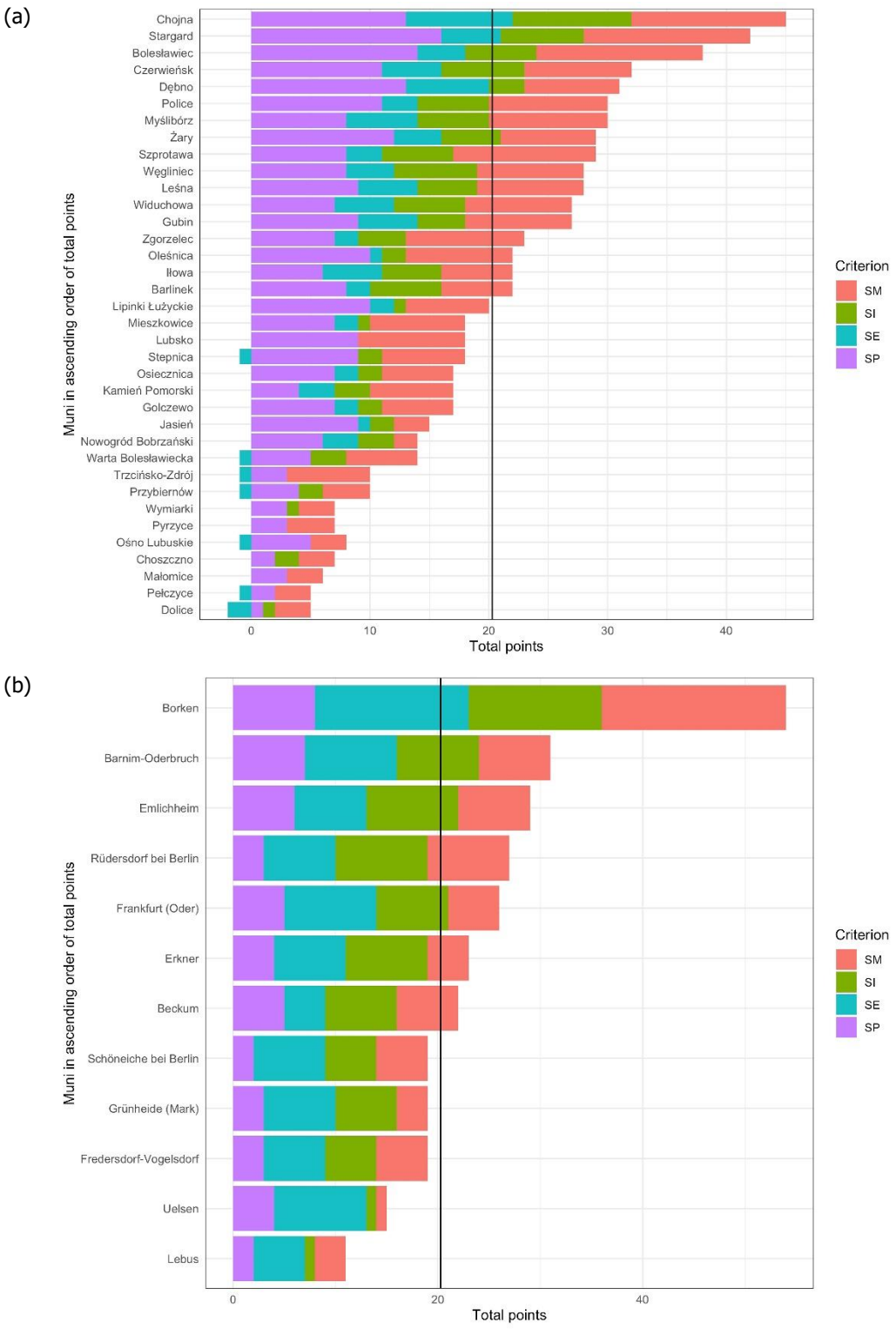



**Fig.4 The structure of the activities undertaken by municipalities in relation to the smart city criterion (a) Polish municipalities (b) German municipalities. Source: Own study**

From the analysis of Fig.4, we may conclude that municipalities manifest the greatest level of activity in the areas of SM and SP. One may also note that in the case of more active municipalities, their degree of involvement in the other two processes is growing, whereas in the case of less active municipalities this involvement is practically absent. It is significant that less active municipalities engage in actions that are unfavourable to the environment, yet in doing so probably consider these activities as environmentally-friendly (in this case, these are the activities indicated under the municipalities axis).

## 5. Analysis of ecological maturity in the classical approach

Classical analysis emerged in relation to protective measures for the Earth's natural resources, such as soil, water, air, and concern for the maintenance of ecological balance, understood as a "state of dynamic equilibrium within a community of organisms" (Verma, 2017). This criterion is related to resources and in this shape communes most often come to solve their problems in a task-oriented manner.

The so-called classical approach included the following areas for analysis:

(1) Care for *soil* quality should start with rational municipal waste management, including difficult, bulky and hazardous waste. An additional advantage for the municipality is the promotion and development of organic crops and their sale at local markets. Also, generally available composters are the simplest as well as being a cost-free method of managing excessive quantities of organic material. They contribute to the ecological nutrition of the soil. In a healthy environment, there is no concept of pest or disease, because all animal and plant organisms serve a specific purpose. The municipality's care for the protection or reintroduction of native species results in healthy crops, and thus the health of its residents. A question was also justifiably raised about the protection of biodiversity which, since the "Convention on Biological Diversity" announced in 1992 during the Earth Summit in Rio de Janeiro, has become one of the main areas of nature protection. Mowing lawns or raking leaves are popular forms of cleaning green areas, but these activities – apart from roads with limited visibility – are harmful and do not protect the soil and the microorganisms living in it.

(2) Fresh *water*, accumulated in surface and underground resources, constitutes only 2.5% of the Earth's water resources. It must be retained in the soil and rationally managed for socio-economic purposes. Lack of action in this area may result in an increase in water prices. Cross-border cooperation in keeping border rivers clean is a 'green' added value.

(3) The most dangerous results of *air* pollution are: smog, global warming and the ozone hole. An effective way to reduce gas and dust emissions is to reduce the extraction of fossil fuels and the burning of coal, and to increase the share of renewable sources in energy production. The actions of the municipality should be important for the health of its residents in terms of creating a real-time air monitoring system, minimising linear emissions by expanding cheap and accessible public transport to replace individual vehicles. Additionally, the expansion of bicycle routes, including cross-border motorways, not only connect neighbouring municipalities, but also significantly contribute to the improvement of air quality in forested border areas, which in turn is relevant to the development of tourism.

(4) In the stationary state of the ecosystem, quantitative and qualitative changes of species occur very slowly, and in a given area there is a balance in the influence of humans and elements of inanimate and animate nature. Within the scope of maintaining the *ecological balance*, relevant action undertaken by the municipality includes: the use of green technologies, the maintenance of natural green belts, planning activities that reduce concreting, deforestation and noise levels.

The activity of communes was divided into four categories, according to the percentage criterion, as indicated by the communes in their responses. The weak ones were those that showed activity up to 25% of the answers proposed in the questionnaire; average are those which showed activity in the range from 25% -50%; good from 50% -75% and very good above 75%.

The conducted analyses show (cf. Fig.5) that the similarity in the activity of municipalities is particularly visible in action related to water management. Only one municipality is highly active, standing out among the entire group. In the case of German municipalities (cf. Fig.6), one may observe that for the majority, care for clean air and water resources are the most common forms of activities. Looking through the prism of the answers given, the most important issue for them is the development of bicycle infrastructure and electromobility – these are objectives that develop ecological municipal transport. Also the stormwater system, the water-tightness of sewage installations and the management of used water stand at the forefront of their plans.

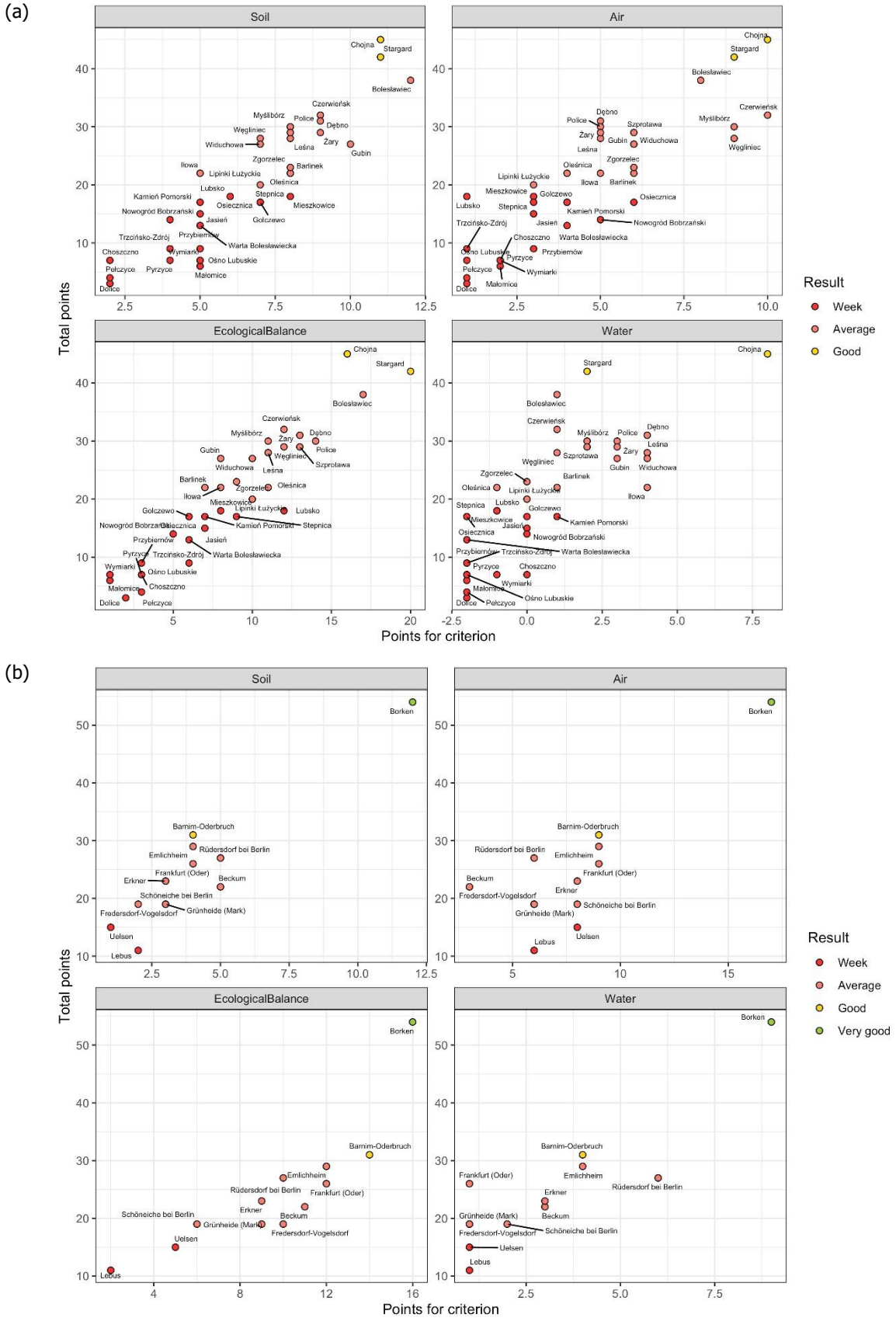



**Fig.5 Number of actions undertaken by municipalities in individual areas of "the classical approach" to the total activity of a municipality (a) Polish municipalities (b) German municipalities. Source: Own study**

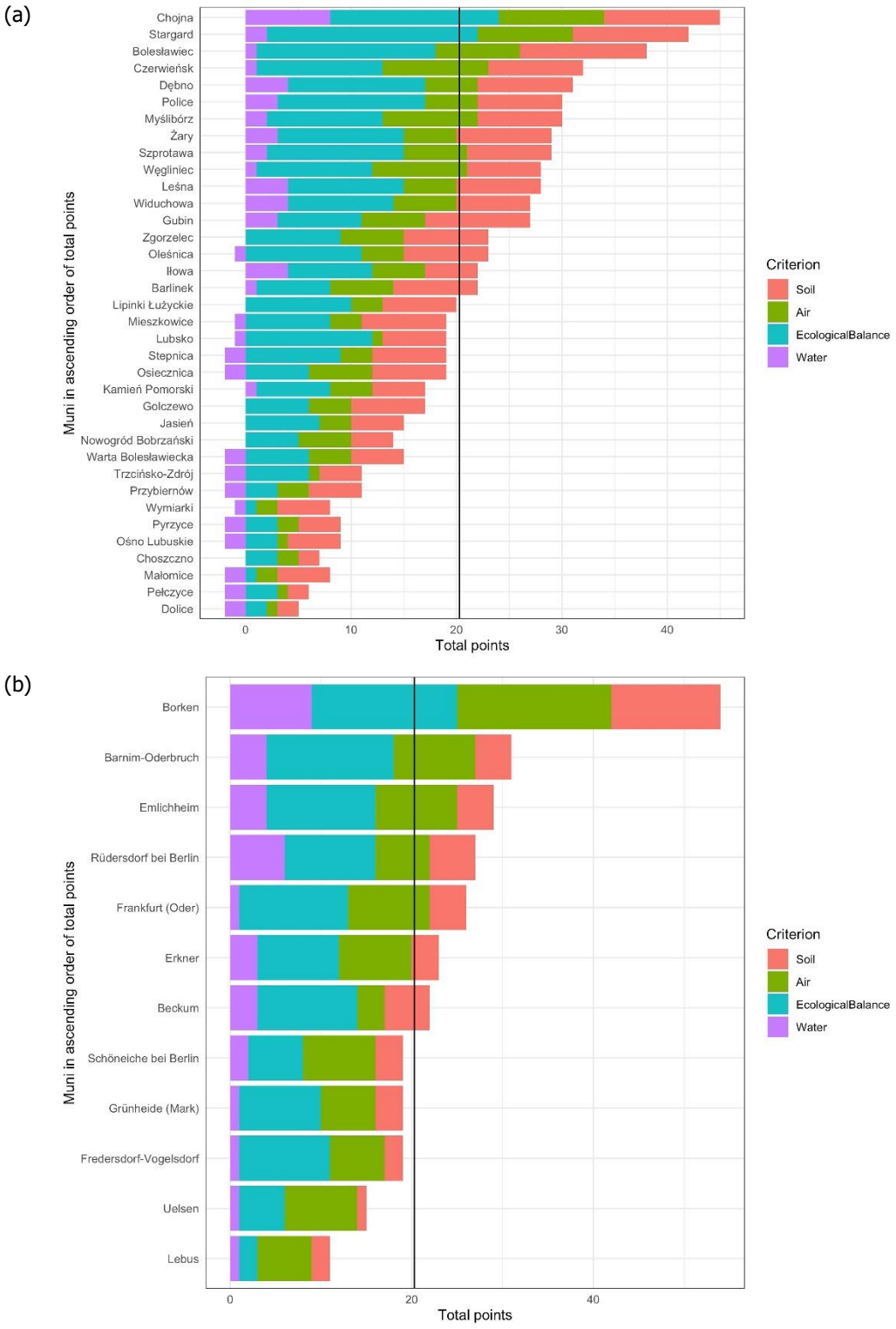


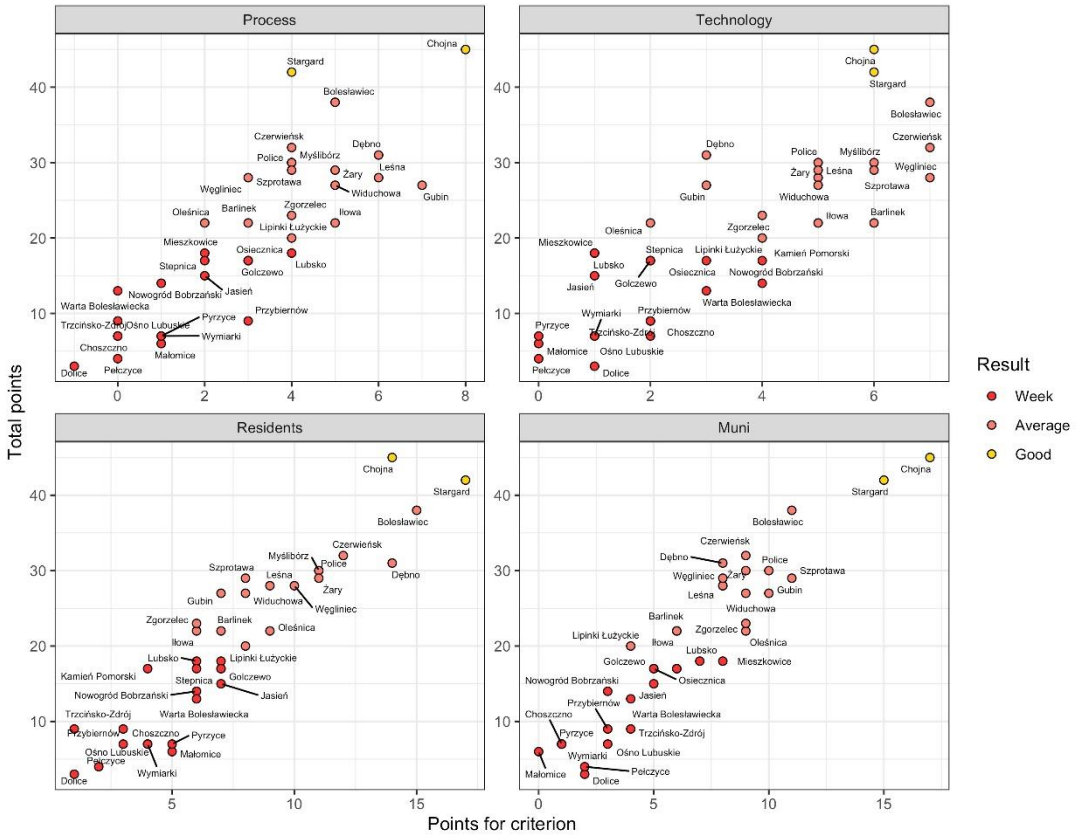

**Fig.6 The structure of the activities undertaken by municipalities in relation to the smart city criterion (a) Polish municipalities (b) German municipalities. Source: Own study**

Considering the structure of activity, and examining the issue from the point of view of the classical criterion (cf. Fig.6a), in particular areas, municipalities manifested the highest level of activity in questions related to ecological balance. Endeavours to retain water in the soil are poor. Further in the article, it turns out that these activities are extremely important for municipalities. In the case of German municipalities (cf. Fig.6b), maintaining the ecological balance is a challenge that most municipalities must face. This is not surprising due to the fact that too little has been done too late and the damage incurred in all ecosystems has been enormous.

## 6. Maturity analysis through the prism of the "green smart city" model

Our original approach to the study of ecological maturity involves looking at the problem from the point of view of four areas which determine good results, especially from the technological perspective. Good communication with residents, and the identification of many processes both in the municipality as an institution and its surroundings, should be supported by knowledge. The municipality authorities should create strategies that assume the municipality's multi-stage ecological development. The solutions should include *technologies* that result in monitoring processes, improving communication, etc. In the second group, four more divisions were distinguished: processes, technology, residents, and municipal authorities. Big data and the Internet of Things support the operation of smart car parks, smart lighting, smart cross-border air monitoring systems or warning systems against natural disasters. The second element comprises the *processes* that determine the formula of activity, determined in an evolutionary mode of change, e.g. diversification of energy sources or air quality monitoring, the introduction of e-documents or information management. All based on the principle of sustainable development, they must be integrated and standardised. The other two links are *human resources* cooperating with each other, distinguished as: the *municipal authorities* and the *residents*. Building bonds and identification with the place of residence as well as horizontal cooperation in the borderland create a value that is timeless and immeasurable in terms of the levels of activity achieved. The "green" vision of its development depends on the creativity and entrepreneurship of municipal authorities. Conceptual work, the use of methods to activate municipal officials and openness to innovative solutions in cooperation with eco-specialists can build a new model of cooperation within the local government. The addressees and beneficiaries of effective management are the residents whose existence in a naturally preserved natural environment will definitely improve. Building social bonds and identification with the place of residence as well as close cooperation along the Polish-German border create a value that is timeless and independent of the levels of activity achieved.

(a)



(b)

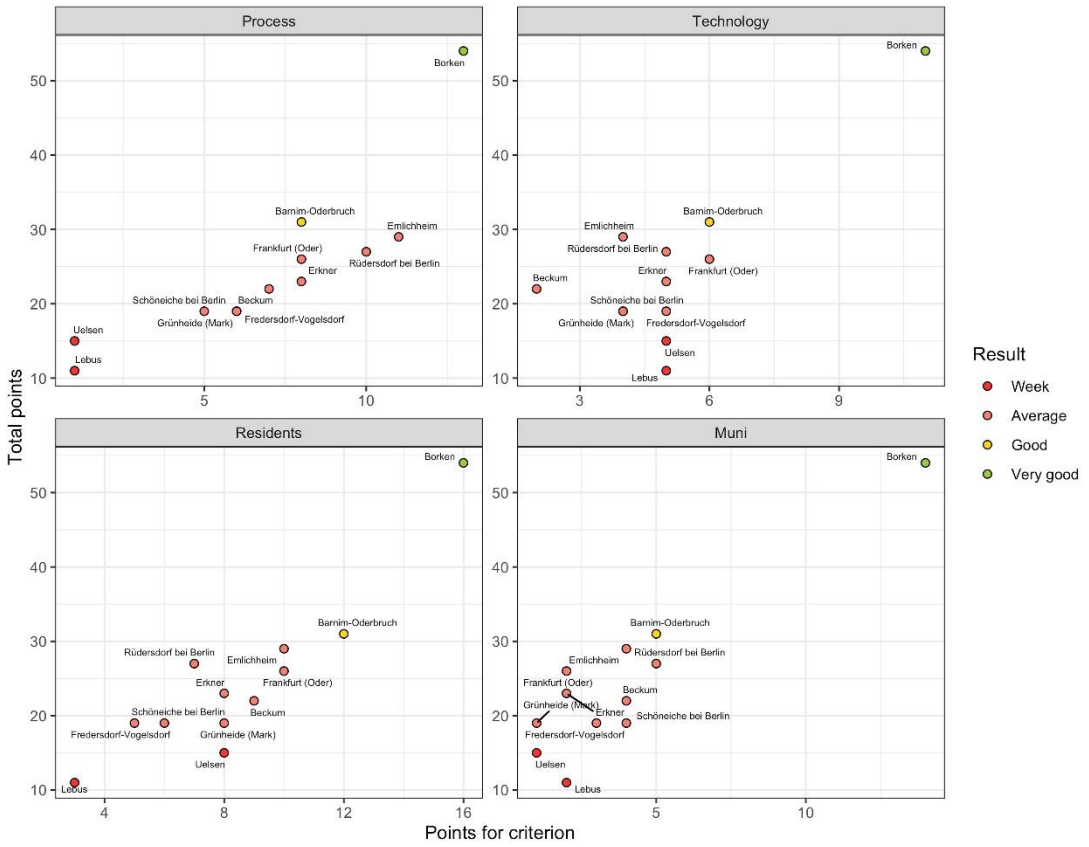



**Fig.7 Number of activities undertaken by municipalities in particular areas of the "green smart city" model (a) Polish municipalities (b) German municipalities. Source: Own study**

Considering the model approach related to analysis through the prism of the adopted criteria, municipalities differ quite significantly.

For the implementation of processes that may help municipalities attain the "green smart city" model, areas related to processes and technologies are extremely important. Here, the practices of large cities show that deficiencies in these areas are crucial for digital, autonomous solutions, etc. Fig. 7a clearly shows that the advancement of activity in terms of the discussed criterion is highly diverse. In the case of German municipalities, process synchronisation is difficult. Developing standards appropriate for this region may be of key importance due to the further development of both the German municipalities themselves and in the context of cross-border cooperation.

Considering the action undertaken by municipalities in particular areas, municipalities appear to be particular active in the area of human resources and municipality authorities. In this case, it should be helpful to study the residents to ascertain whether they manifest pro-ecological attitudes and if not, how could they be educated in order to systematically build such attitudes?

Also within the scope of the study, a digital tool for researching the ecological maturity of residents was created whereby residents can assess their pro-ecological attitude in areas such as: household, transport, and lifestyle. In this model, this is an area that complements the results obtained from the municipalities. In the case of Polish municipalities (cf. Fig.8a), Chojna stands out in terms of its particularly high level of activity. The residents and the municipality authorities are also particularly active. On the other hand, in the case of the German municipalities (cf. Fig.8b), the greatest level of activity also occurred to be in relation to the residents. From the contact points available where people may seek advice regarding energy saving methods and thermal imaging control of buildings, one might reach the conclusion that this is a trend that promises great economic benefits for residents, and thus for the climate.

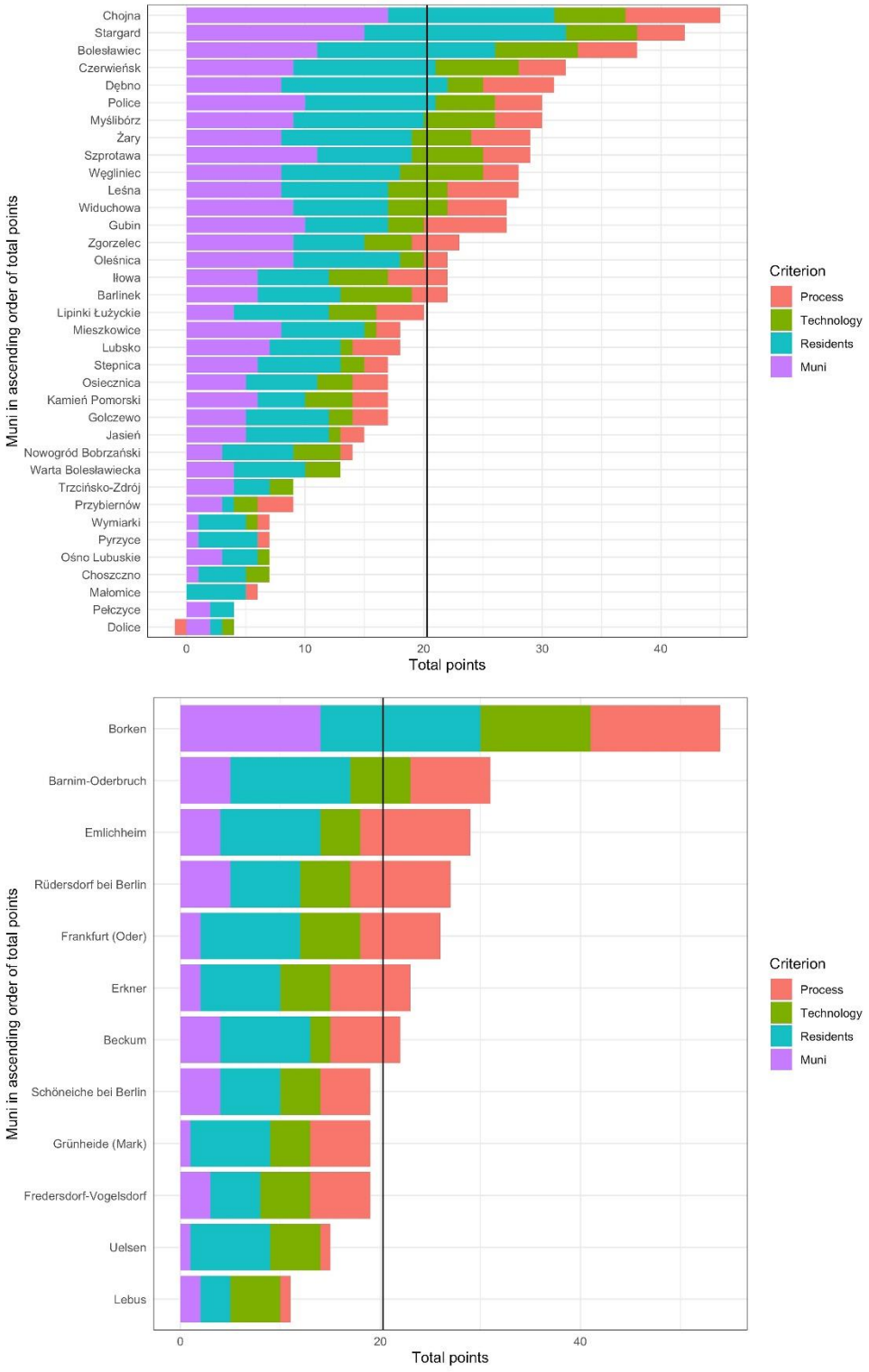



**Fig.8 The structure of municipal activity in the so-called model criterion. Source: Own study**

## 7. Eco-transformation processes in the Polish-German borderland

The stages of ecological maturity regarding municipalities in the Polish-German borderland region are related to their transformation in various areas: technology, the type of organisation that the municipality is, the residents, processes towards an open "green smart city" with an internationalisation of processes, process integration, orientation towards residents and raising their quality of life. An "open" municipality that creates new spaces for life and economic development undergoes self-assessment of its activity in the field of ecology. Through questionnaire research, it is possible to determine the developmental stage of a particular municipality (Fig.9).

We also discover what instruments it uses, in which areas it is particularly active (this has not been described, because it would require a highly detailed account, which is not the purpose of this article), in which areas it features developmental deficiencies, what strategies it adopts, etc. We learn that the municipalities demonstrate a somewhat average level of activity and are on their way towards further transformation. In the case of municipalities in the Polish-German borderland region, it is important that the survey contains some educational as well as incentive value.

Throughout the whole surveyed population of municipalities, what definitely came across as weak was the level of thought about pro-environmental development in the category of development challenges, i.e. eco-transformation processes.

All surveyed municipalities are characterised by the following:

- Among the solutions they apply, some are universal, e.g. initiating so-called "Mini Pszoks" in the area, promoting ecologically clean zones, access to public transport, protection of endangered species, installing LED lighting, conducting educational and offering opportunities for involvement, e.g. for seniors, planting plants that retain water in the soil, air monitoring systems, integrating planning activities, etc.
- Openness to residents' initiatives, i.e. they are involved in decision-making processes and willingly take part in initiatives, such as: devising civic budgets, drafting maps where residents can actively highlight existing environmental problems, etc.
- Interoperability is the compatibility of the proposed systems with other similar solutions, mainly because the proposed solutions can be adapted to various digital environments.
- Virtualisation means moving most of the data and operations to a virtual space, which may include broadband internet, an integrated platform for servicing residents, mobile broadband internet (3G, 4G, 5G), availability of parking applications, and free Wi-Fi.
- The solutions applied should be based on autonomous (maintenance-free) concepts. This may include solutions in areas such as communication, waste management, and water resources. These concepts are particularly technically advanced and require a great deal of investment.
- Working in real time is a highly significant feature of this system. The possibilities offered by modern technologies, in particular by personal communication devices, facilitate better problem-solving, both for communication flow from town to citizens, and for collecting feedback.

The presented results and conclusions from the research are different for the examined Polish and German communes. First of all, the assessment should take into account different legal environment, economic possibilities, experience in solving ecological problems, etc.

The questionnaire results collected enabled the identification of four groups of Polish and German municipalities with different characteristics. *Active municipalities* incorporate ecological and economic solutions with varying results, because they face a number of obstacles. They could be much more active, but they lack maturity in the area of technology, and process while additionally hindered by insufficiently active or creative residents.

They are often weak in the organisational context. Many processes overlap. There is no transparency in terms of competences, no project approach or creativity in action. They are unable to find the right business models for municipal projects and lack a clearly defined development vision, strategy, etc. The needs of such municipalities are tremendous and they need to be supported by accurately identifying their requirements, gaps, obstacles, and environmental problems. The municipalities in this group are not always categorically weak in all of the areas mentioned.

Their position is primarily due to the fact that they have clearly formulated visions of ecological development. They need support and, first and foremost, external consultancy, greater openness to training, and also attempt to apply for funding for small soft projects that would pave the way for further development.

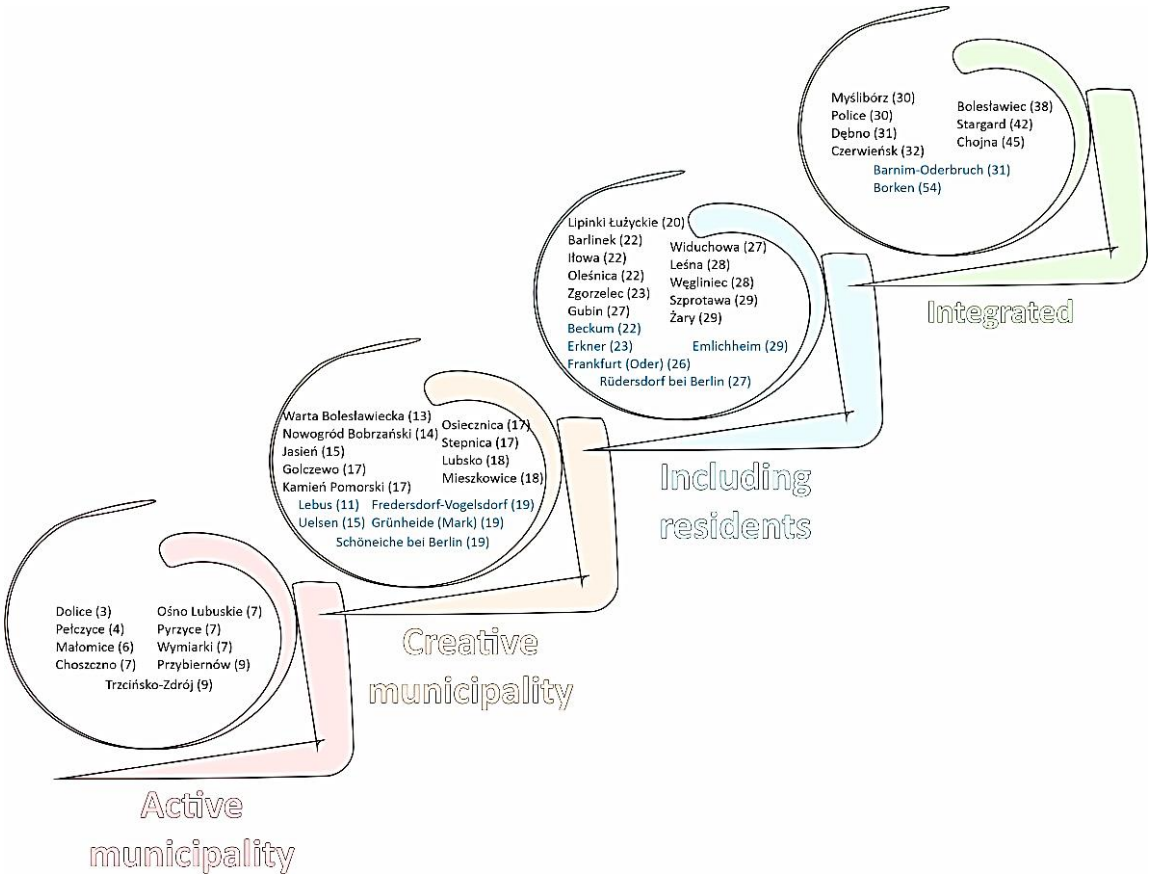



**Fig.9 Eco-transformation processes aimed at increasing residents' quality of life. Source: Own study**

*Creative municipalities* are much more involved in ecological development processes than active ones. They have digital and other solutions at their disposal that satisfy some of the residents' expectations. Unfortunately, these solutions are often random and have no logical consistency. They do not create harmonious systems that significantly reduce environmental problems. Again, help is needed to maximise the benefits of these different solutions. It may be claimed that these municipalities are on their way towards a "green smart city", but they need constant monitoring of their own actions, external advice from specialists in digital technologies, good and committed leadership, and the development of cross-border relations, etc.

*Municipalities that include their residents* assess their added value through the prism of the residents' strong involvement in the development processes. The benefits of this type of behaviour are significant in terms of better identification of problems, matching solutions to the needs of residents, residents identifying with the municipality, which has a positive effect on its image, etc. By joining the development processes, residents strengthen the municipality with their knowledge, competences, decisions on where to invest, etc. This is a stage in the development of municipalities that allows them to move further towards a "green smart city". Residents initiate, create new ideas, and monitor needs and expectations. Further efficient development depends on them.

*Integrated municipalities* see benefits in process integration, internationalisation and standardisation. They are keen to implement smart projects, which they incorporate into larger joint ventures, e.g. regarding mobility, waste management or water management. This is a process that is just beginning to develop among the front-runners. In Poland, large cities often face many difficulties in integrating, for example, communication services. The main aim of the model is a *green smart city*, which is the highest level as well as the most open to new solutions and cooperation. Resistant to external factors.

In the case of border municipalities, the socio-economic added value is visible through the mobilisation of endogenous potential by strengthening the local level as partners and initiators of cross-border cooperation, the participation of economic and social entities, environmental organisations and tourist agencies. Another

important issue is how to enhance professional qualifications and ecological competences, as well as additional development, e.g. in the field of infrastructure, transport, tourism, the natural environment, education, research and cooperation between small and medium-sized enterprises. The municipalities that participated in the survey pursue this goal. When considering the situation of border communes, it should be taken into account that they belong, at least on the Polish side of the border, to regions that are burdened with a weak economic structure and slightly resistant to COVID-19 (Śleszyński et al., 2020).

## 8. Recommendations for municipalities and conclusions for climate policy

The municipalities that took part in the study assign themselves various tasks to be performed in their areas. Fig. 10 indicates these goals for both Polish and German municipalities. Those in red are the tasks set by German border municipalities.

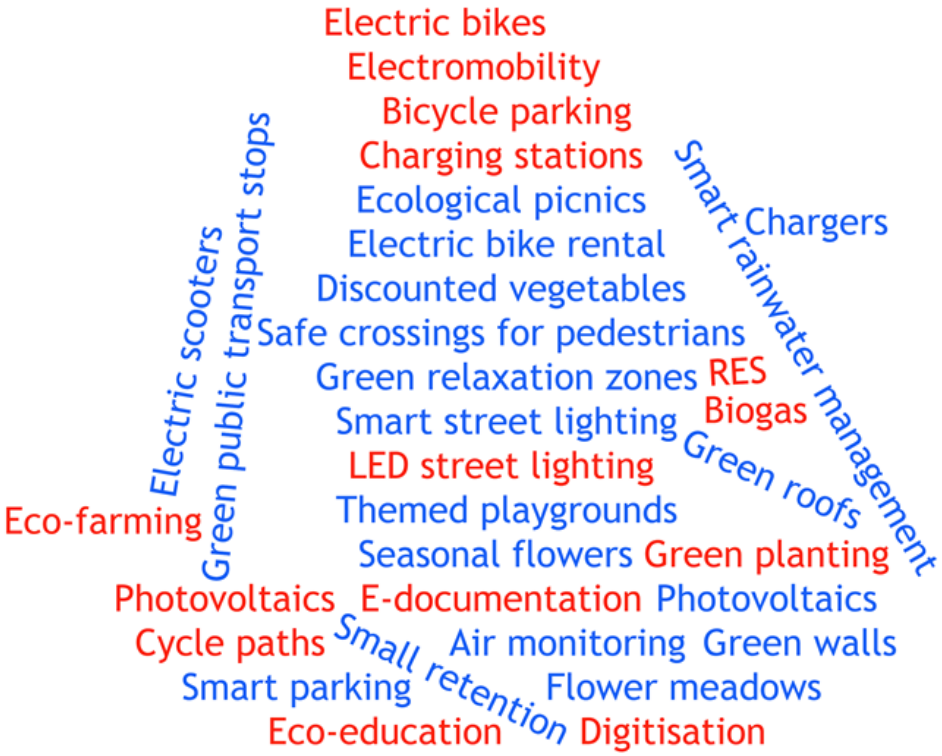



**Fig.10 Tasks declared by municipalities on the Polish-German border with the aim of ecological activation. Source: Own study**

FFH (the colloquial term for the protection of fauna, flora and habitats in accordance with EU Directive 92/43/EEC and the protection of birds in accordance with Directive 79/409/EEC). It includes "Natura 2000" sites. The list of protected areas is established by member states in accordance with the federal act on nature conservation.

Currently, Polish and German municipalities indicate the following pro-ecological activities, which are included in Tab.2.

The survey yielded some rather interesting conclusions for municipalities that wish to follow the path of eco-transformation. The most important include:

- the need to build a "green smart city" strategy that will steer municipalities towards further significant action;
- boosting the role of external consultancy in municipalities in fields often far removed from the competences of municipal employees, such as digital technologies, renewable energy, energy, etc.;

- focus on closer sharing of experiences and organising cross-border webinars dedicated to various groups of residents and municipality employees;
- searching for various solutions in the field of business models for ecological ventures;
- closer cooperation with the university community and pro-ecological organisations;
- supporting information flow within the municipality in real time;
- supporting projects undertaken in municipalities and initiating cross-border projects.

| Specification | Polish municipalities | German municipalities |
|---|---|---|
| Air protection | Air monitoring system in the municipality of Dębna, implementation of an anti-smog program, co-financing of the replacement of solid-fuel furnaces with ecological furnaces, cooperation with a private geothermal project, the "Ośno Lubuskie Urzeka Klimatem" environmental education project on air protection | Air quality in the municipality is controlled along with free thermovision measurements in private premises and homes |
| Town greenery | New planting of trees and shrubs in parks and green areas, achieving a forest cover of about 49% | The green areas of the municipality are extended, including the expansion of flower meadows and windbreaks in combination with natural elements, without human interference. In agreement with the residents, protection of old trees is carried out in privately-owned areas along with the maintenance of natural and uncut grass, roadside green belts adjacent to public roads |
| Removal of asbestos | Widuchowa Municipality | = |
| Waste-water management | Co-finance for the construction of household sewage treatment plants from the municipality budget, the municipality co-finances the construction of household sewage treatment plants where there is no possibility of connecting a collective sewage system | A coherent model of water and wastewater management has been developed |
| Energy | Subsidies for residents for solar panels, replacement of street lighting with LED lighting | Development of Smart Grids which combine production, storage and consumption, and thus compensate for fluctuations in renewable energy. Public buildings have been equipped with energy-efficient lighting with motion sensors, and energy management systems have been revitalised, and green gardens have been installed on the roofs |
| Tourist infrastructure | Building a cycle path network | Within the scope of sustainable transport, the expansion of bicycle paths, charging stations and the expansion of the park of electric public transport vehicles |
| Eco-education | = | Support for the eco-education of the municipal administration officials and cooperation with eco-organisations |
| E-communication | = | E-communication was developed for Citizen Services along with advice points on energy management in private households |
| Virtualisation of space | = | There are wifi-hotspots in public areas and broadband internet |
| Water retention | = | Retention action is undertaken and the collection of rainwater for municipal needs is financially supported by financing reservoirs and reusing unclean water |
| Facilities for entrepreneurs | = | Tax benefits offered to eco-entrepreneurs |

**Tab.2 The current activity of Polish and German municipalities. Source: Own study**

Added value resulting from the study of the activity of municipalities in striving for ecological maturity, manifests itself in:

- education of municipalities and residents;
- cognitive aspects;
- implications for regional policy;
- implications for cross-border cooperation in the field of ecology;
- identification of development niches;
- recommendations for entrepreneurs regarding investment opportunities in a given area, guidelines for formulating further directions of development;
- adaptation of specific solutions;
- influencing the change of the paradigm of process management in the commune from looking for causes changes in the natural environment by identifying processes at a given moment (through available information) for extrapolation and anticipation of future changes. Taking into account the considerations presented in the article, we can also refer to a number of them ideas that appeared here as debatable and difficult to incorporate by the communes, without being critical approach to many areas of knowledge, e.g. commune management processes, technology, macroeconomic specificity and mesoeconomics, behavioral analyzes.

As a result of the research conducted, several other implications emerged that may facilitate municipalities' eco-transformation process in the Polish-German borderland region.

They concern a deeper macro approach that could prove useful in the long run. Companies from this region that incorporate green solutions and smart technologies should be covered by a protective tax umbrella. Tax breaks or preferential loans for new enterprises may provide an economic impulse for the development of this region. This also applies to subsidies for organic farming, home crops and agritourism, which will boost employment and help keep young people in the area. Green actions undertaken by the residents and pro-ecological efforts exerted by the municipal authorities to maintain natural values may constitute an "ecological product" of this region. Highly specialised knowledge is required for a decent, economic and modern eco-transformation.

Within the scope of cross-border cooperation, it is worth establishing working groups of eco-advisers, whose knowledge municipalities should make use of. This is the best way to eliminate misguided investments, wrong decisions and a waste of public money. Also, digital solutions for intra- and inter-municipality communication as well as modern technologies introduced to improve the life of residents in changing climatic conditions can stimulate their creativity and willingness to cooperate. Transparency of decisions-making and the creativity of the leaders is also the key to changing the peripheral image of border municipalities.

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## Author's profile

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# Mobility scooters in Italy: the reason of a "missed revolution". A potential resource for individual mobility in the Covid-19 era needs legislation

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**Abstract**
Mobility scooters have evolved up to modern cabin versions and to application of still futuristic solutions in the automotive sector: they could even be a resource for individual mobility in the Covid-19 era, but in Italy they seem unable to establish, mainly because of lacking and approximate legislation. Article 46 of the Italian Highway Code generically delegates the definition of "machines for disabled persons" (not considered vehicles) to "current Community provisions", but the explanatory note of heading 8713 of EU Combined Nomenclature of goods and EU Regulations 718/2009 and 2021/1367 equate mobility scooters to motor vehicles: as such they are an unknown entity for the Highway Code, therefore they should be considered unregulated atypical vehicles, which are forbidden in public areas. We propose the classification of mobility scooters as "motor vehicles" for both able and disabled persons and a specific regulation of their characteristics and circulation. Our legislative proposal could be useful even outside Italy, since some disputes at the European and National Courts and the absence of mobility scooters among the three-wheel vehicles and quadricycles categorized by EU Regulation 168/2013 are a symptom that they are still a controversial topic even abroad and need a clear-cut national and international legislation.

**Keywords**
Mobility scooters; Electric wheelchairs; Electric micromobility; Urban mobility; Legislation.

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# 1. Introduction

Mobility scooters in Italy are called "electric scooters for the disabled and elderly" ("scooter elettrici per disabili e anziani"). This negative name has its roots in the Italian Classification of Medical Devices, where they are still indicated by the extremely generic term of "electric scooters" ("scooter elettrici", code Y122124). Currently the Italian Highway Code does not consider them vehicles nor does its classification of vehicles provide for a vehicle specifically called "scooter". Regardless of whether they are considered vehicles or not, calling them "electric scooters" is misleading, especially since in recent years electric road scooters have become established (from mopeds like Vespa Elettrica L1 to maxiscooters like BMW C Evolution, today in Italy you can choose from more than 70 electric models) and now the confusion between categories reigns supreme. On the other hand, we reject the more specific but restrictive and ghettoizing denomination of "electric scooters for the disabled and elderly", being convinced that they can prove to be a formidable aid also for the mobility of so-called able persons and that their success in other countries is due to the lesser connotation of disability compared to electric wheelchairs, especially if we consider also the innovative paradigm of autonomous vehicles that will characterize our future mobility. Therefore, personally we have adopted the international name of "mobility scooter" in our Italian language and we propose that it should be adopted even in the Italian Classification of Medical Devices.

But the real problem is something else. While we were trying to set up a scientific study on the modern and versatile cabin versions, suspicious of the too many difficulties that we were facing in finding them in shops and on road, we detected a bad flaw in the legislation of mobility assistive devices which dramatically compromises the possibility that any mobility scooter is allowed to circulate in areas open to the public, and which seems definitely unknown even to sector operators. Therefore, we want to raise awareness of this problem and to propose a comprehensive solution, since mobility scooters are systematically ignored by any decree on electric micromobility instead of being valorized as the most serious micromobility device for both disabled and able persons, and are still a matter of controversy even abroad.

# 2. Why "scooters"? The legislation background of these "motor vehicles"

The "scooter" is defined as a motor vehicle of motorcycle origin characterized by a frame which is centrally open in the upper part and by a lower platform that allows the driver to sit in an upright position with parallel legs. The term scooter originated from the existence of the platform, which recalls the kick scooter. The diffusion of the term is mainly due to the success of a model produced by the English company ABC, called "Scootamota" with the clear intention of recalling the term "scooter motor" by assonance, many years before the world-famous Italian Vespa made it a real custom phenomenon.

Mobility scooters in fact follow the structure and the driving setting of a motor scooter, more comfortable than a motorcycle, and the modern cabin mobility scooters approximate the comfort of a car.

## 2.1 Mobility scooters today

There are currently various types of mobility scooters (Cannata & Foti, 2020): portable, three-wheel, four-wheel, and cabin (Fig.1).

Portable models can be folded or partially disassembled to find accommodation in the trunk of an automobile. They are the most manageable and those with the smallest turning radius, but are less sturdy and have a limited carrying capacity.

The three-wheel mobility scooters, faithful to the first historical models of the 50s and 60s, are equipped with two rear wheels and one front steering wheel. They are more powerful, robust and comfortable than the previous ones, maintaining good doses of manageability and size that allow their use even at home. In the external environment they work best on flat and uniform surfaces.

**Fig.1 The various types of mobility scooters: portable, three-wheel, four-wheel, and cabin *(source: Officine Ortopediche S.r.l.)***

The four-wheel mobility scooters ensure better stability: they are the fastest and most reliable models and are stable in the external environment on uneven surfaces, with a wider turning radius and less maneuverability. The cabin models are equipped with a closed body, which makes them almost as versatile as small cars.
Mobility scooters are a great advantage, in travelling short and medium-haul routes, for all those people who have reduced mobility due to disability or old age. Thanks to these assistive devices, in fact, these subjects can receive autonomy and independence in daily life activities, also benefiting from safety and comfort (Thoreau, 2015; Gitelman et al., 2020). Some models can accommodate two seats and allow companionship and assistance to patients with disabilities; others have the ability to overcome differences in level even higher than 20-25%, allowing the removal of urban barriers with a consequent important progress also socially (Mortenson & Kim, 2016). An important difference between the cabin mobility scooter and the open one is the possibility of using the first even in the colder months as it guarantees total protection from the outside, in addition to the presence of internal heating devices; in the same way it offers shelter from the sun in the warmer months and even air conditioning on some models. In addition to the protective function of the cabin structure also against impacts, security measures are represented by cameras and parking sensors. The use of these scooters, promoting greater autonomy in external mobility (and therefore a greater possibility of social contact), reduces the risk of the onset of depression (especially in the elderly). Autonomy is also seen as personal growth, as the acquisition of power by the individual capable of making decisions, relating to others, managing and planning his own life, which is not measurable but which is appreciated in a completely individual and personal way from the subject and improves his quality of life (Akhavan & Vecchio, 2018; Battarra et al., 2018). Finally, judged from the outside, the use of these devices in patients with visual impairments may seem careless, however recent studies have shown an improvement in autonomy in this population in parallel with a conscious and safe use of the device itself (McMullan & Butler, 2019). The safety equipment, and not only for this particular category of subjects, could be further increased by the adoption of automatic emergency braking, now widespread on conventional cars.
Mobility scooters can be prescribed to patients who are unable to push a wheelchair or who require comfortable and fatigue-free assisted mobility, provided they have sufficient upper limb validity for driving, good head and trunk control and the ability to carry out postural passages independently. Furthermore, a certain control of the lower limbs must be preserved, in the absence of contractures that hinder the flexion of the knees. The turning radius of a mobility scooter, especially of a four-wheeled, is greater than that of an electric wheelchair, making it more suitable for use in the external environment (Cannata & Foti, 2020).

## 2.2 From assistive devices to new vehicles for a sustainable mobility?

Can it be hypothesized that these assistive devices, originally designed for disabled and elderly people, could become a further alternative in mobility also for able people? According to the International Classification of Functioning, Disability and Health (ICF) model, disability is defined as the "result of the correlation between a person's health condition and environmental factors that represent obstacles or facilitators to the exercise of

rights and participation". Among the environmental factors that negatively affect the participation of individuals, the psychological stress that results from spending many hours in traffic or finding parking, which a small vehicle could improve, should also be considered; in the same way, from a strictly physical point of view, the decrease in time spent sitting behind the steering wheel could help to reduce the incidence of disabling problems such as low back pain. The "electric scooter for the disabled and elderly", therefore, could help to remove in a broad sense the physical and social barriers that hinder the exercise of rights and participation even in subjects considered still able. Accessibility is also a cornerstone of the European disability strategy 2010-2020, with particular attention to removing obstacles to mobility.

Another aspect to consider is the strong debate that is currently involving the transport sector, with particular reference to land vehicles, which represent one of the main culprits of PM10 e CO2 emissions. The phenomenon of climate change, the fluctuation of oil prices and the important technological innovations in sectors relevant to the automotive industry (for example in the battery production) have given a strong boost to the use of electric and hybrid vehicles and to the development of charging infrastructure. In Italy, for example, 2019 marked an important milestone for the spread of the electric car, since for the first time, in April, the threshold of 1,000 vehicles registered in a month was exceeded (data from the third edition of the Smart Mobility Report). In this sense, a greater diffusion of mobility scooters would be a potential aid to environmental issues; it would also help to reduce the purchase costs of modern and versatile cabin scooters, which are still relatively high compared to those of open scooters albeit lower than those of an electric car, to the benefit of the often low-income categories for which they were originally designed.

The driving range of mobility scooters is a few tens of km, sufficient for an urban use without particular restrictions; users may find an effective range lower than the theoretical range declared by the company, but it is a common problem also for electric cars. Being light and relatively slow, they need a fairly small and not too expensive battery pack, which can also be detached from the scooter and taken home for recharging. Additional batteries are available if required. A myriad of models of mobility scooters are marketed worldwide to rival the variety offered by the automotive market: slower and faster, single and two-seater, open and covered, they meet the most varied needs for autonomy of the disabled persons and can easily be adapted even to the needs and modalities of urban mobility of able persons.

Unfortunately, these encouraging premises in Italy have to deal with a regulatory situation that is far from favourable, even for disabled persons themselves.

## 2.3 What the Italian Highway Code says: a delegation to "current Community provisions"

The "machines for use by disabled persons" are taken into consideration in Articles 46 and 190 of the "New Highway Code" of 1992 and in Article 196 of the related "Implementing Regulation" of the same year, which were subject to some updates in later periods.

The first draft of Article 46 of the 1992 Highway Code specified that machines for the use of disabled people, even if serviced by an engine, whose characteristics do not exceed the limits established by the Regulation, do not fall within the definition of vehicle; according to Article 190, they are allowed to circulate on the parts of the road reserved for pedestrians.

Article 196 of the 1992 Implementing Regulation, modified in 1996, lists the construction characteristics of the assistive devices for disabled persons, which must be such as not to exceed the following limits: a) maximum length 1.10 m; b) maximum width 0.50 m, with the exception of the area between two vertical planes, orthogonal to the median longitudinal plane of the "vehicle" and 0.60 m distant from each other, where the maximum width can reach 0.70 m; c) maximum height 1.35 m, in the area where the maximum width of the device can reach 0.70 m, linearly variable from 1.35 m to 0.80 m, the maximum value that can be reached at the front end of the device; d) single seat; e) mass in running order 40 kg; f) maximum engine power 1 kw;

g) maximum speed 6 km/h for devices equipped with engines. This limit is obtained by design and refers to the maximum number of revolutions of use of the engine declared by the manufacturer and to the higher gear ratio. The test is carried out on the road by the driver in an upright position (mass 70 ± 5 kg).
Exceeding even one of the indicated limits involves the inclusion of the machine in the actual vehicles.
The law 29 July 2010, n. 120 "Provisions on road safety" has drastically modified Article 46: any reference to the limits established by the Implementing Regulation disappears, and it is specified that machines for the use of disabled persons, *which are included in medical assistive devices according to the current Community provisions*, do not fall within the definition of vehicle, even if they are serviced by an engine.
According to some interpretations of the provisions of Italian Highway Code (Gagliano, 2014; Cappellini, 2020), including the modification to Article 46 occurred in 2010, the "electric scooters for the disabled and elderly" do not fall within the definition of vehicle and must anyway respect the limits imposed by Article 196 of the Implementing Regulation. If they exceed even one of these limits, they are included in the vehicles, but since they are not homologated as such, they can only circulate in private areas that are forbidden to the public. On some models the 6 km/h speed limit can be manually deactivated with a switch and brought to higher speeds; also in this case the device must be used exclusively on private areas closed to the public, since the Regulation orders a maximum *design* speed of 6 km/h.
However, we believe that the modification of Article 46, paragraph 1 of the Highway Code laid down by the Law of 29 July 2010 offers a different reading key, which articulates the regulatory interpretation of motorized assistive devices for the mobility of disabled persons with even more worrying implications for mobility scooters.
In fact, in the new Article 46, the right weight must be given to the phrase *included in medical assistive devices according to the current Community provisions* which has replaced the phrase *whose characteristics do not exceed the limits established by the Regulation*. Consequently, the technical characteristics of the "machines for the use of disabled persons" provided by Article 196 of the Implementing Regulation are exceeded by those identified by the "current Community provisions": in other words, if according to current Community provisions a mobility scooter is included in medical assistive devices, it derogates from all the dimensional, weight and performance limits laid down by the Regulation to authorize its circulation in areas open to the public, it being understood that it does not fall within the definition of vehicle and can therefore only circulate on parts of the road reserved for pedestrians.
A note in the document "Urban mobility scooters and the rules of the Highway Code" of the Seniorlife company corroborates this different interpretation: "The law 120/2010 Article 8 paragraph b amends Articles 46 and 190 of the Highway Code eliminating the dimensional prescriptions of the same, referring to community provisions, and not to Article 196 of the Implementing Regulation 495/1992".
But what are the "current Community provisions" on mobility scooters?

## 2.4 What the "current Community provisions" say: a drastic split in "carriages for disabled persons"

The goods nomenclature of the European Community, called the "Combined Nomenclature" (published on 7 September 1987 in the Official Journal of the European Communities L256 and updated in 2004), identifies with the code 8703 the "Motor cars and other motor vehicles principally designed for the transport. of persons", distinguishing them from goods with code 8713 designated as "Invalid carriages, whether or not motorized or otherwise mechanically propelled: 87131000 Not mechanically propelled and 87139000 Other". Mobility scooters seem to fall under the heading "87139000 Other", although this heading is very generic and without technical specifications.

But in the Official Journal of the European Union C1 of January 4, 2005, an explanatory note of the heading "8713 – Carriages for disabled persons, whether or not motorized or otherwise mechanically propelled – 87139000 Other" was published:

"Motorised vehicles specifically designed for disabled persons are distinguishable from vehicles of heading 8703 mainly because they have:

- a maximum speed of 10 km per hour, i.e. a fast walking pace;
- a maximum width of 80 cm;
- 2 sets of wheels touching the ground;
- special features to alleviate the disability (for example, footrests for stabilising the legs).

Such vehicles may have:

- an additional set of wheels (anti-tips);
- steering and other controls (for example, a joystick) that are easy to manipulate; such controls are usually attached to one of the armrests; they are never in the form of a separate, adjustable steering column.

This subheading includes electrically-driven vehicles similar to wheelchairs which are only for the transport of disabled people. They can have the following appearance:

**Fig.2 According to the explanatory note of the heading 8713 of the EU Combined Nomenclature of goods, this is a "carriage for disabled persons"** ***(source: Official Journal of the European Union C1 of 4 January 2005)***

However, motor-driven scooters (mobility scooters) fitted with a separate, adjustable steering column are excluded from this subheading. They can have the following appearance and are classified in heading 8703:"

**Fig.3 Instead this device with a steering column is a "motor vehicle principally designed for the transport of persons"** ***(source: Official Journal of the European Union C1 of 4 January 2005)***

Therefore, according to this European regulation, the presence of "a separate, adjustable steering column" classifies mobility scooters as *motor vehicles*, not as carriages for disabled persons.

While motorized wheelchairs benefit from an improvement of their characteristics (maximum width and speed increased to 80 cm and 10 km/h, no limit to other dimensions, mass, power and number of seats), for mobility scooters only the presence of the steering column and their equivalence to motor vehicles are specified.

For further clarification, on 4 August 2009 the Commission of the European Communities produced the Regulation No. 718/2009 specifically concerning the classification of mobility scooters in the Combined

Nomenclature, that was published in the Official Journal of the European Union L205 of 7 August 2009. This Regulation explains the reason for the classification of mobility scooters under code 8703 rather than 8713 in the following terms, together with an approximate and questionable description of their technical characteristics.

## Description of the goods

Four-wheeled vehicle with an electric motor powered by two rechargeable 12 V batteries. It is approximately 48 cm wide, 99 cm long and 58 cm high (with the backrest folded down), with a total weight without batteries of approximately 34.5 kg. The maximum load is approximately 115 kg.
The vehicle has the following characteristics:

- a horizontal platform connecting the front and rear sections,
- small wheels (approximately 2.5 × 19.0 cm) with anti-leak tyres,
- an adjustable seat without armrests and grips whose height can be set in one of two positions, and
- a steering column that can be folded down.

The steering column has a small control unit including a contact switch, a horn, a battery output display and a button to set the maximum speed.
The vehicle has two thumb-operated levers for accelerating, braking and reversing. There are anti-tip wheels at the back of the vehicle to prevent it from tipping over. It has an electronic dual braking system.
When its batteries are fully charged it has a maximum range of approximately 16 kilometres and can reach a maximum speed of approximately 6.5 km/h.
The vehicle can be disassembled into four light components. It is designed for use at home, on footpaths and in public spaces, for activities such as shopping trips.

**Fig.4 According to the EU Regulation 718/2009, this four-wheeled device is a "special type of a vehicle for the transport of persons" which is not specially designed for the transport of disabled persons and has no special features to alleviate a disability *(source: Official Journal of the European Union L205 of 7 August 2009)***

Three-wheeled vehicle with an electric motor powered by two rechargeable 12 V batteries. It is approximately 61 cm wide, 120 cm long and 76 cm high (with the backrest folded down), with a total weight without batteries of approximately 46 kg. The maximum load is approximately 160 kg.
The vehicle has the following characteristics:

- a horizontal platform connecting the front and rear sections,
- small wheels (approximately 8.9 × 25.4 cm) with anti-leak tyres,
- an adjustable seat with armrests and grips whose height can be set in one of three positions, and
- a steering column that can be folded down.

The steering column has a small control unit including a battery meter, a contact switch, buttons to activate lights, a horn and a button to set the maximum speed.
The vehicle has two thumb-operated levers for accelerating, braking and reversing. There are anti-tip wheels at the back of the vehicle to prevent it from tipping over. It has an electronic dual braking system.

When its batteries are fully charged it has a maximum range of approximately 40 kilometres and can reach a maximum speed of approximately 8 km/h.
The vehicle can be disassembled into seven light components. It is designed for use at home, on footpaths and in public spaces, for activities such as shopping trips.

**Fig.5 Even this three-wheeled device is a "special type of a vehicle for the transport of persons" not specially designed for the transport of disabled persons *(source: Official Journal of the European Union L205 of 7 August 2009)***

## Classification (Combined Nomenclature code): 8703 10 18

## Reasons

Classification is determined by General Rules 1 and 6 for the interpretation of the Combined Nomenclature and by the wording of CN codes 8703, 8703 10 and 8703 10 18.
The vehicle is a special type of a vehicle for the transport of persons.
Classification under heading 8713 is excluded as the vehicle is not specially designed for the transport of disabled persons and it has no special features to alleviate a disability. (See also the Harmonised System Explanatory Notes to heading 8713 and the Combined Nomenclature Explanatory Notes to subheading 8713 90 00.)
The vehicle is therefore to be classified under CN code 8703 10 18 as a motor vehicle principally designed for the transport of persons."
So the change to Article 46 of the Italian Highway Code has produced the result that, regardless of exceeding even one of the limits indicated in the first paragraph of Article 196 of the Implementing Regulation, the "current Community provisions" imply the inclusion of mobility scooters "in the vehicles referred to in the first sentence of Article 46, paragraph 1". As such they are an entity unknown to the classification of vehicles operated by Article 47 of the Italian Highway Code, *and therefore in Italy could not even circulate in areas open to the public*.
Apart from the distorted effects of this combination between the Italian Highway Code and the Community provisions, in the European Union States the devices for the disabled persons enjoy exemption from customs duties and other tax breaks, and therefore the legal disputes at the Court of Justice of the European Union were not late.
The judgment of the European Court (Seventh Chamber) of 22 December 2010, Case C-12/10, Lecson Elektromobile GmbH (importer of mobility scooters) v Hauptzollamt Dortmund (German customs agency) has strengthened and developed the provisions from the explanatory note of 2005:
"Heading 8703 of the Combined Nomenclature in Annex 1 to Regulation No 2658/87 on the tariff and statistical nomenclature and on the Common Customs Tariff, as amended by Regulation No 1810/2004, must be interpreted as covering three or four-wheeled vehicles designed for the transport of one person *who is not necessarily a disabled person*, powered by a battery-operated electric motor, reaching a maximum speed of 6 to 15 km/h and equipped with a separate, adjustable steering column, known as 'electric mobility scooters'. *(omissis)* The mere fact that those electric mobility scooters may be used, where appropriate, by disabled persons or even may be adapted for use by disabled persons does not affect the tariff classification of such

vehicles, given that *they are suitable for use for several other activities by persons who do not suffer from any disability*, but who for one reason or another prefer to travel short distances other than on foot, like golfers or persons going shopping."

Therefore, this judgment reiterates that mobility scooters are to be considered vehicles and are not assistive devices for the disabled person.

But a few years later, in a completely analogous controversy, the judgment of the European Court (Tenth chamber) of 26 May 2016, Case C-198/15, Invamed Group Ltd, Invacare UK Ltd, Days Healthcare Ltd, Electric Mobility Euro Ltd, Medicare Technology Ltd, Sunrise Medical Ltd, Invacare International SARL (UK importer of mobility scooters) v Commissioners for Her Majesty's Revenue & Customs (UK custom agency), reaches diametrically opposed conclusions:

"That reasoning confirms, *a contrario*, that the fact that the vehicles at issue in the main proceedings may, in some circumstances, be used by non-disabled persons is irrelevant to the tariff classification of such vehicles under heading 8713 of the Combined Nomenclature, since by reason of their original purpose, *those vehicles are unsuitable for other persons who do not suffer disabilities*. *(omissis)* Heading 8713 of the Combined Nomenclature set out in Annex I to Council Regulation (EEC) No 2658/87 of 23 July 1987 on the tariff and statistical nomenclature and on the Common Customs Tariff, as amended by Commission Regulation (EC) No 1810/2004 of 7 September 2004, must be interpreted as meaning:

- the words 'for disabled persons' mean that the product is designed solely for disabled persons;
- the fact that a vehicle may be used by non-disabled persons is irrelevant to the classification under heading 8713 of the Combined Nomenclature;
- *the Explanatory Notes to the Combined Nomenclature are not capable of amending the scope of the tariff headings of the Combined Nomenclature*."

The European Court therefore sanctioned in 2010 that mobility scooters are suitable for both the disabled and the able persons, but then in 2016 it specified that they continue to be considered "carriages for disabled persons" since, due to their initial destination, they are not suitable to people who do not suffer from disability, even going so far as to deny the explanatory note of the European Community itself and thus giving rise to dangerous ambiguities, contradictions and regulatory gaps that hinder the usability of mobility scooters for both the disabled and the able persons.

In fact the 2016 sentence fostered a series of contradictory sentences of the UK National Court. The last sentence issued on 25 February 2020 (appeal of Invamed Group Ltd and other companies, case No. A3/2018/2938) conformed to the 2016 sentence of the European Court. At the same time it pointed out that the Regulation No. 718/2009 came too late to apply to the mobility scooters imported in the period 2004 to 2007 which featured on that dispute. Had it applied then, it would have been binding and definitive, subject only to a possible challenge to its validity in the European Court. Nowadays it remains crucial as confirmation of a general and consistent treatment of mobility scooters as vehicles falling within heading 8703. It is considered even more mandatory than the previous 2005 note to the heading 8713.

The positive aspect is that a common thread emerges from these contradictory judgments: mobility scooters are considered vehicles for the use of both able and disabled persons.

The search engine of the portal of the European Commission of Mobility and Transport, entering the words "mobility scooters" in quotes, merely provides a document dated 8 January 2016 (just before the second judgment of the European Court) relating to a community decision in customs matter with regard to the United Kingdom, in which the incorrectness of classifying mobility scooters with the "duty free" code 8713 instead of the code 8703 is marginally recalled.

Quite recently, on 6 August 2021 the European Union has felt the need to issue a further clarifying document on its classification of mobility scooters, the Commission Implementing Regulation (EU) 2021/1367 *(Official Journal of the European Union L294 of 17 August 2021)*, which puts a tombstone on any possibility that

mobility scooters may be "included in medical assistive devices according to the current Community provisions", albeit leaving open the possibility that a national authority may carry out a post-clearance assessment of the vehicle for purposes other than those laid down in customs legislation:

## Description of the goods

Four-wheeled vehicle with a DC 24 V 800 W electric motor powered by two 12 V rechargeable batteries with 45 Ah-capacity. It is approximately 65 cm wide, 125 cm long and 129 cm high (measured at the seat back, 85 cm with the seat back folded down). Its total weight is approximately 107 kg (108 kg including the batteries). The maximum load is approximately 130 kg.

The vehicle has the following characteristics:

- a horizontal platform connecting the front and rear sections; the platform cannot be adjusted in any way (e.g. folded or tilted) to suit the user's needs;
- two sprung axles, rear-axle drive and an 820 mm wheelbase;
- gradient capability 13°;
- turning circle 210 cm,
- two sets of inflatable tyres (the rear tyres being larger than the front ones);
- a configurable, height-adjustable rotating seat with supports and armrests and a non-slip surface for the feet;
- an adjustable fold-down steering column with oval-shaped handlebars;
- front and rear lights, direction indicators and rear-view mirrors.

The steering column also has a dashboard featuring a switch box, a speed control, a horn button, an engine-idle button, a blinker switch, a light switch, a battery-status indicator and a speed adjuster.

The vehicle has two manually operated levers for accelerating, braking and reversing. The steering can be adjusted to allow operation with one hand. It has a 'smart' regenerative electromagnetic braking system.

With fully charged batteries, the vehicle has a maximum range of up to 45 kilometres and can reach a maximum speed of approximately 15-16 km/h.

It may be fitted with small anti-tipping wheels at the back, a shopping basket, a walking-stick holder, etc.

The vehicle may be stowed for transport purposes. It may be used on roads, pavements, footpaths, pathways in parks, cycle paths and certain leisure trails, or in pedestrian areas (e.g. shopping precincts).

## Classification (Combined Nomenclature code): 8703 10 18

## Reasons

Classification is determined by General Rules 1 and 6 for the interpretation of the Combined Nomenclature and by the wording of CN codes 8703, 8703 10 and 8703 10 18.

Classification under heading 8713 as a carriage for disabled persons is excluded as the vehicle is not specially designed for the transport of disabled persons: it has no special features to alleviate a disability.

Although the vehicle is designed so that the steering can be controlled with one hand and features a comfortable rotating seat with supports and a non-slip surface for the feet (and may optionally be fitted with small anti-tipping wheels), such characteristics do not objectively constitute special features designed to alleviate a disability (see also the Combined Nomenclature Explanatory Notes (CNEN) to subheading 8713 90 00, the Harmonized System Explanatory Notes to heading 8713 and HS classification opinion 8703.10/1).

In addition, vehicles fitted with a separate, adjustable steering column and those reaching a maximum speed over 10 km per hour are excluded from heading 8713 (see also CNEN to subheading 8713 90 00).

The vehicle is used for transporting persons and upon presentation to customs authorities it is not recognisable as a vehicle designed solely for disabled persons (see Case C-198/15: Judgment of the Court of 26 May 2016, *Invamed Group Ltd and Others v Commissioners for Her Majesty's Revenue & Customs*, ECLI:EU:C:2016:362), based on its objective characteristics and properties which must be assessed at the time of customs clearance (see Case C-286/15: Judgment of the Court of 26 May 2016, *Latvijas propāna gaze*, ECLI:EU:C:2016:363, paragraph 33). Any subsequent post-clearance modification of the vehicle is disregarded as is any assessment of the vehicle that may be carried out by a national authority for purposes other than those laid down in customs legislation.

The vehicle is a special type of vehicle for the transport of persons.

It is therefore to be classified under CN code 8703 10 18 as a motor vehicle principally designed for the transport of persons, similar to golf cars."

**Fig.6 According to the EU Regulation 2021/1367, this device is to be classified as a motor vehicle similar to golf cars and may be used almost everywhere *(source: Official Journal of the European Union L294 of 17 August 2021)***

The Community Regulation No. 168/2013 of the European Parliament and of the Council of 15 January 2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles, with subsequent amendments and adjustments *(Official Journal of the European Union L060 of 2 March 2013, L53 of 21 February 2014, L77 of 23 March 2016, L30 of 31 January 2019)*, has profoundly updated the classification and approval procedures of two or three-wheeled motor vehicles and quadricycles, but the mobility scooter category is still not envisaged. It should be emphasized that mobility scooters, although they share a basic design and various functions, represent a somewhat heterogeneous category with some characteristics also shared by electric wheelchairs. There is no "the" mobility scooter, and it is precisely this relative lack of homogeneity in form and functions that makes it difficult to regulate them (Birtchnell et al., 2018). But this only confirms how indispensable it is now to make them the subject of specific and precise legislation, and not only at national level.

Confusion reigns in this regulatory vacuum, even among professionals. Almost everywhere on the web, when looking for legislation according to which mobility scooters are to be considered medical devices so that they can circulate as "non-vehicles" pursuant to the provisions of the reformulation of Article 46 of the Highway Code, we come across this typical explanation:

"It is necessary that the manufacturer declare that the product is built according to the current Community provisions. Specifically, the manufacturer's declarations should certify that the vehicle has been designed for people who are unable to walk or have difficulty in walking and are physically and mentally able to drive an electric vehicle, and that it has been produced in accordance with the European standards (e.g. EN 12184) and is entered in the Register of Medical Devices in accordance with the decree of the Minister of Health of 20 February 2007. Better if the vehicle has been successfully tested for its safety according to German and international standards."

The code EN 12184 indicates a European construction standard that concerns the requirements and test methods for electrically powered wheelchairs, mobility scooters and their chargers. *This is not the same as saying that mobility scooters are medical assistive devices.* It would be like saying that since a car adapted for a disabled person needs automatic gearbox and power steering, then any car equipped with automatic gearbox and power steering is a medical assistive device. The inclusion in the Italian Register of Medical Devices and the successful tests according to German and international standards are even less relevant.

## 2.5 Mobility scooters according to the UK legislation: two classes of "motor vehicles" that can also be driven on the road

In United Kingdom, manual and motorized wheelchairs and mobility scooters are considered medical devices for people who are unable to walk or have difficulty in walking; in legal language they can still be found with the definition of "invalid carriages", but are currently defined as "mobility vehicles". The UK Government website provides a guidance classifying "vehicles, bicycles, parts and accessories" for import and export (HM Revenue & Customs, last updated october 2018) where mobility scooters are defined as *vehicles* designed for use in the home, on footpaths and in public spaces. They are classified under heading 8703 subheading 8703 10 18.

There are three types of "invalid carriage" defined in "The Use of Invalid Carriages on Highways Regulations 1988":

- Class 1: manual wheelchairs, not electrically powered;
- Class 2: powered wheelchairs and mobility scooters, intended for footpath or pavement use only with a maximum speed limit of 4 mph (6,4 km/h);
- Class 3: powered wheelchairs and mobility scooters, that can also be driven on the road, with a maximum speed of 8 mph (12.8 km/h) but equipped with a speed limiter at 4 mph for use in pedestrian areas.

Requirements for a Class 2 vehicle: unladen weight excluding driver up to 113.4 kg; maximum speed 4 mph (6.4 km/h); lights and reflectors only if used on the carriageway between sunset and sunrise; braking system.

Requirements for a Class 3 vehicle: width up to 0.85 m; unladen weight excluding driver up to 150 kg; maximum speed 8 mph (12.8 km/h); front and rear lights and reflectors; direction indicators capable of operating as a hazard warning signal; amber flashing light when used on dual carriageways; rear view mirror; audible warning instrument; braking system.

In essence, a detailed and precise regulation where necessary, realistic enough, which extends the usability of "mobility vehicles", clearing the field of ambiguity and misinterpretation. Many countries follow the UK model in distinguishing two categories of mobility scooters and in differentiating the maximum speeds they can reach in pedestrian areas or on the road (Steyn & Chan, 2008).

The downside is that in United Kingdom mobility scooters may only be used by disabled persons, while two-seater scooters are not allowed to circulate in public areas, whether they are roads or sidewalks. However, this restriction does not prevent United Kingdom from being at the forefront throughout Europe in the diffusion of mobility scooters, which are even more common than two-wheeled electric kick scooters used by younger people as a rapid and economic alternative in urban transport. Around 80,000 mobility scooters are sold each year in United Kingdom and up to 350,000 mobility scooters and motorized wheelchairs are estimated to travel (Research Institute for Consumer Affairs, 2014). "Mobility shops" can be found just about anywhere and new ones open every month. It is easy to observe flocks of mobility scooters around shops, promenades, tourist attractions and public parks, symbolizing freedom, progress and independence. People who in the past were relegated to their homes now have the opportunity to go to bar, restaurant and shopping with a vehicle that does not stigmatize their motor limitations like an electric wheelchair. A clear and well-drafted legislation is always beneficial, even for purely economic aspects, leading to an epochal change if one considers that until

the 1980s these devices were almost unknown in United Kingdom. In Italy they continue to be semi-unknown and those few that circulate are held up as a symbol of "handicap".

## 2.6 Country you go, legislation you find: but when in Rome don't do as the Romans do

We have taken the UK legislation as a reference because it seems to us particularly complete and somewhat adaptable to the characteristics of the Italian context, but the laws in Europe and in the world concerning motorized assistive devices for mobility are very variable.

Another country where mobility scooters are quite widespread is Holland, but if we compare its legislation with the UK one, there are profound differences. In the Netherlands, mobility scooters are registered vehicles, which can be driven from 16 years of age, can circulate on the road and reach a speed of 45 km/h (practically like Italian light quadricycles), just below the limit of 50 km/h which applies in built-up areas. They are subject to the obligation of insurance, the mark of which must be clearly displayed. At the same time, they are allowed to circulate on the wide network of cycle paths, where they cannot exceed 30 km/h in the town and 40 km/h outside the town: speeds significantly higher than the average of cyclists, but usually, when they use cycle paths, mobility scooter drivers limit their speed to 20 km/h, in order to favour "cohabitation". It being understood that they can also circulate on pavements, where they are considered pedestrians and cannot exceed the speed of 6 km/h. The maximum dimensions are surprising: width 1.10 m, height 2 m and a length of 3.50 m.

Steyn & Chan (2008) carried out an extensive review of the regulations for mobility scooters in various countries: UK, Denmark, Sweden, the Netherlands, France, Spain, Australia (state of Queensland), New Zealand and British Columbia (Canada). The selection of countries and regions was based on the availability and clarity of information on regulations: it is probably no coincidence that Italy was missing, and we do not believe that the subsequent advent of the amendment to Article 46 of the Italian Highway Code would have made it part of the selection. Spain did not have national legislation but recommended following UK legislation; currently each local authority can establish its own rules.

This review highlighted that most jurisdictions make a distinction between slow and fast mobility scooters: the intent seems to be to regulate their speed in different road or traffic contexts. There is a consensus that mobility scooters need to travel at lower speeds in pedestrian environments such as pavements, where they should be treated as pedestrians. Mobility scooters capable of higher speeds can only reach them on the road and are classified as vehicles. In general, their classification as vehicles is accompanied by the obligation of registration and vehicle equipment; in some jurisdictions there is also an insurance requirement. Speeds in pedestrian areas vary from 4-5 km/h in Sweden to 10 km/h in Queensland (Australia), passing through 6 km/h in France and 6.4 km/h in UK. Mobility scooters are allowed on cycle paths in the Netherlands, but it is unclear whether this is also the case in other jurisdictions. New Zealand legislation is the most explicit in terms of consequences for those who break the rules: driving a mobility scooter carelessly, recklessly or at dangerous speeds can result in a penalty. If it causes injury or death, the user of a mobility scooter could even be sentenced to imprisonment.

In the state of Queensland (Australia), user registration is required, who needs a medical certificate to prove that the scooter is intended to compensate for mobility problems. The requirement for proof of a mobility problem appears to be a unique feature of the Queensland regulatory model. Furthermore, none of the jurisdictions examined require mobility scooter users to have a driving license and they are not required to provide proof of fitness to drive. The medical certificate required in Queensland only certifies that the user of the mobility scooter must use it due to a serious impairment of mobility and not suitability to use it. However, Queensland legislation stipulates that a mobility scooter must only be used by the registered operator. A regulation for the education and training of users was not found in any of the countries examined.

The Israeli Transport Regulations issued in 2013 provide that mobility scooters can also have two seats, with a width of up to 1 m and a maximum speed of 12 km/h, allowing driving on the road if the sidewalk is impassable; electric propulsion is mandatory (Gitelman et al., 2016).

We also examined two Eastern European countries, Romania and Poland. In Romania the situation is still evolving: the laws are constantly being modified and updated, with attempts that are not always fruitful, to align with European trends. Only recently has a clear distinction been made between "mopeds" (mopeds, tricycles and light quadricycles with a maximum speed of 45 km/h) and mobility scooters. The latter can have a maximum speed of 25 km/h and are also allowed on cycle paths. It should be noted that mobility scooters are not considered assistive devices for the mobility of disabled or elderly people, but a means of transport to reduce traffic and pollution. In Poland there are no explicit regulations, but the tendency is to conform to UK law; mobility scooters are allowed on pavements and roads, but not on cycle paths.

The research by Steyn and Chan (2008) included a stakeholder survey of their views on regulations, as well as a stakeholder and user survey of the routes and difficulties encountered while using a mobility scooter in terms of architectural barriers. Only a minority of stakeholders supported a "deregulation", considering it sufficient to rely on individual common sense. The majority, on the other hand, considered it essential to have legislation that regulates at least the areas of circulation and speeds, up to proposing a formal and structured classification and a specific regulation for mobility scooters.

Based on the information obtained from stakeholders and users, the researchers were also able to identify and document the problems of routes for users of mobility scooters, existing in any community that is not declared "mobility scooter friendly", with a rich iconography: narrow or non-existent sidewalks; permanent (poles) or temporary obstacles (construction sites, removable fences, vegetation) and inadequate spaces to bypass them; uneven, slippery, soft or steep surfaces; joints, curbs and differences in height; high and angular sidewalk edges; lack of ramps. Regarding some particularly congested areas of Italy, we would like to add among the temporary obstacles: cars and motorcycles parked wild on sidewalks, ramps and walkways.

The paper by Steyn & Chan (2008), which constitutes the final report of a research project of the University of Fraser Valley – Centre for Education & Research on Aging, funded by the Province of British Columbia (Canada), to our opinion remains a point of reference for regulatory and infrastructural planning on mobility scooters even after many years.

The most consistent finding of this study concerns the importance of mobility scooters in maintaining and improving the quality of life, which met with a strong consensus among all the participants in the research, including stakeholders and users. The general sentiment is that mobility scooter use "must be protected", and that any change in legislation and/or regulation must be considered with extreme care in terms of impact on the user's habits and quality of life.

The lack of adequate infrastructure is an element that can compromise a person's propensity to use a mobility scooter, making it perceived as a potentially dangerous means of transport. The impracticability of a sidewalk can force the user to drive the mobility scooter on the road, where he has to deal with larger and faster vehicles. Statistics on mobility scooter accidents are scarce, but the percentage of collisions with other vehicles seems very low in the face of falls, which indicate problems with infrastructures (Cassell & Clapperton, 2006). Mobility scooter users are careful in choosing their routes, with an intuitive preference for slow traffic conditions that probably helps prevent road accidents. However, in low traffic conditions, it is not uncommon that some users tend to disregard traffic rules even if the sidewalks are practicable, driving mobility scooters on the road in the directions and lanes that are convenient for them at that time (Gitelman et al., 2016).

How many differences exist in traffic conditions between cities in different countries and continents and within the different areas of the same city. It is impossible to find a uniquely "ideal" city to travel on a mobility scooter. There are areas where even pedestrians have difficulty moving from one point to another, even very

close as the crow flies (Gaglione et al., 2019). A recent urban plan is no guarantee of a "mobility scooter friendly" community: users can experience the same difficulties in Old Europe as in the Brand New Continent. How appreciable are Rome and the Italian ancient towns of any size, which allow people to live "in a walkable way" except for a few areas: thanks to the mistreated senescence of their urban layout (and to the questionable viability of the most recent built-up areas), they are more suitable to be travelled in mobility scooters rather than in SUVs or, if you say well, in "city cars" which now systematically start from a width of more than 1.70 metres. In our urban realities, mobility scooters can prove to be necessary means for travel, not only for people with disabilities, but also for those who do not have any apparent and clinically evident ones. Just like any other electric micromobility device.

Anyway, the above confirms that each nation regulates mobility scooters on its own based on the characteristics of the territory, the roads, the infrastructures, the transport needs and even the personality of the citizens: therefore, it appears even more out of place that the Italian Highway Code generically refers to "current community provisions" to parameter characteristics and circulation of motorized assistive devices for the disabled.

The motor disability rate in the population does not seem to be a determining factor and is not easily correlated with the spread of mobility scooters and the type of related legislation, given that, apart from the categorical provisions of Queensland, the requirement of "motor disability" seems to be understood in a rather broad sense and fades into the need for greater comfort in mobility universally felt by aged subjects (Bricocoli et al., 2018; Papa et al., 2018).

## 2.7 The "electric micromobility decree": a missed opportunity

Returning to Italy, on June 4, 2019 the Ministry of Infrastructure and Transport issued the decree for the experimentation of electric micromobility devices on the road. It deals with hoverboards, segways, electric kick scooters, monowheels, but there is no trace of mobility scooters. Yet, in all frankness, mobility scooters would be a much more versatile and stable device of electric micromobility than devices that require a dose of balancing that is not common even among perfectly able subjects.

## 2.8 The situation worsens after the conversion into law of the "milleproroghe" decree: the spectre of… destruction

Article 33-bis of the law of 28 February 2020, n. 8 "Conversion into law, with amendments, of the decree-law of 30 December 2019, n. 162, containing urgent provisions regarding the extension of legislative terms, the organization of public administrations, as well as technological innovation", the so-called "milleproroghe" decree ("thousand-extension" decree), in addition to postponing the end of the experimentation of the aforementioned electric micromobility devices for twelve months, has extrapolated the electric kick scooters, which have been compared to bicycles and liberalized on the road. Kick scooters with electric motors of continuous rated power not exceeding 0.50 kW and meeting the other technical and constructional requirements indicated in the decree of 4 June 2019 can be driven by users who have reached the age of fourteen and can circulate on urban roads with a speed limit of 50 km/h where the circulation of velocipedes is allowed, as well as on extra-urban roads if there is a cycle path and exclusively inside it. They cannot exceed the speed of 25 km/h when they travel on the roadway and 6 km/h when they travel on pedestrian areas. To drive at night and in low light conditions, lights must be provided, while the driver must wear the high-visibility reflective vest or braces. Helmets are mandatory for drivers under the age of 18. In any case it is forbidden to transport other people, objects or animals, to tow vehicles, to drive animals and to be towed by another vehicle. Rental services have the obligation of insurance coverage.

Mobility scooters could easily have been included in the decree for the experimentation of electric micromobility (Cannata et al., 2019), but this "milleproroghe" decree-law would lend itself even better to accommodate them alongside kick scooters, with some minor regulatory differences.
Instead, this same decree-law indirectly presents even darker scenarios to mobility scooters.
As we said, the "current Community provisions" to which Article 46 of the Highway Code refers do not consider mobility scooters as medical assistive device but equate them to motor vehicles.
But as such, mobility scooters, due to their specific characteristics, are not among the vehicles defined in Chapter I "About vehicles in general" of the Highway Code. Therefore, according to Article 59 "Vehicles with atypical characteristics" (modified by Legislative Decree 162/08 converted with modifications by Law 201/08), paragraph 1, they are to be considered atypical vehicles.
Pursuant to paragraph 2 of the same article (paragraph thus amended by law no. 120 of 29 July 2010), the Minister of Transport and Navigation, having heard the Ministers concerned, establishes, with his own decree:
a) the category, among those identified in this chapter, to which atypical vehicles must be assimilated for the purpose of circulation and driving;
b) the technical eligibility requirements for the circulation of the same vehicles, identifying them, with equivalence criteria, among those envisaged for one or more of the above categories.
To date, no categories and no technical requirements have been established for mobility scooters.
Article 33-bis, paragraph 3, of the conversion into law with modifications of the "milleproroghe" decree, added the following paragraph 2-bis to Article 59 of the Highway Code:
"Anyone travelling with an atypical vehicle for which the technical and functional characteristics indicated in paragraph 2 have not yet been defined is subject to the administrative sanction of paying a sum from € 200 to € 800. The violation is followed by the accessory administrative sanction of the confiscation of the vehicle, according to the rules of Title VI, Chapter I, Section II. In any case, its destruction is carried out".

## 2.9 A counterproductive "solution"

The issues between Italy and the European Union on the classification of mobility scooters as "vehicles" indeed have an outdated precedent. In 2007, an Italian parliamentary question called for regulatory changes to the Highway Code, approving this device and recognizing it, as planned by European legislation, as a "light moped" or including it in the "atypical vehicles" category. At that time, the original draft of article 46 of the Italian Highway Code with its reference to article 196 of the Implementing Regulation was still in force, while the explanatory note of code 8713 "Carriages for disabled persons, whether or not motorized or otherwise mechanically propelled" of the Combined Nomenclature had just been published in the Official Journal of the European Union. A draft decree was therefore drawn up by an Italian commission in order to establish, for wheelchairs and mobility scooters, construction characteristics other than those now anachronistic indicated in article 196 of the Implementing Regulation. The Italian Ministry of Transport notified the draft decree to the European Commission: but the latter, surprisingly and in open contradiction with its own explanatory note, stated that wheelchairs and mobility scooters were indiscriminately included among medical devices and as such could not be regulated by national standards that establish particular technical solutions (Marsicano, 2008). And so, in 2010 Italy chose the solution to modify article 46 of the Highway Code, delegating the definition of the technical characteristics of "non-vehicles" for disabled persons to the European Union. Just the year before, the Commission of the European Communities had issued Regulation No. 718/2009, even more categorical and binding than the previous explanatory note in not considering mobility scooters as medical devices. A catastrophic chain of events, which in Italy ended up drastically compromising the public circulation of mobility scooters, but which also demonstrated a clear inconsistency of the European Union in interpreting and applying its own regulations. Today, after the advent and consolidation of Regulation No. 718/2009 and its recent update by the Regulation No. 2021/1367, probably the response of the European

Union would be different and Italy would be free to regulate the technical characteristics and areas of circulation of these "motor vehicles" on its own, as happens in other countries. However, the European Union for its part should anyway contribute to definitively clarify, by including these "motor vehicles" in the classification of "two- or three-wheel vehicles and quadricycles" of its Regulation No. 168/2013.

## 3. Summing-up

It is common ground that United Kingdom, by limiting the use of mobility scooters to disabled persons by its own law, had the full right to challenge Community provisions which instead consider them to be motor vehicles for able persons. But it is even more striking how automatically the European Court has overturned the conclusions of a previous sentence of opposite tenor and has even denied the same explanatory note to the combined nomenclature, in fact following the UK legislation and at the same time taking care to specify that each final decision is referred to the national court. Anyway, even UK ended up adapting to the "current Community provisions", since the Regulation No. 718/2009 is considered more mandatory than the previous explanatory note of the heading 8713 even by the National Court. Finally, the recent Regulation No. 2021/1367 has definitively clarified that the European Union does not consider mobility scooters as assistive devices for disability, albeit leaving open the possibility of a post-clearance assessment of the vehicle that may be carried out by a national authority for purposes other than those laid down in customs legislation.
Therefore the substantial error was committed in the modification of Article 46 of the Italian Highway Code which intervened in 2010, by delegating the definition of "machines for the use of disabled" to "current Community provisions" without taking into account the drastic split in "carriages for disabled persons" that the European Community had already deliberated at the time of the modification. Moreover, these "current Community provisions" are still approximate and questionable and, more or less explicitly, could reserve the right to delegate in turn to provisions of the individual nation, at least for matters of dispute prior to the Regulation No. 718/2009, and even the most mandatory Regulation No. 2021/1367 admits the possibility of a re-assessment of the vehicle by a national authority which is anyway disregarded by the European Union classification. Assuming that the "current Community provisions" do not have sufficient decision-making force, the Italian provisions still remain those of Article 196 of the Regulation implementing the Highway Code, never formally suppressed, which imposes extremely restrictive and by now anachronistic limits on the technical characteristics of mobility scooters, putting a good part of them out of play. The intent of the 2010 amendment to Article 46 of the Highway Code was clearly to update these provisions somewhat hastily, making them overcome by "current Community provisions", which instead can put them all out of play.

### 3.1 Our proposal for a legislation of mobility scooters intended to circulate in Italy (useful even for the European Union)

Our legislative proposal starts precisely from the Community orientation expressed by the explanatory note of heading 8713 of the EU Combined Nomenclature and by the EU Regulations No. 718/2009 and No. 2021/1367, takes some inspiration from UK legislation and is divided into three basic points, which imply first of all modifications of the Highway Code and of its Implementing Regulation:

- Identify mobility scooters as a new category of electrically powered vehicles suitable for both the able and the disabled persons, subject to a specific legislation that entails a real homologation for use in areas open to the public;
- Divide them into two subcategories, called "light mobility scooters" and "heavy mobility scooters", anyway not registered, not subject to property tax and not requiring a license and registration certificate;
  *Light mobility scooters:* adjust the limits imposed by the current Article 196 of the Implementing Regulation of the Highway Code to those of the community note, specifying only a width limit increased

to 0.80 m, but confirming the maximum design speed strictly limited to 6 km/h; single seat; obligation of automatic emergency braking and reverse gear light with acoustic warning; authorized use on pedestrian areas, cycle paths and reserved lanes; possibility of being used by minors. They should be assimilated to motorized wheelchairs and would be the most suitable subcategory for disabled people who do not need an accompanying person (given the single seat): thus even bariatric disabled persons who need an "oversized" assistive device (however within the width of 0.80 m provided by the community note) could circulate in areas open to the public, having to deal only with architectural barriers sized for assistive mobility devices with standard dimensions;

*Heavy mobility scooters:* maximum width 0.85 m, mass limit in running order (excluding driver) 150 kg, maximum design speed strictly limited to 25 km/h with the requirement of basic equipment as a real motor vehicle (front and rear lights and reflectors, direction indicators capable of operating as a hazard warning signal, rear-view mirror, horn, safety belts), amber flashing light, speed limiter at 6 km/h with manual and telemetric operation, automatic emergency braking, automatic curve speed reduction, rear view camera, rear parking sensors and reverse gear light with acoustic warning; possibility of a second seat usable either by the authorized accompanying person or by a disabled owner while the accompanying person is driving; authorized use on pedestrian areas (only up to 6 km/h), cycle paths, reserved lanes and on the road in Zones 30 (roads with a speed limit of 30 km/h), possibly equating them to electric kick scooters and liberalizing their circulation even on urban roads with a speed limit of 50 km/h (where they could reach a maximum speed of 25 km/h); possibility of being conducted only by adults and by minors who hold at least a category AM driving license; helmet obligation for open-top versions, not for cabin versions. They would be the most suitable subcategory for able persons (for the possibility of travelling at speeds above 6 km/h outside the pedestrian areas) and for disabled persons who need to be accompanied (for the possibility of two seats);

- Establish the obligation of civic liability insurance for heavy mobility scooters (and in general for any motorized micromobility device with a maximum speed exceeding 6 km/h) that circulate in areas open to the public.

The 0.85 m limit for the width of heavy mobility scooters is not an uncritical imitation of British legislation: the Segway X2 SE, entitled by the "electric micromobility decree" to venture on pedestrian areas, cycle paths and roads, is 0.84 m wide.

According to our proposal, mobility scooters would therefore be classified as vehicles that could be driven by both able and disabled persons. The only difference would be that able persons would buy them by paying them out of pocket and without tax breaks (i.e. reduced VAT, deductibility), whereas the disabled persons could take advantage of tax breaks or even of granting by the National Health Service (which in turn should issue a clear regulation for the criteria of eligibility, avoiding uncertainty among Physicians and disputes with patients).

Furthermore, the regulations for the circulation of "mobility scooter vehicles" conducted either by able or disabled persons in areas open to the public should also be revised without confining them to pedestrian areas, in order to improve their usability and the consequent benefits for traffic and the environment without affecting the road safety. Forcing a mobility scooter to run on a narrow, crowded and rough sidewalk can be much less safe than allowing it to move on certain roads or on selected routes. It would not be out of place to expressly reiterate that in pedestrian areas vehicles considered medical assistive devices by the "current Community provisions" such as motorized wheelchairs must in any case observe the speed limit of 6 km/h even if the aforementioned provisions allow a maximum speed of 10 km/h (which is definitely more than "a fast walking pace"). The broader regulatory review proposed by us could go through an experimental phase. Some targeted additions and amendments to the decree of 4 June 2019 for testing the circulation of electric micromobility

devices on the road and to the "milleproroghe" decree, including mobility scooters, could be the simplest and most immediate solution.

Mobility scooters should also be included among the categories of three and four-wheel vehicles provided by Regulation No. 168/2013 of the European Union. Light mobility scooters, having a maximum design speed not exceeding 6 km/h, should be included among the vehicles in Article 2 to which the Regulation does not apply. Heavy mobility scooters, having a maximum speed up to 25 km/h without pedal propulsion, should be classified as L-category vehicles:

- heavy three-wheel mobility scooters as a new subcategory of category L2e (three-wheel moped);
- heavy four-wheel mobility scooters as a new sub-subcategory of subcategory L6e-B (light quadri-mobile) of category L6e (light quadricycle).

This would also contribute to give a specific location to various electric vehicles on the market equipped with a seat and an electric engine capable of independent propulsion from pedals up to 25 km/h, which are currently hit by severe fines for public circulation without license plate, registration document and helmet or for misleading advertising, not excluding confiscation and destruction.

## 4. Discussion and conclusions

The regulatory vacuum on mobility scooters opened by the amendment to Article 46 of the Italian Highway Code which occurred in 2010 cannot stagnate yet and the recent decree for the on-road testing of electric micromobility devices, which ignored the objectively most versatile, safe and "serious" device, lost a great opportunity, whereas the more recent conversion into law with modifications of the "milleproroghe" decree indirectly profiles the spectrum of destruction for mobility scooters if they are caught circulating in public as atypical unregulated vehicles.

This situation must be remedied without waiting for this regulatory flaw to come out on the occasion of some dramatic event such as a road accident. The classification of mobility scooters as "vehicles" suitable for both able and disabled persons – also in accordance with the European Union orientation – and a specific regulation of their circulation in public areas through the desired changes to the Highway Code, its Implementing Regulation and the decrees for the on-road experimentation of electric micromobility devices, as well as the identification of a control and information body, would easily put an end to this regulatory vacuum and to the confusion and misinformation that derived from it, finally favoring the well-deserved diffusion of mobility scooters to benefit of all: able, disabled, urban traffic and the environment. Among other things, on mobility scooters circulating abroad, in addition to the hoped-for automatic emergency braking, solutions that are still futuristic in the automotive sector are already being applied, such as solar energy supply and drive-by-wire.

The latter, which has long been yearned for cars where it is still confined to salon prototypes, in mobility assistive devices represents rather a "return" to the joystick of electric wheelchairs which, like the automatic gearbox for cars, from a disability stigma (implemented as such even by the explanatory note to heading 8713) is about to become a "must" of advanced driving for mobility scooters. How will the European Union deal with mobility scooters that will lose the fateful "steering column"? It would be regrettable if Italy were still cut off from all this innovative ferment because of a legislation to be redone. We are convinced that even the European Union should redefine the main difference between mobility scooters and electric wheelchairs, which leads it to classify mobility scooters as "motor vehicles": not the presence of a steering column, but the presence of a steerable front axle, regardless of whether steering action is determined by a steering column or by an electroactuated system (Fig.7). It should also clarify whether a manual wheelchair electrified by a front power assist drive unit with steering column remains a medical assistive device or becomes a "motor vehicle" as well (Fig.8).

**Fig.7 This device should be classified as mobility scooter because of the presence of a steerable front axle, even if it steers with a joystick *(source: scoozy.nl; photographer: Jorrit Lousberg)***

**Fig.8 Manual wheelchair electrified by a front power assist drive unit with steering column: medical assistive device or motor vehicle? *(source: Officine Ortopediche S.r.l.)***

We are available for any initiative aimed at raising awareness of the problem and of the need for a regulatory reform among the competent bodies, hoping that something similar to the "mobility scooter revolution" started overseas more than 40 years ago will also come out in Italy and worldwide.

In the meantime, we continue our information work in the healthcare field, where our Italian colleagues admit that they know little about mobility scooters and that they are doubtful even on the prescriptive criteria. Without prejudice to the top priority of the desired regulatory reform, without which there will be no possible prescriptive criteria and in Italy mobility scooters will never be able to realize their positive effects.

*Cabin mobility scooters could even be a safe, protective and affordable resource for individual mobility in the Covid-19 era.* Their enclosed bodywork in itself offers protection against airborne infectious agents, and it would be sufficient to equip both inlet and outlet air intakes with adequate filters to allow users to move without fear of contagion even inside closed public environments. Apart from the "integral protection" offered by cabin models, even the agile and economical open-top mobility scooters, compared to mass transport, could help limit the airborne spread of infectious agents, while benefiting from greater stability and comfort than other devices of individual electric micromobility and without further worsening the conditions of traffic, parking and environment as is happening with the now massive use of individual transport by cars and motorcycles.

Another unique feature that can be deduced from the set of regulations of the various countries and from EU Regulation 2021/1367, taken up and revised by our proposal, could also induce "able and young persons" to prefer mobility scooters to other small electric vehicles that are more attractive in terms of the ratio between size and performance (mopeds, light quadricycles): *these are the only vehicles allowed to circulate both on the road, in pedestrian areas, on cycle paths, on pathways in parks, and indoors.*

A more pleasant and less "assistive device for the disabled" aesthetics would certainly improve their attractiveness: however, it should be considered that abroad there are already mobility scooters that in terms of aesthetics have nothing to envy to other well-known vehicles "for able persons" (Fig.9).

(a)

(b)

**Fig.9 (a) from New Zealand *(source: Stuff Limited);* (b) from Canada *(source: Daymak)***

Even the automatic gearbox was once considered "stuff for the disabled"… Who would dare to say it nowadays, given that it has become an indispensable equipment in luxury sedans and sports dreamcars? Perhaps one day even mobility scooters will be considered advanced mobility devices. Legislation permitting, because in Italy, at present, in public they cannot even function as assistive devices for the disabled. Even if with the change in legislation these vehicles remained for almost exclusive use by disabled and elderly, it would always be better than the current situation, in which they cannot be used by anyone in public. But after all, is the elderly person disabled? The progressive reduction of mobility caused by the physiological deterioration of the musculoskeletal system and of other organs and systems such as cardiovascular and nervous systems cannot be identified with a disabling disease. And when should a person be called "elderly"? The chronological age cannot be taken as an absolute value (La Rocca & Fistola, 2018). Therefore, mobility scooters would anyway end up benefiting people who can still be considered "able" and not necessarily "elderly", while on the other hand the quite stringent requirements for driving mobility scooters make them incompatible with most frank disabilities, which can rely on the various types of electric wheelchairs. In the absence of clear-cut criteria to define "elderly enough" or "disabled but not too much", the disputes do not spare even the countries that have been able to legislate better than Italy but still restrict the use of mobility scooters to generic disorders of walking (Lea, 2017): therefore it seems wiser to liberalize them for any type of user, possibly after an aimed medical assessment of ability to drive them accompanied by a specific safe driving course, such as those carried out in UK and Holland (Cannata & Monello, 2021), without however imposing a real driving license.

Any resource for everyday urban mobility is a fundamental contributor to individual's well-being and quality of life (Akhavan & Vecchio, 2018): mobility scooters are a great resource for mobility, but in Italy they are almost ignored and even hindered. And while it is somewhat true that keeping older people driving as long and safely as possible may well be the most feasible and cost-effective mobility option for an ageing society, it is necessary to establish other options that will be available once using the car will not be a feasible option

(Burlando & Cusano, 2018). Mobility scooters are an option, which compared to others has a great advantage: simplicity. You just need to know how to regulate them.

In UK, where mobility scooters can only be driven by people who "have trouble walking because of an injury, physical disability or medical condition", the mobility scooters sold every year are more than half of the Segways sold around the world in twenty years. Furthermore, they appear to be proving attractive to people who have no medical need for them: the number of able-bodied youngsters using them as cheap alternatives to cars is increasing. The vagueness of the wording of the restrictions (no mention of specific disabling diseases or how they should be documented) creates a "grey area" in which anybody can go out and buy or hire one without breaking the law, with consequent parliamentary debates (Lea, 2017). And in recent times, market research reports have been multiplying which universally forecast a significant growth rate in the global mobility scooter market, made even more striking by the negative economic context linked to the Covid-19 pandemic, particularly in the automotive and mobility sectors. Factors supplementing this growth include not only increased percent of senior citizens, but also inclination toward the use of mobility scooters as an eco-friendly and efficient solution, as well as rising awareness for advanced mobility devices (Singh & Mutreja, 2021).

We think that our legislative review and proposal could be useful even outside Italy, since the aforementioned legal disputes at the European and National Courts are a symptom that mobility scooters are still a controversial topic even abroad and need a clear-cut legislation by both national and international bodies. It is also paradigmatic that mobility scooters are not yet included among the categories of three-wheel vehicles and quadricycles provided by Regulation No. 168/2013 of the European Union, even if the European Union itself considers them "motor vehicles" in its explanatory note of the heading 8713 of the Combined Nomenclature and in its Regulations No. 718/2009 and No. 2021/1367. The inconsistency of the European Union in interpreting and applying its own regulations on mobility scooters is also responsible, at least in part, for the current Italian "non-regulation".

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# The river contract in urban context as a new network of experiences

## New opportunities in the post pandemic era

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**Abstract**
The river contract can be identified as a process, linking different intervention scales, able to solve the complex system of relationships between all involved components. In the landscape improving interventions, the River Contract is a new opportunity to experiment innovative planning and design approaches for fragile territories. Due to climate change, they have become favourite settings to simultaneously implement territorial and local strategies. This paper concentrates in particular on the European panorama and tries to deepen the analysis of some test areas in Italy, proposing a methodology to compare their applications and their relationship with the planning tools in force.

**Keywords**
Landscape; River districts; Strategic and local planning tools; River contracts.

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# 1. Introduction

Landscape issues influence the inhabitants of urban areas and, subsequently, their quality of life. The waterways have always given structure to the landscape and human activity has induced further changes and modifications, from the structures linked to agricultural activities, to reclamation operations, to regimentations, to the exploitation of the valley floors, to settlement interventions. Throughout Europe, analysing the last two millennia, river landscapes have been attacked by operations such as deforestation, drainage of swampy areas, with widespread erosion or sedimentation phenomena, which have led to an immeasurable expansion of hydrogeological risks. Furthermore, there are numerous rivers that cross the cities, which have seen the relationship and interaction between physical, economic, and social dimensions in the territory change over the centuries. The international debate addresses all these issues with a further concern due to climate change by developing adaptive theories.

In the most recent years, the will to counter this rampant phenomenon has been outlined at European level: starting from the "European Strategy on adaptation to climate change" (European Commission, 2013), to the document drawn up by the European Environment Agency (EEA, 2013), up to the Italian national drafting of the "National Strategy for Adaptation to Climate Change" (Repubblica Italiana, 2015), from which the "National Plan for Adaptation to Climate Change" was derived, widely shared by all Italian regions in 2018, with the aim of normalising risk management related to climate change. In this context, the territories crossed by watercourses constitute a field of application of great interest, for climate adaptation purposes and represent an additional opportunity in the post-pandemic landscape. Although both the National Plan and the related Regional Strategies should not be an additional super-level imposition, it is necessary to pay attention to the local level institutions which, with a multilevel government, are responsible for the adaptation of their urban planning tools. A field of interest, which still needs further investigation, is that of instruments linked to voluntary participation, including the River Contracts (RC). The investigation presented here contains some reflections, emerging from the preparation of the next National Committee of River Contracts.

In the Steering Committee Assembly, of which the first author is a member, a Discussion Document was prepared, aimed at the inclusion of the RC in the new national and regional programs. Currently, the RC has an important role in the implementation and improvement of local government policies: the participation of all the institutions involved in the management of water bodies - in particular rivers - allows the addressing of a multiplicity of aspects, hydraulic, agricultural, urban planning and economic (Bastiani, 2019; Cialdea, 2020a, 2020b).

An important achievement of the Committee, obtained in 2016, was the introduction of *art. 68bis* in the Italian Environmental Code in the third part "Regulations on soil protection and the fight against desertification, protection of water from pollution and management of water resources" (Repubblica Italiana, 2019), which states that river contracts contribute to the definition and implementation of district planning tools at the river basin level, such as "voluntary strategic and negotiated planning tools that pursue the protection, correct management of water resources and enhancement of river territories, together with risk protection, contributing to the local development of these areas ". And subsequently, in 2020, again with the support of the Committee's activities, the resolution on the River Contracts (Camera dei Deputati, 2020) was unanimously approved by the Environment Commission of the Chamber of Deputies. This resolution confirms the issues stimulated by the recent Assemblies, held in the three sessions of the month of July 2020 in preparation for the next 2021 Committee (Bastiani, 2020). Ultimately, with the support of the recent world forum on the theme of planet safeguarding (World Economic Forum, 2019), defines river contracts as forms of agreement that allow "the adoption of a system of rules based on public utility, economic performance, social value and environmental sustainability "; also hopes that the government will support the RC tool due to its ability to produce participatory action programs with concrete territorial repercussions, providing for easier access to the funds of the National Recovery and Resilience Plan and to the resources of the Recovery Fund.

Certainly, the RC does not yet have the structure of a planning tool, but it proposes itself as a facilitator of the projects for landscape transformations. The stakeholders act by virtue of the related tools' ordinances and of a panorama of plans and programs, varying greatly from region to region and with significant differences also for the landscape transformation control through the Landscape Plan.

The European Landscape Convention, signed in 2000 and to which European states continue to adhere today, has just turned 21 (Council of Europe, 2000). Despite the clarity of its principles, the fundamental problem seems to be its application: the European Landscape Convention expects individual European States to develop their own evaluation methodologies aimed at the management of their territories, which are, therefore, applied to the different geographical contexts. What is stated in the first article of the Convention, however, clearly highlights the limits of the interpretation of landscape interventions. It defines what is meant by "landscape management" ("Landscape management" means action, from a perspective of sustainable development, to ensure the regular upkeep of a landscape, so as to guide and harmonise changes which are brought about by social, economic and environmental processes) and for "landscape planning" ("Landscape planning" means strong forward-looking action to enhance, restore or create landscapes). In the Italian language this difference cannot specifically mean only actions but has to refer to the entire planning process. Therefore, such as landscape policies that should derive from the Convention itself, often do not consider conservation aspects, provided that specific measures are implemented to protect, manage and plan landscapes (Busquets Fàbregas & Cortina Ramos, 2017; Roe, 2007; Council of Europe, 2017).

The fundamental issue is how these policies fit into the planning tools framework of each country, and then how the State favours their implementation through regional strategies, which are also always diversified. This problem is emerging particularly in Italy, where the sectoral planning tool - the landscape plan - provides for vast area knowledge: it aims to intervene on it, according to the Convention's principles, proposing an instrument suitable not only for the protection but also the development of the territory. In fact, according to national legislation, it is entrusted to local authorities, and the regions must draw up the plan, with a view to co-planning, not well specified and often disregarded, with the Ministry of Cultural Heritage.

The research, therefore, concerns the topic of the river landscape's fragility, to define possible solutions to the complexity of the "river" theme, which concerns not only the physical dimension but also from an institutional viewpoint. The literature - with texts and articles relating to principles and samples - constitutes the article backbone and it is constantly examined in its drafting. This paper undertakes a research path by combining considerations related to theoretical issues and to practical interventions, carried out on waterways by different nature processes. The main goal is to point out the River Contracts process in order to implement the Landscape Plan issues.

This paper is divided into four sections: the introduction (Section 1) describes the main issues of the paper, including the literature review. Section 2 defines the methodology, which also includes an explanation of choice of the proposed participatory process. Section 3 explains the results and section 4 contains the conclusion, geared towards stimulating future research.

## 2. Methodological Approach

The literature dealing with the relationship between river, landscape and the city is extensive. This paragraph reports the results of the authors' considerations in relation to the contemporary debate and related adopted methodologies of territorial surveys.

### 2.1 Fragility & Complexity

When it comes to river networks, a substantial aspect is their character as fragile and complex territories: fragile in that they are crossed and conditioned by ecological, climatic, and anthropic features; complex because in them the question of landscape protection (environmental dimension) and the question of urban

liveability (urban dimension) meet and clash. To define these characteristics, it was decided to investigate beyond national borders, through case studies where state and regional interventions provide virtuous approaches to the characteristics of fragility and complexity of river landscapes.

The different aspects of fragility denote a complexity in river landscapes: different environmental and urban dimensions, material and immaterial relationships, natural (ecological) and anthropic (historical-cultural) networks. When it comes to fragility, therefore, it is necessary to address the issue of complexity. In the specific case of river networks, it is closely connected to the landscape and to the interpretations given by different schools of thought (developed in the United States). These attempt to re-read urban environments from a landscape perspective, combining - both etymologically and in "substance" - landscape and urban planning (Landscape Urbanism- LU), hidden natural systems and man-made environment (Ecological Urbanism- EU), natural networks and human networks (Infrastructural Urbanism- IU). These try to explain the physical complexity of the interrelation between river and people, between natural processes and human activity, between the landscape and the city and they see the latter as the set of interconnected ecological elements (Turner, 1996; Connolly, 2004; Shane, 2004). A different vision for city planning is therefore defined in which the landscape replaces architecture as a basic element of urban planning, becoming both the objective and the means to represent and build the contemporary city, suggesting a new field of operational possibility (DKKV, 1997; Waldheim, 2006), in which the landscape offers the double opportunity to reformulate urban problems and recontextualize the practice in general (AALU, 2017). It is precisely in practice that one must try to overcome the visual limits of the "landscape" object itself (Mostafavi & Najle, 2003) and instead define a modality of intervention that sees the individual elements as nodes of a wider network (ecological networks). For this to be possible in the design and planning of open spaces, the landscape must be the structuring means, proposed as an initial step rather than a final step (Gray, 2011). These theoretical bases guide the regeneration of coastal and riverbanks, green infrastructures, and urban voids, as evidenced by the Manhattan waterfront project on the Hudson River, developed in the 1980s. The waterfront was largely an abandoned landscape with dilapidated docks, parking lots, and warehouses.

After the decline of maritime trade and the collapse of a section of the West Side Highway, a lot of attention was paid towards deteriorated infrastructure in New York and the Westway project was created. This project planned to fill a portion of the Hudson River to create an underground interstate highway. The plan was unsuccessful, but there was the opportunity to reinvent this area by creating a park, enhancing its relationship with the river. Hudson River Park was established in 1998 through the Hudson River Park Act and is now managed by the Hudson River Park Trust, a unique partnership between the City and New York State. It promotes numerous projects at various scales that aim to make the river a landscape element of great ecological importance compared to the strongly urban character of Manhattan and New York. The design and construction of the Park are not yet completed and have been included in the Vision 2020 for New York, to define the activities related to Natural, Public, Working and Redeveloping Waterfronts (City of New York, 1992, 2011; Quercio, 2014). In this project, the key issues of the LU, EU and IU approaches emerge, such as the environmental dimension of the city in its relationship with ecological elements, the importance of biodiversity conservation of the ecological element, the urban dimension of the river as a connecting element and the creation of public spaces to improve quality of life and well-being in the city.

Complexity, in its components of theoretical complexity - which affects the disciplinary debate - and of physical complexity - which emerges from professional practice - totally involves urban and suburban systems (Vercelloni, 1992; Farina, 2004; Arcduecittà, 2013).

On the other hand, in the case of territories that are crossed by large green or blue infrastructures, such as wooded areas or river networks, the aim is to combine urban growth with environmental protection, emphasizing the ecosystem and social amenities provided by green spaces in cities, such as regulating temperatures, conserving native species, wind corridors, air purification, noise reduction, providing alternative

transport routes and effective spaces for running, walking or cycling (Allen, 1999; Tsenkova, 2016; Allen et al., 2017). Furthermore, complexity is also augmented by climate change (CC), which increases the level of complexity both on a theoretical level (supporters and non-supporters of climate change and its influence on the environment) and on a practical level (dealing with the consequences of change) (Gill et al., 2007; Kelbaugh, 2019). A project in line with this evolution of complexity that faces the relationship between LU, EU, IU and CC is the Resilient New York strategy, promoted by the municipality of New York on the Atlantic coasts. It is part of the PlaNYC, a sustainability plan for long-term city development based on climate science. The plan includes ideas on how to rebuild New York communities affected by Hurricane Sandy in 2012 and how to increase the resilience of natural and man-made infrastructure throughout the city to protect it from extreme events (City of New York, 2013). The strategy led to the enhancement of existing and newly built urban parks (Hunters Point South Park, Brooklyn Bridge Park, Freshkill Park, East Side Coastal Resiliency, Living Breakwaters), as adaptation and mitigation systems for a city resilient to sea rise phenomena (NYCMORR, 2019; Zacks, 2019). The need emerges to broaden the gaze on river and coastal landscapes in relation to contemporary problems, as "planning" resilience (Angelucci et al., 2014; Morosini et al., 2018; Brunetta & Voghera, 2014).

The approaches of the above-mentioned theories (the "urbanism" approaches) can aim to enhance biodiversity conservation aspects or to support urban design, with a strong ecological component (Mostafavi & Doherty, 2010). To explain such theoretical approaches in terms of application, the most emerging elements for the planning of contemporary river landscapes have been analysed.

## 2.2 Landscape Features & Planning Issues

Fragility emerges more and more in relation to three essential aspects linked to river networks: the ecological aspects, the risks caused by climate change and the use by citizens - which depends on the attractiveness of the landscape itself (Ippolito, 2011; Indovina, 2015; Caprotti et al., 2017; Vitillo, 2018).

From an ecological point of view, the fragility of the river derives from its being a web of natural and semi-natural habitats and an interconnected system of spaces capable of safeguarding and improving the biological diversity of a territory, despite human activities and anthropization (Acierno, 2019). Extending the discussion to a network level, considering the ecological aspect means implementing various actions to keep river biodiversity and its systemic role intact. A concept of desirable balance between man and ecosystem has been in place since the World Conference on Environment and Development held in Rio de Janeiro in 1992, and it deals increasingly with environmental and ecological problems in relation to the sustainability issue (Smith TM & Smith RL, 2017; United Nations, 1992a, 1992b, 1997). In Europe, the Netherlands is a leader in managing the ecological fragility of river areas. Here the government has promoted wide-ranging national programs (Goossen, 2019; Rijkswaterstaat, 2020) for greater safety of river environments, focusing on water purification and naturalization interventions, which then become the basis for ecologically attractive natural areas not only for fauna or flora, but also for the urban communities that are located near it (Al Sader et al., 2020). The Room for the River, for example, is a program that was initiated after the floods of 1993 and 1995 and subsequently to Plan Stork, which focused on restoring dynamic natural processes in floodplains while meeting flood protection goals. Within this national program, the WaalWeelde Program (launched in 2006 by Radboud University) is focused on the floodplain area of the Waal river, the main branch of the Rhine river (Fliervoet & Van Den Born, 2016). One of the most successful projects of this program is the Gamerense Waard floodplain environmental recovery plan, which was used as a clay quarry and brick production area until 1980. When activity declined and after flood events it was necessary to rebuild the dam for the protection of the factories, which were later demolished. This left a large area heavily compromised and the river needing more space. The plain was therefore transformed into a nature reserve and the Waard River was left free to extend through secondary channels. This intervention has led to the proliferation of a great variety of flora and fauna, allowing

nature to help the area recover (Mak, 2013). At the ecological level, therefore, the balance between man and ecosystem is considered the basis for increasing the efficiency not only of the river system, but also of the urban system, favouring the maximum habitability of places (Monguzzi, 2019) and that is why interventions to restore the natural ecological level of river networks are generally aimed at the re-naturalization of abandoned quarries, the conservation of wetlands and purification systems for polluted waters.

Ecological fragility is also closely connected to flood phenomena, which are increasingly violent today, leading to the flooding of rivers and the consequent risks in urban and semi-urban areas. The anthropic transformation of the landscape has in fact often changed the courses and riverbanks, making the risks associated with floods more frequent, which however are natural events to which humanity has always been and will be subject. The most proactive and interesting approach to address ecological fragility is that of risk mitigation through land use planning, which influences the uses of the areas and which has led to the growing interest in Nature Based Solutions (NBS), with interventions such as expansion tanks or rolling basins for the containment of river floods and the protection of surrounding inhabited centres (Gobattoni et al., 2016; Kabisch et al., 2017; IUCN, 2019; Somarakis et al., 2019; European Commission, 2015).

In this regard, Germany has implemented virtuous actions to address the fragility of river landscapes following flood phenomena (Zimmermann et al., 2015), as happened for the Elbe River which in 2002 caused extensive damage to the surrounding areas. This event led to an integrated flood risk management system across the nation. Many cities have initiated projects for the safety of the city and the riverside, even after other widespread flood events (Thieken et al., 2016). The German Commission for Disaster Reduction has drawn up a report which collected all the "lessons learned" from this situation, with the aim of limiting human interference on the floodplains. To further strengthen this strategy, the Federal Ministry of the Environment established a national protection program in 2014 to identify potential reactivation areas of floodplains and new polder areas of national significance. One of the most effective strategies at the local level, in response to national planning guidelines for risk management, is the Flood Management Concept, implemented in various cities in Germany (DKKV, 2004). In the town of Miltenberg, the Flood Management Concept (2009) created new riverbanks on the River Main on two levels, one level with the river, with paved promenades, rest and panoramic areas, and naturalistic areas, and one on an upper level, where the safety of urban activities is guaranteed. The protection systems of the town of Worth am Main, on the other hand, are of a different nature, where in 2001 mobile solutions integrated with the buildings and an extended dam designed as a park were created, where the barriers constitute a design element that close as if they were a gate for flood protection of the Main River (Prominski et al., 2012). These cases highlight how direct interventions on river networks, especially through the NBS, can face the "alluvial" fragility of river landscapes, trying to transform their intrinsic problematic and negative character into a propositional and positive one.

For this to be possible, however, it is necessary to consider the attractiveness of the river landscapes. Since the birth of cities, rivers have represented the place of historical memory and the place of life par excellence, also undergoing phases of underutilization and reduction of their value (Jacobs, 1961; Sairinen & Kumpulainen, 2006; Ercolini, 2012; Cialdea, 2020c).

In response to natural phenomena (such as floods) that involve the river and uproot the river context, inhabitants are often passive in their attitude, almost a sort of impotence, which we have called "human fragility". The regeneration of rivers has become an element of investment attraction that is used to ensure greater safety: they also produce positive effects on city image but also on human well-being (Van Der Knaap & Pinder, 1992; Sahar & Ibrahim, 2018; Cialdea & Pompei, 2020).

In Europe, Hamburg is a city that has implemented effective planning strategies for the transformation of the river network from an exclusive trading network to a network of cultural, economic, and environmental attractiveness. The beginning of the post-industrial period made the authorities rethink the image of the city in terms of river urban landscape. This was necessary after the decommissioning of industrial and port sites,

linked to the transition that took place throughout Europe from a Fordist industrial society to a post- industrial one with strong outsourcing (Donnarumma, 2013; Lepore et al., 2017). The port-city, which developed at the beginning of the 9th century, is crossed by a network of canals and three rivers (Alster, Bille and Elba) and the first measure to regenerate 6 km of waterfront of the Elbe was put in place in the 1980s. Starting from the 90s, the revitalization and regeneration of the riverfront has moved towards newly built areas, one of the best known being Hafencity (Schubert, 2016). The project created a new district in the heart of the city and the Masterplan was approved in 2000. What makes HafenCity an innovative regeneration model for the resolution of the "human fragility" of river areas is its interaction between planning, design and implementation that has led to the completion of the project ten years after approval, involving a great variety of stakeholders. The results obtained have endowed the area with an architectural and urban quality in line with the idea of a sustainable city (Mazzoleni, 2013). The mix of commercial and leisure uses have created an area surrounded by water capable of reconnecting the dimensional scale of the historic city with the complexity of relationships and the variety of functions typical of the contemporary city (Clemente, 2011). By paying attention to tree species, stopping points and meeting places and panoramic or floating terraces, tourists and residents can enjoy the new Hanseatic city rediscovering its fluvial dimension.

The above mentioned examples are not models to be followed blindly but are able to transform fragility and complexity into innovative river landscapes.

Their critical analysis aims to provide new perspectives for planning and designing fluvial and coastal landscapes in a more extensive vision than those dealing only with individual countries.

In this first phase, an attempt was made to define urban planning elements, deriving from the different theories on city interpretation, from a landscape viewpoint.

These elements seek to provide operational solutions to the characteristics of fragility and complexity that constitute the landscape as an urban ecosystem (Tab.1).

| **Territorial Elements** | **Theoretical Approaches** | | | **Urban Elements** |
|---|---|---|---|---|
| **Landscape Features** | **Landscape Urbanism** | **Ecological Urbanism** | **Infrastructural Urbanism** | **Planning Issues** |
| **Fragility** | Relationship with nature | Ecological networks and Biodiversity | Natural networks | **Ecology** |
| | Flood risks | Ecological safeguard | Natural ecosystems | **Risks** |
| **Complexity** | Institutional aspects | Relationship with human activity | Interconnected systems | |
| | Relationship with city | Interconnected systems | Social networks | **Usability** |
| | Anthropization | Biodiversity | Social infrastructures | |

**Tab.1 Theoretical approaches from landscape to the city**

## 3. Results

Complexity affects the physical characteristics of river landscapes but involves the institutional environment even more, especially in plans and projects. Referring to the Italian context, an examination of some situations in the national panorama was carried out. They have been chosen as significant of different attitudes, to verify the River Contract capability to be a problem solver for issues identified in the paper's introduction.

In particular, the cases have been identified because of the coexistence of protected areas, already established or in progress, in river areas. This issue is currently the subject of specific reflections within a working group called "Parks for River Contracts", recently created, on the initiative of the RC National Steering Committee, of whom the authors are part of. On the national territory, in fact, there are numerous parks adhering to RC, but the situations vary greatly. In some cases, the park was the main promoter of the RC process, in others

the RC brought to the creation of a protected area, in other cases the pre-existence of a protected area has precluded the start of a RC.

## 3.1 Interventions: Italian case studies

The discussion highlights, therefore, how much the RC promotes interventions on rivers, and how often, instead, the RC is not set in motion, when there is a solid financial base and established protected areas. For the purpose of extrapolating the most recurring responses to the planning issues, four case studies have been chosen, which are part of a broader investigation (Cialdea & Pompei, 2018a, 2018b, 2019). They are the most representative in terms of operational responses for the resolution of planning issues: furthermore, these cases are in a very advanced state of implementation, compared to others, still in their initial steps.

The first case examined is that of the Sarca River Park, where important interventions have been carried out related to the ecological aspects of the river environment. A RC has not been implemented for this river, but there are many good practices, involving the participatory model to enhance environmental and cultural heritage. In this case, the driving force was the Reserves Network, a new tool introduced by the nature areas and forestry protection law (Provincia Autonoma di Trento, 2007). In 2012, a Memorandum was signed for the creation of the "Low stream Sarca Reserves Network", hoping to expand to the Upper Sarca areas as well. Subsequently, the Fluvial Park was established, whose mainstream is the Sarca Mincio Garda, and the Montano Imbrifero Basin Consortium activated a territorial participatory laboratory (Università di Trento, 2015; Pederzolli, 2020).

The redevelopment of the banks and the riverbed was implemented, with attention to the high environmental quality of these sites, which since the 19th century have been traveller hotspots for those coming from central Europe to Garda Lake. In this case it is evident how physical complexity is directly transformed into institutional complexity. It achieved a positive result, as it doesn't involve only the territorial basin but the whole river corridor, connecting the most significant areas from environmental and cultural points of view. In these ecological interventions, the Sarca connects "the largest glacier in Italy" to the "largest lake in Italy", ideally from the "Alps" to the "Mediterranean" (Comune di Arco, 2009; BIM Sarca Mincio Garda, 2012). The Reserves Network has multiple functions, also in relation to the improvement of environmental connectivity, between high naturalistic values and intense agricultural activities, which occur above all in the widespread areas of intense wine production (Provincia Autonoma di Trento, 2019).

A RC that was able to implement interesting actions related to river usability is the RC "Terre del Lamone" in Ravenna, of which the declaration of intent was signed in 2017. The "Lamone Bene Comune" project was developed with the aim of welcoming citizens' proposals for shared management of the river, for conscious tourism and for soft mobility. This RC presents similarities in the approach to the territory with the previous example: the riverbank is a united network of sensitive areas to be ecologically protected and enhanced in terms of use and knowledge for the population (Bissoli & Montaletti, 2018, Bagnari & Buganè, 2013).

The case of the Olona - Bozzente - Lura RC describes a completely different situation because the River Park project started from the RC. On a technical level, the Lura River has a low water flow; however with violent rain phenomena it immediately reaches flood level, causing devastating damage to all the surrounding areas. In accordance with the European Directives and Legislative Decree 49/2010 which establishes the Flood Risk Management Plan (Repubblica Italiana, 2010), the Lombardy Region has implemented various protection measures in Lura Park: two rolling basins (in-line and off-line), flood gates, shunts, and embankments, thus making the river basin safer (Innocenti et al., 2009). Attention was initially focused on the issue of risks, but then an interesting activity to increase population participation was created (Regione Lombardia ERSAF, 2015; Scaduto, 2016). The Lura sub-basin Project is a particularly compelling example because it is based on a widespread responsibility principle shared by various stakeholders (from citizens to local administrations, to businesses, to managers, to Parks, up to the regional government). The sub-basin Project represents the first

and fundamental result of a co-planning process of the river basin, in a local partnership with the Region. Other risk mitigation operations have been promoted by the recent RC of the Pellice Torrent Basin. The basin was studied for the Alcotra 2007-2013 Territorial Cooperation Program and aimed to analyse the hydrogeological structure and the environmental state. In particular, the European project had issues related to the study and management of the mountain stretch of Pellice from the hydraulic, geological and naturalistic point of view. It had promoted the collaboration between the territorial stakeholders, including the Turin Polytechnic as leader and the Turin Province and the Conseil Général Hautes Alpes as partners (European Commission, 2008; Conseil General Hautes Alpes, Turin Polytechnic, Città Metropolitana di Torino, 2019). The course of the river, therefore, also involves cross-border contexts: in this case France is involved, and financial support was provided by EU funding. The RC was recently signed (in October 2020) and provides for the implementation of three macro-interventions: water quality and quantity protection, banks and river area requalification and hydraulic risk mitigation (Regione Piemonte, 2020).Furthermore, the case of the Alpine Convention is intriguing, created with the aim of safeguarding Alpine ecosystems. There have been virtuous processes aimed at the sustainable management of water resources and promoting international cooperation. They have also resulted in the promotion of RC activities, such as that for the Roia river or that for the upper Adda basin (Angelini, 2017; Bianchini, 2014). Tab.2 underlines how different projects can face the urban planning issues with different actions coping with the territorial fragility and complexity.

| **Landscape Features** | **Urban Planning Issues** | **CASE STUDIES RESPONSES** | | | |
|---|---|---|---|---|---|
| | | ***Sarca* River** | ***Lamone* River** | ***Lura* River** | ***Pellice* River** |
| **Fragility** | **Ecology** | Ecological safeguard<br>Biodiversity protection | Ecological safeguard<br>Biodiversity protection | Ecological safeguard<br>Biodiversity protection | Ecological safeguard<br>Water quality protection |
| | **Risks** | Environmental connectivity implementation with human settlements | Environmental connectivity implementation with human settlements | Flood protection | Mitigation of hydraulic risks |
| **Complexity** | **Usability** | River ecological and cultural networks<br>Tourism | Tourism<br>Soft mobility | Participatory process<br>Co-planning process | Requalification of riverbanks<br>Institutional cooperation |

**Tab.2 Case studies analysis**

These cases highlight how complex river contexts can trigger significant transformation processes, if involved in participatory processes. In the cases of trans-regional and cross-border river courses, the different approaches to river issues (ecology, risks, and usability) constitute a field of experimental and innovative solutions. To obtain these results, from the investigation it was also clear that the real issue for positive practices is the participation process, in which the RC can play an increasingly positive role.

## 4. Discussion and Conclusions: Towards a solution for complexity

The identification of the fragility and complexity concepts was functional to the research and it represents the innovative aspect of this paper. Fragility's principles, in the writers' opinion, are the basis of the main territorial transformations.

River landscapes are fragile territories, as physical boundaries and limits for the development of natural and human values; they represent areas of experimentation, in which people can be involved in the analysis, planning and design of space and ways of using it. The aim was to identify - from theories, projects, and policies - recurring functional elements to improve the national landscape planning tools. The sample analysis has been concentrated on areas close to protected areas or within them (preserved in various ways) or where

conservation prevails over development. In Europe and in the United States, the best solutions were found to be those in which the project aims to regenerate the territory around the river, to establish a reconnection between it and the landscape. The creation of ecologically safe enclaves, which transform existing infrastructures into flows of ecological resources, can guarantee strategic protection and further economic development, especially where the river could influence urban liveability. In these cases, it emerges that the decision-making and financial strength of one or more stakeholders was sufficient to set the regeneration in motion. In Italy, on the other hand, the most innovative solutions are identified in projects implemented by the River Contracts. In fact, the RC is configured as a process capable of integrating at various levels the theoretical, physical, and institutional fragility and complexity, which are interwoven with ecology, risk and usability issues. Institutional complexity is the prevailing problem at national level, and it determines the transformability of river areas. Italy is a peculiar context, because of the different planning levels that set several planning laws and tools to be respected for landscape and water management. This legislative condition is also another element of our ongoing research, with the aim of comparison with other nations' approaches, and their different institutional framework.

In this context, the River Contract is outlined as a possible way for the mediation of institutional complexity in a panorama of different urban planning tools, where the stakeholders are numerous and not sufficiently strong nor at the decision-making nor the financial level (Bastiani, 2011; Cialdea, 2020a; Cialdea & Cacucci, 2017; Ingaramo & Voghera, 2016). In resolving this complexity, the RC - although not yet clearly placed within the scope of spatial planning tools - has the potential to transform the river into an elective place for matching ordinary and landscape planning regulations. Of course, the landscape plan can be the tool for choosing a substantially different form of territorial planning from that of the participatory type, but which should be integrated with it for the practical implementation of any interventions. A fundamental role, therefore, is played by the Region's ability to further implement the vast area planning tools according to the Urbani Code (Repubblica Italiana, 2004): this could lead to an "integrated system" for the enhancement of "common goods" (Cialdea, 2019). It is purely in the implementation phase where it is necessary to work harder, encouraging relations with local stakeholders, such as administrations, sector authorities and the citizens. For this reason, an important role can be played by participatory processes. In this essay, in conclusion, an attempt has been made to highlight the aspects to focus on for proactive landscape planning. The aspects analysed - linked to ecology, risk protection and usability - can therefore play an important role in the structuring of fluvial planning guidelines, especially where the river constitutes an identifying element of the landscape.

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# Investigating the side-effects and consequences of the formation of second homes in Alamut rural areas, Central Alborz of Iran

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**Abstract**
Rural out-migration is one of the most critical issues in all countries. This flow increases the rural decline, and in many cases, causes rural abandonment. But against our imaginations, there is also a reverse flow from cities to villages. In the Alamut region in central Alborz of Iran, some villages attract populations by the reverse migration flow. This temporary flow forms a new type of housing in the rural areas called "second home". The analysis of second home appearance is the main issue in this article. We used surveys method from locals and field observation in eight villages of the eastern Alamut area. The QSPM (Quantitative Strategic Planning Matrix) matrix is used for analyzing observation and side-effects of second homes in the short-term and long-term. The result showed that second homes in these rural areas have different side-effects. Low skill employment creation, temporary increase of local consumers, rural re-novation cost, and second home owner's participation in agriculture activities are the positive effects. But there are also some negative impacts like; seasonal and low-income jobs, destructive impacts on the environment, erosion of natural resources, and increasing demographic instability. This phenomenon has positive impacts in the short-term and negative consequences in the long-term. The approaches for decreasing the expansion of second holiday home and using the positive implications of this phenomenon for developing the rural areas would be explained in this paper.

**Keywords**
Rural second home; Alamut rural area; Reverse migration flow.

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# 1. Introduction

In many countries like the USA, Sweden, Canada, Australia, China, and Japan, the rural decline is the most critical issue that villages are facing. This issue has been exposed since 1960 in the United States (Li et al., 2019). As figure No.1 shows, decline occurs in a circle. Villages pointed out the rural decline in his studies and believes that rural decline occurs under two mutually reinforcing trends: first, shortage of jobs and sustainable business activity; second, inadequate and declining services. Also, figure No.1 shows rural decline's circle. (Villages, 2018). The essential factor in this circle is rural out-migration. Migration flow is usually from the rural area to the urban area. Ravenstein states that every migration flow from rural to urban areas has a mutual trend (from urban to rural) (Papoli Yazdi & Rajabi, 2013). There are two kinds of migration to rural areas. The first group is the international agriculture workers who work and live seasonal or long-term. The other group was searched for different lifestyles and were interested in living in rural areas or buying a second home (Qian, 2011). In this article, we focused on "second home" in rural areas. Many different terms can describe a second home. These examples include recreation homes, summer homes, vacation homes, cottages, flats, cabins, lodges, huts, chalets, farmhouses, etc. some kinds of dwellings labeled as second homes include boats, tents, and caravans (Marjavaara, 2008). This phenomenon isn't new. But, it turns into a usual issue because of the increasing pressure of urban life (Kheyroddin et al., 2017). The appearance of this kind of habitat is caused by some factors that will be explained. This phenomenon also has various economic, social, and environmental effects in rural areas as the sensitive area.

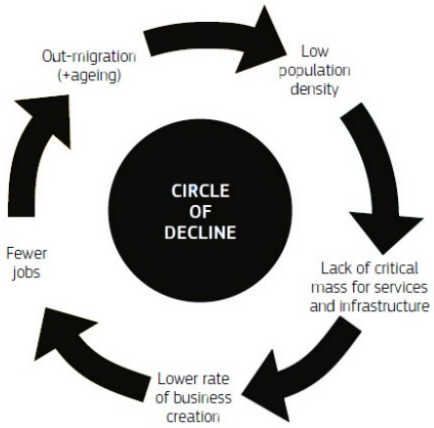


**Fig.1 The circle of rural decline (Villages, 2018)**

# 2. Problem statements and Method

In this research, we try to explain the reasons and the process of the emergence of second rural houses. The main question of the present article is, what are the consequences and effects of second homes in Alamut Rural Region? The effects and consequences of the formation of second rural houses in the central Alborz regions of Iran (Alamut) have not been carefully studied and presented. Examining and answering the questions in this article can reduce the negative and destructive effects of second home formation on the rural areas. Also, some positive consequences of this phenomenon could be oriented to the endogenous development of rural areas. We chose eight villages between eastern Alamut rural and interviewed twenty persons. The clustered topological structure of the rural areas and difficult access make us chose some of them. But almost all of these villages are faced with second homes. Also, for improving our observation we chose an area that could show non-native second homeowners better. Alamut is known as Alamut lake. So there are always some tourists that traveling to this place every year. Local people didn't simply accept non-native peoples. So it was difficult to interview a specific number of them. Actually, the interview was going to continue with second homeowners too, but Covid-19 has made a limitation. According to the article purpose,

interview questions include second home acquiring methods, resident's uses, and the length of their accommodation. Tab.1 shows the interview question purpose.

| Questions | Purposes |
|---|---|
| "How to get a second home property?" | knowing about the ownership method |
| "Are second home residents occupied or retired?" | extracting the occupations pattern |
| "Are they native? Or non-native?" | diagnosis the difference between cultures and lifestyles |
| "Are second home habitations temporary? Or permanent?" | for determining the length of occupation |
| Have the second homeowners ever participated in agricultural activities?" | extracting positive impacts |
| Have they invested in rural development?" | |
| "Have they affected on jobs or economic development?" | |
| "Do second homes built in gardens?" | determining consequences |
| "Has there ever been a conflict between the owner of the second house?" | |

**Tab.1 The purposes of interview question**

The effect of the second home will be evaluated using a SWOT (Strengths, Weaknesses, Opportunities, and threats) matrix based on the answers and field observations. But this matrix doesn't show the importance of long-term and short-term effects, so we use the QSPM matrix. This matrix prioritizes strategies. Strategies get weights based on improving the situation with strengths and opportunities and reducing weaknesses and threats. Also, we used satellite pictures to show second home development in rural agricultural lands.

## 3. Theoretical context

Second home is different from owning multiple homes. Multiple homes originate from capital accumulation. The second home doesn't have a specified definition and has various meanings in diverse geography. According to Marjavaara (2008), the core of definition is that second homeowners must have primary residence somewhere else, where they spend most of their time there. Based on this definition, second homes are for temporary use. Some drivers appear this kind of housing, like demands for leisure space, buying empty homes (Oliveira & et al., 2015), buying lands (which mainly include farmlands), and investing in childhood regions. Second homes create short-term or long-term socio-economic links between owners and their new society (Hoogendoorn, 2010).

Metropolitan growth also influences second home development. It formed in two shapes, high-income with luxury homes and low-income migrants. These residents save their connection with cities. Converting permanent homes to property homes is one of the second home creation methods. New buildings in private lands and development by construction companies in some places with high demand are the other methods (Kheyroddin & et al., 2017). Rural second homes in Iran places in the second type. This phenomenon takes place at a different distance from cities. But, in some cases, urban sprawl divides cities and make an opportunity for second home development. The south area of Medellin, Envigado, Bello is one of example of this kind of second homes that belongs to rich citizen's weekend homes (Palacio, 2012).

Some connotations associated with the second home phenomenon, including "getting away from the grind," "romantic," "cottage garden," "slow down and relax," "simple life close to nature," "spiritual second home," and rest and peace." Also, 'complementary spaces' and 'seasonal suburbanization' are other second home spatial connotations (Alipour &et al., 2017). Second home doesn't describe the technical form only but also refers to the function of the house (Adamiak, 2016). This phenomenon is the result of 'commodification of rural through re-structuring of land from marginal agriculture into second home developments' according to Alipour quoted from Overvåg (Alipour et al., 2017).

## 3.1 An overview on the emergence of rural second home

The second home initiative refers to Ancient Egypt. Wealthy families chose out-of-town villas for rest. In the third and second decade, in Hellenistic Greece, rich people traveled for their leisure and comfort (Gomes & et al., 2017). Romans took up residence in some villas on the borders of the Tiber rivers. In the seventeenth and eighteenth centuries, Amsterdam's wealthy classes stayed their second homes in summers (Dijest& et al., 2004). By the eighteenth century, Danish nobbles tried to create estates, castles in rural areas for summer vacation (Tress, 2002). The second home isn't a new subject. There are a lot of studies that show the background of this kind of house. In the late 1950s, second homes have been more popular in western countries. This time middle-class households were involved in addition to high-incomes (Li & Fan, 2020).
There are a lot of studies about second home in the world. "Housing-in-England" report states that two percent of homes in England are second homes or vacant long-term. With some initiative programs for empty homes by the government, the number of vacant houses fallen by 38% (NAO, 2017). English peoples have various habits from other nations. Just 31 percent of second homes were bought in England (Savills, 2019). In French, a study in the late 1960s showed that the proportion of second homeowners increases by settlement's size (Dijest et al., 2004). The French prefer to buy their second homes in their own country (Savills, 2019). More than one-fifth of Swedish families have a second home, and this level hasn't changed since 1970 (Dijest et al., 2004). Because of the urban population's growth, second home ownership in Sweden has some political goals. These goals related to the quality of life include health, and wealth improvement, enjoying open-air activities, and rural landscape (Lundmark & Marjavaara, 2013). In Denmark, second home creation is just allowed in recreational locations. Also, retired peoples are the only groups that can use it as a permanent settlement. Today almost 10% of these homes are used as permanent homes (Slätmo et al., 2019). There is another type of second home with a different purpose in China. In China, Hukoh[1] system makes aliens rent suburbs second home to work in cities (Huang & Yi, 2011).

## 3.2 The Emergence Factor of Second Home

Daily excursions, weekends and short-time holidays, seasonal migration (Hoogendoorn, 2010) are the aims of second home utilization. Second home is relevant to nature and natural activities. The human's relation with nature is undeniable. Second home plays a valuable role in people's connection with nature (Hoogendoorn, 2010; Alipour et al., 2017). It is also a multipurpose home and may have different aspects like a long-term investment or capital accumulation (Lundmark & Marjavaara, 2013). Most researchers believe this purchase is a part of personal or family life-stage investment strategies (Huang & Yi, 2011). One of the first and most important of second home ownership motivation is the sense of belonging to the place. Owners try to experience a different lifestyle and feel nostalgic in their childhood places. Also, second homes provide opportunities for social and recreational activities (Hoogendoorn, 2010). A variety of recreational activities is one of the rural attractions. Traditional recreation activities transferred to modern's in urban settlements. But this kind of leisure is still alive in villages (Overvag, 2009). Also, urban modern-life is so stressful for citizens. This issue encourages them to escape from cities (Huang & Yi, 2014). Climate change and urbanization also hurt social stability and quality of life (Shirgir et al., 2019). Owners find this kind of life more valuable and richer than urban life. Second homes are the result of planners' failure in providing quality of life (Hoogendoorn, 2010). One of the most important issues in modern cities is the aging population (Mariotti et al., 2018). Rural areas are faced with it too. Some of the owners are young people that migrate to urban areas to find jobs and coming back to their childhood place after retirement.

[1] China's household registration

Three critical processes in second homes' development mentioned by Coppack. These processes include high disposable income, more leisure time because of leisure and work fragmentation, and a high mobility rate (Popescu, 2010; Dijest et al., 2004; Hoogendoorn, 2010).

Second homes frequently build in the region with the natural landscape, seaside, mountains, etc. (Adamiak, 2016). Depends on the settlement distance, these constructions could expand in suburbs or rural areas. As an impartible part of the rural regions and their history, second homes are consumption-based, not a production (Hoogendoorn, 2010). Time is the other factor related to this phenomenon. The second homes usually use on the weekends and seasonal holidays.

Second homeowners include retired and old peoples with high incomes. There is a "semi-retired" stage to convert a second home to a permanent home (Huang & Yi, 2014).

Rural areas face population decline and have low-cost houses and lands (Popescu, 2010) compared to cities. This issue affects citizens' demand for a rural home (Dijest & et al., 2004). Table No. 2 shows some of the indicators from the literature review that were used in interview questions.

| Factors | Researchers |
|---|---|
| Occupation pattern | Dijest 2004, Hoogendoorn 2010, Huang & Yi 2014, Overvag 2009, Paris 2013, Slätmo 2019 |
| Family investment | Huang & Yi 2014 |
| Emotional dependency | Geyer 2015, Hoogendoorn 2010, Huang & Yi 2014, Lundmarka & Marjavaaraa 2013, Marjavaaraa 2008, Stergiou & et al. 2016, Rye 2011, Slätmo 2019 |
| Accessibility | Adamiak & et al. 2015, Dijest 2004, Hilber 2016, Hiltunen & et al. 2015, Hoogendoorn 2010, Huang & Yi 2014, Overvag 2009, Sarker & et al. 2018, Slätmo 2019 |
| Life style | Adamiak & et al. 2015, Popescu 2010, Hiltunen & et al. 2015, Hoogendoorn 2010, Huang & Yi 2014, Marjavaaraa 2008, Overvag 2009, Slätmo 2019 |
| Natural links | Adamiak 2016, Alipour & et al. 2016, Dijest 2004, Geyer 2015, Hoogendoorn 2010, Slätmo 2019 |

**Tab.2 Second home factors**

# 4. The Case study: the emergence of second home in rural areas in Central Alborz of Iran

Qazvin province is located on the Alborz southern mountains and the Iran plateau, with 15626 square kilometers in 2016 (Qazvin comprehensive plan, 2011; Qazvin economic, social, cultural report, 2016). With a 1919 square kilometer area, Alamut is one of Qazvin's eastern north sections (Qazvin director plan, 2004). Alamut is a rural area with more than 200 villages that consists of six rural districts. Low population, small, sprawl, poor infrastructure, poor communication, limited production activities, instability are Alamut's village's features (Qazvin regional development plan, 2006). Alamut has rough topography. But this issue couldn't affect second home development. Evan, Zarabad, Varbon, Ayin, Dikin, Koushk, Zavardasht, Garmarud Sofla are our study villages. figure No. 2 shows our study area.

## 4.1 The second home in Alamut rural area

Because of local's attitude about strangers, our interview sample is some local peoples who were ready to talk with us. Our responders included farmers, wholesalers, tour guides, housewives and etc. Locals stated that this kind of construction has become popular since the Rodbar earthquake. Most of the second homeowners are retired. They choose their childhood places to spend their weekends and holidays. Our case study owners are native. There are some non-natives too, especially in Evan lake's rural area. This lake plays an essential role to attracts these people. According to rural statements, almost all second homes are personal property,

but as local stated "there aren't rental or for-sell houses. If there are, they purchase it from locals and we don't have strange people here".

Second homes have temporary residents, seasonal or weekends. Some residents work on gardens and stay longer than others. Some owners rebuild their inherited homes, but others expand second homes in farmlands. This phenomenon increased land price. Also, second homes don't obey rural home's architectures, which causes visual heterogeneities. The other important issue that effects on the environment is accessibility to these villages. Because of Alamut rough topography, access to villages is only possible with personal vehicles.

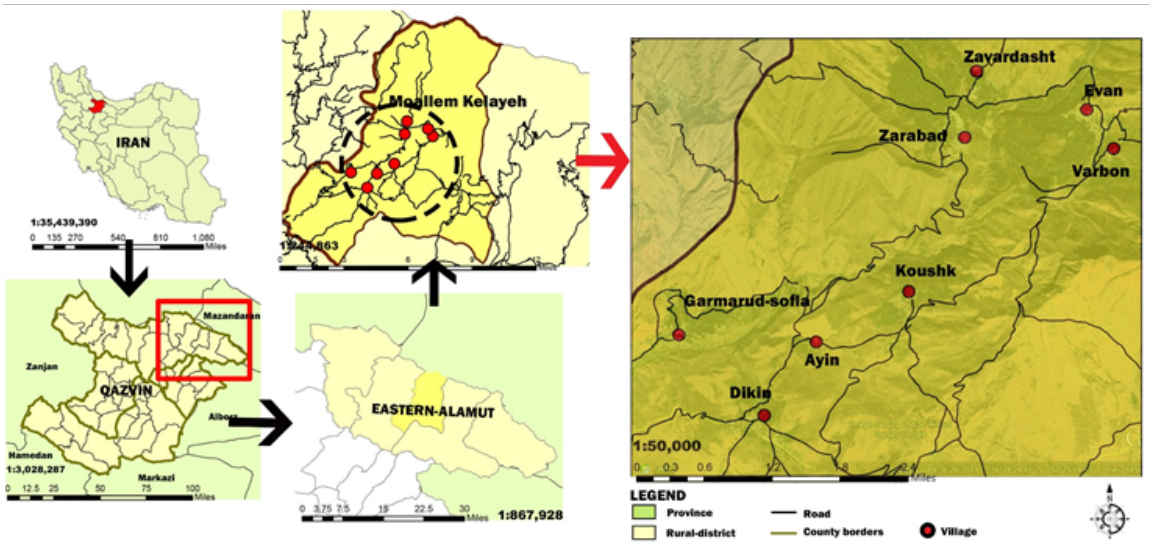


**Fig.2 Location of case study villages in Alamut region**

## 4.2 Side effects analysis of second home in Alamut

Second home has different effects on the surrounding areas. As Oliveira (2015) states, these impacts depend on some factors include; rural and urban features, development level of the second home location, residency length, and distance from the primary house. Rural areas are the only settlements that have a direct relation to the environment. Rural temporary population growth couldn't always have positive effects. There are still two deprived villages in our case study. So we describe the positive and negative effects of it.

### Economic effects

Second home development affects the local economy in the short-term and long-term. Second homeowners are the consumers of local products and services. Consumers affect local purchasing power by increasing the cost of products. It has some positive impacts like; economic and job diversity, low-skill jobs, and restoration of rural economics. Rural peoples stated second homes didn't create new jobs, and sometimes, they provide some short-term services like helping in gardening like one of our responder point that "…there are some locals that help them in garden's activities, like picking fruits" or building construction. These are low-income and seasonal. Some owners work on farmlands that maybe help to improve agriculture in the future, as they said "they do agriculture activities and have gardens and farmlands here". "they spend money on rural development and road construction".

The second home construction profit belongs to farmers, who invest their lands due to low-profit agriculture and lack of agriculture-related institutions. Some local's answer about land cost is: "yes it's increased as much as you like" or "land cost increased because this is a touristic place". Land and houses cost increase by these luxury buildings. This temporary population needs services and infrastructure. Rough topography in these villages doesn't have enough capacity for this demand. Our villages struggled with Gas piping distribution, but

this issue couldn't affect second home expansion (Fig.3a). Some locals believed that second homes had an effect on it: "gas infrastructures come here, because of them, but they didn't create job opportunities". Rural shopping centers playing an essential role in developing rural products. But, instead of rural organic products, our villages supply urban food (Fig.3b).

(a)

(b)

**Fig.3 (a) Lack of infrastructures (oct,2019) and (b) rural shopping with urban product supply (oct,2019)**

## Environmental effects

Second home converts "nature" to "culture" and replaces non-residential lands with buildings and human activities (Rye, 2011). "Villages are going to be far from the rural shape and form like apartments" was one of our responder ideas. Owning Multiple homes causes increase energy consummation. Natural area and resource erosion, increasing greenhouse gases, wildlife disorder, biodiversity decrease, desertification, and pollution of water, soil, air pollution are environmental consequences. Also, landscape fragmentation and nature beauty destruction influence the rural environment.

**Fig.4 Rural landscape (oct,2019)**

Villages are nature settlements, so environmental issues have a direct impact on them. Second homeowners using energy for their daily activities. They increase the heat and influence climate change. According to one of our old responders who were farmers mentioned it too "it will affect climate changes. Also, the weather is

going to warmer and agriculture is going to absolute". Rural people have limited contribution from nature capacity. Increasing population creates demand over this capacity. Some owners effect rural decline by built their second homes in gardens. Our observations showed that second homes influence rural landscape with their specific facade. Locals point that "destroyed lands. These row houses were farmlands". Second home development in gardens pulls infrastructures to farmlands. This issue decreases productive power in rural areas. The colorful roofs of these houses are all around the village (Fig.4). Also, difficult access to these villages caused increasing personal vehicle usage. This issue increases greenhouse gases in the long-term.

## Spatial effects

According to satellite pictures since 2011, the spatial structure had been changed in all villages. Second home developed in rural centers and surrounding. Figg. 6, 7, and 8 shows tangible spatial changes in Evan, Dikin, and Zavardasht villages. Even some of them built out of village borders (Fig.5a). Some owners create their second holiday homes in gardens (Fig.5b). Figure no 6 show that even rough topography couldn't affects second home development (Fig.5c).

(a)

(b)

(c)

**Fig.5 (a) Developed out of rural borders (oct,2019), (b) developed in gardens (oct,2019) and (c) rough topography (oct,2019)**

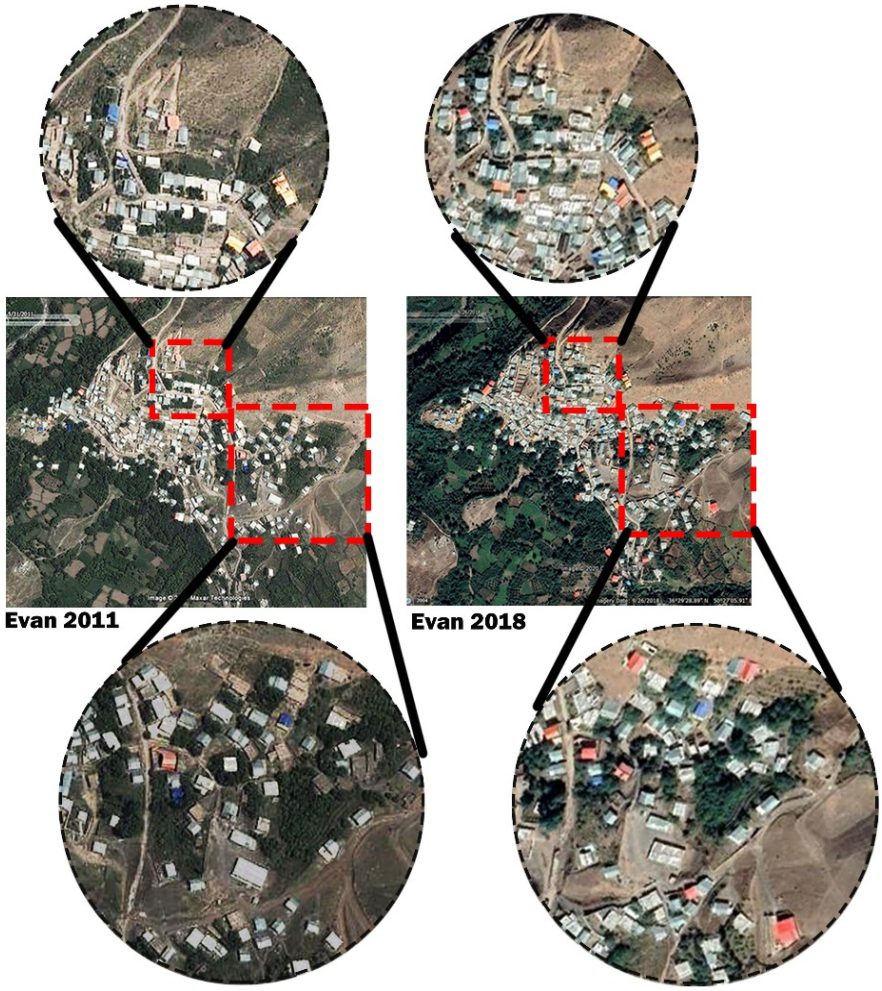


**Fig.6 Spatial changes in Evan**

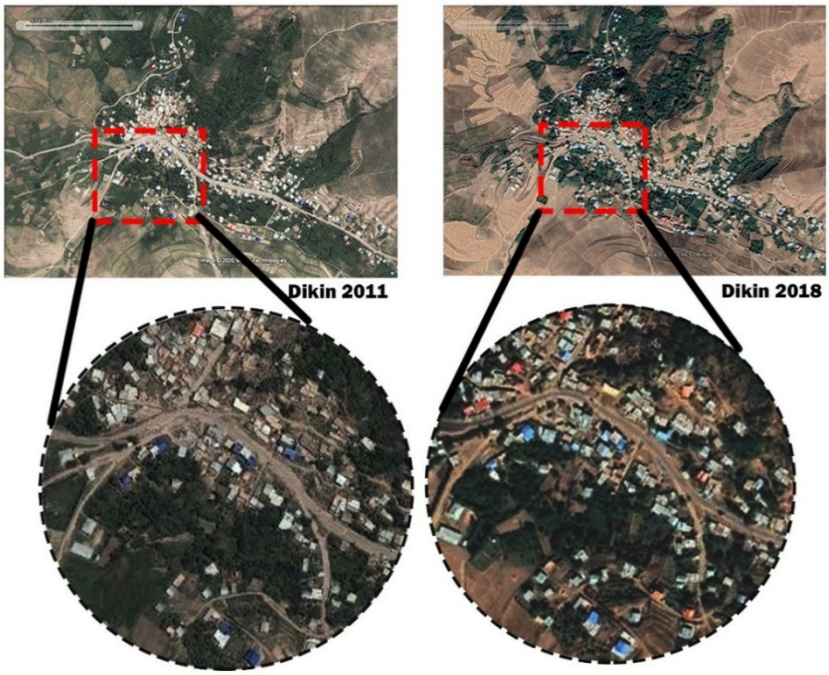


**Fig.7 Spatial changes in Dikin**

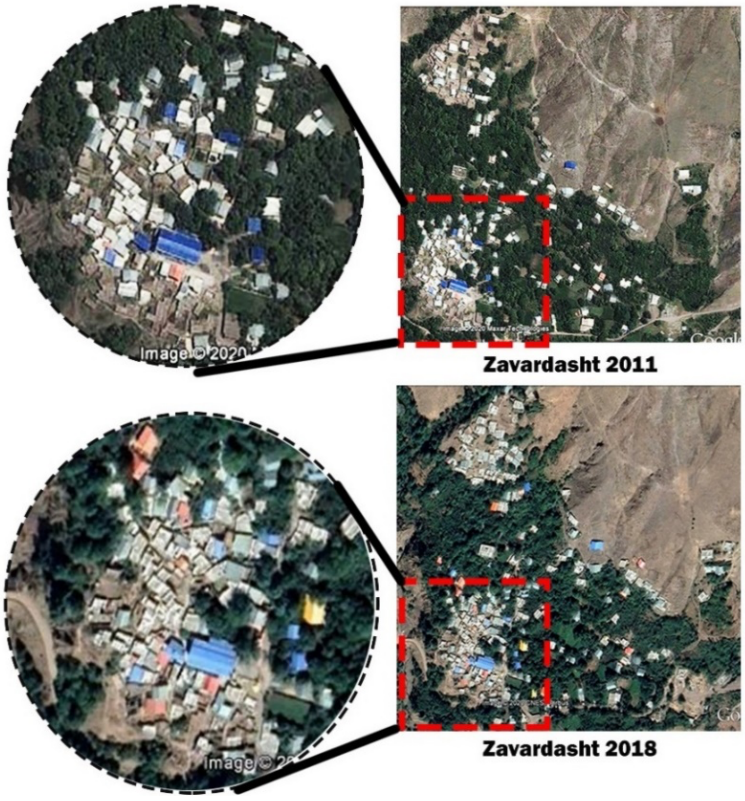


**Fig.8 Spatial changes in Zavardasht**

After SWOT analysis, the QSPM matrix is used for prioritizing strategies. Tab.5 shows the total scores of strategies according to IFEM (Internal Factor Evaluation Matrix), Tab.3, and EFEM (External Factor Evaluation Matrix), Tab.4 results.

| | **Strength** | **Wight** | **Effectiveness score** | **Final scores** |
|---|---|---|---|---|
| S1 | Employment diversity | 0.06 | 2 | 0.12 |
| S2 | Low-skill occupation | 0.04 | 2 | 0.08 |
| S3 | Increasing local service consumers | 0.06 | 2 | 0.12 |
| S4 | Learning about rural life style | 0.08 | 3 | 0.24 |
| S5 | Communication with nature | 0.06 | 3 | 0.18 |
| S6 | Open space activities | 0.06 | 3 | 0.18 |
| S7 | Experience different life | 0.06 | 2 | 0.12 |
| S8 | Relieving from modern life pressure | 0.06 | 2 | 0.12 |
| S9 | Agriculture affluence | 0.08 | 4 | 0.32 |
| | **weakness** | | | |
| W1 | Seasonal and low-income occupation | 0.06 | 3 | 0.18 |
| W3 | Increasing greenhouse gases release | 0.08 | 4 | 0.32 |
| W4 | Farmland destruction | 0.08 | 4 | 0.32 |
| W5 | Natural landscape destruction | 0.08 | 3 | 0.24 |
| W6 | Increasing land costs | 0.06 | 3 | 0.18 |
| W7 | Construction without using local materials | 0.08 | 3 | 0.24 |
| **sum** | | 1 | | 2.96 |

**Tab.3 Internal Factor Evaluation Matrix**

In Tab.5, we suggest some solutions for adjustment second home effect. By using the second homeowner's knowledge and capital, we can reduce weaknesses and threats. Also, rural-urban links should strengthen. So, it isn't necessary to create a second home to experience rural life.

| | **Opportunities** | **Wight** | **Effectiveness score** | **Final scores** |
|---|---|---|---|---|
| O1 | Supplying rural renovation costs | 0.04 | 3 | 0.12 |
| O2 | Stimulation local economic | 0.06 | 3 | 0.18 |
| O3 | Knowledge and capital transferring | 0.06 | 4 | 0.24 |
| O4 | Increasing community power to access local resource | 0.04 | 3 | 0.12 |
| O5 | Achieving finance and profit for investors | 0.02 | 1 | 0.02 |
| O6 | Increasing local relations with external networks | 0.04 | 2 | 0.08 |
| O7 | Participation in agriculture activities | 0.04 | 3 | 0.12 |
| | **threats** | | | |
| T1 | Decreasing rural purchasing power | 0.06 | 3 | 0.18 |
| T2 | Transforming rural productive role to services | 0.06 | 4 | 0.24 |
| T3 | Intensification economic inflation | 0.06 | 3 | 0.18 |
| T4 | Rural local markets weakness | 0.04 | 3 | 0.12 |
| T5 | Natural recourses erosion | 0.06 | 4 | 0.24 |
| T6 | Air, soil, water pollution | 0.06 | 4 | 0.24 |
| sum | | 1 | | |

**Tab.4 External Factor Evaluation Matrix**

| **Strategies** | **Total attractive-ness scores** | **Policies** | **Implementation** |
|---|---|---|---|
| **Garden and farmland protection** | 3.7 | Encouraging owners in agriculture activities<br>Prevent building development in farmland | Cession or rent farmland to retirees.<br>Pay penalty for building in farmlands. |
| **Protecting natural resource and landscape** | 3.44 | Harmonic construction with rural architecture | Use indigenous material in construction.<br>Use rural architecture for second homes. |
| **Enforcement of rural economy** | 3.26 | Improvement of agriculture production | Supply organic products in rural markets.<br>Develop agricultural and bestial products. |
| **Using of owner's experience and investment** | 2.7 | Supplying the cost of rural re-novation<br>Rural indigenous product development | Use second home in a timesharing mood.<br>Pay second home's tax.<br>Encourage young people to develop rural handicrafts and products. |
| **Strength rural-urban link** | 2.56 | Facilitating rural access to urban services and vice versa | Develop public transportation.<br>Encourage citizens to invest in farmlands.<br>Develop rural markets beyond rural areas. |
| **Consolidation of local's power in housing marker** | 2.34 | Prevent land trade<br>Limiting second home's temporary usage | Prevent farmlands dealing for building<br>Integrate rural land price.<br>Hold the right to housing balance.<br>Convert second homes to primary homes in the long-term. |

**Tab.5 QSPM results and policies**

## 5. Conclusions

Rural areas are struggling with losing population. But, in this article, temporary reverse migration is observed in Alamut rural areas. Second homes are the result of this population flow. Farmer studies showed that second home have long history and almost all wealthy families had second home. But, nowadays second home buying is possible for more people. All of countries faced with this phenomenon and their government try to use it in the best ways. Alamut second homeowners are natives. These houses aren't touristic and have been used in half of year. Second homeowners didn't pay taxes. According to our studies, this kind of population attraction can't cause rural development. Second homes couldn't prevent rural decline and increase it in the long-term. Our rural population density is still low because this population is unstable.

The critical services have lack capacity. Governments don't control second home creation and don't consider their demands. One of the essential factors in this circle is a job. Second homes couldn't create new business opportunities. Even a second home could encourage rural out-migration. Second homeowners create a wealthy imagination and make the young population migrate. Second home increases the price of land. This issue ruined the balance of the right to housing. Rural new families can't purchase houses. Villages have struggled with agriculture decrease. Second homes could make a motivation for farmers to sell their gardens to achieve capital. In the long-term, villages turn to lands with buildings that are vacant in half of the year. This phenomenon has positive short-term impacts, but adverse long-term effects are irreparable. These people make villages a place like urban. So, providing opportunities to profiteer owners who look for a low-cost property to build luxury homes doesn't help the rural situation.

It is better to make motivations for locals to develop their villages. Second homes shouldn't develop in this kind of rural area. Second home development could be allowed only with some conditions, including participation in agriculture activities, achieving investments for farmland improvement, paying taxes, etc. Also, our villages have a difficult accessibility and it shows that family belonging can counteract distances. Lack of second home's number data, GIS data, building's age, residency length, second home's population are some of this study challenges. Satellite pictures are only available since 2011, and we couldn't access older photos. Iran's census gathers in November, and some second homeowners have been calculated. So some village's population showed significant growth. Unclear data about second home usage in single or multiple families is another problem in this article. This phenomenon is uncontrollable and unpredictable, like other kinds of social flows.

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# Public space and 15-minute city. A conceptual exploration for the functional reconfiguration of proximity city

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**Abstract**
The global Covid-19 pandemic has changed individuals, uses and perceptions of spaces and cities. The current debate in Urban Planning is animated by the themes of proximity, public space and accessibility to essential urban functions. The functioning of the contemporary city has definitely exploded, showing its shortcomings and underlining the need to interpret it as a fragmentable and self-sufficient entity in case of emergency. The new urban models and approaches adopted seek to respond to this by reallocating essential urban functions and eco-systemic connections so that the urban and peri-urban cooperate to initiate a process of socio-economic development. The idea of a multi-polar system marked by the metric of time of use is pursued. The centrality evolves from the geographical concept to the directional one, becoming infrastructural and cognitive to increase the liveability of the urban space. The aim of the paper is to evaluate how urban transformations, through the analysis of best practices and scientific literature, can be elements in support of the proximity city and how transformative placemaking can be part of the strategy.

**Keywords**
Post-pandemic city; Centralities; 15-minute city; Placemaking transformative; Public space.

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# 1. Introduction

Today it is no longer the twentieth-century Master Plan of the Territory – the one that defined the space of a city and its functions – that must interest us, but a Master Plan of Urban Time (Biondillo, 2021).

The modern and contemporary city has its main characteristic discontinuity and parcelling. Everything is separated and syncopated: the various areas with different functions, the buildings detached from each other, the streets more like conveyor belts that transfer cars from one place to another (Pagliardini, 2009).

This urban situation has accelerated processes that were already underway, with the realisation that neighbourhoods are not monofunctional entities and that moving within the city has become difficult due to severe health restrictions. In response to this, Covid-19 rediscovered architecture's ability to create hybrids, from nature-architecture juxtaposition to the recent physical-digital life mix, with urban spaces reconfigured in uncertainty.

This situation has prompted large cities – Paris, Melbourne, Portland, Milan, etc. – to work on sustainability and the possible transposition of time into the use of urban space, especially in the vision of the 15-minute city (Moreno et al., 2021) interpreted as a solution to the pandemic, the economy and the environment.

The 15-minute city is a combination of different projects on the territory that consider education and healthcare. It is also clear that the reshaping of the world of work, today predominantly remote, offers the possibility of regenerating parts of the city in difficulty, favouring the improvement of accessibility and the development of existing and emerging businesses.

The urban interventions and strategies implemented are in line with the principles of the Green Deal and are based on the need to make cities increasingly green, safe and inclusive. This reflects the to the guidelines of the New European Bauhaus, the New Leipzig Charter and the Sustainable Goals Developments, in particular Good health and well-being (Goal 3) and Sustainable cities and communities (Goal 11).

It is not easy to define univocally what the 15-minute city is because of the multiple overlaps and juxtapositions between built space (squares, architectural quality) and perceived space (safety), between accessibility and quality of living. The urban system, thus interpreted, shows that there is the possibility of creating an elastic city, as defined by Ware (2020): an urban system that can be easily fragmented and self-dependent in case of emergency situations. In fact, it is about the possibility that each urban fragment carries a centrality and a defined and identifiable spatial quality. This concept reflects on the concentration/expansion of space and 'distributed' urbanisation in spatio-temporal terms.

An inclusive and fractal metropolis will also have on a larger scale fast routes, large-scale retail areas, hospitals of excellence and business centres. But it will not focus its development on these alone (Biondillo, 2021). The city of 15 minute or the city of proximity, in addition the nearness of essential services and facilities, thinks about a different use of space, in particular the characteristics of pedestrian connections, or rather walkability as a result of density, urban mix and the pleasantness of the environment. All these characteristics represent the heart of a community as they respond to an essential need for society and the individuals that compose it (Oldenburg, 1999).

The aim of this work is to evaluate how urban transformations of the city and public space, i.e. the system of networks and places, can be elements supporting the city 15 minute and proximity. The work includes two ways of obtaining information. Firstly, international scientific research using bibliographic databases, as well as press articles and urban and spatial planning documents. The second includes evaluation by analysing the functions of the selected projects. The rest of the article is organised as explained below (Fig.1):

- *The scientific paradigm,* the identification of scientific-disciplinary paradigms that can be linked to the definition of the 15-minute city;
- *Urban space prepadness: different names, same goals,* analysis of case studies, with a focus on the theme of urban spaces;

- *Place, business and proximity,* promoting urban well-being through transformative placemaking and reconfiguring the role of local plans;
- *Conclusion,* research perspectives resulting from the analyses carried out.

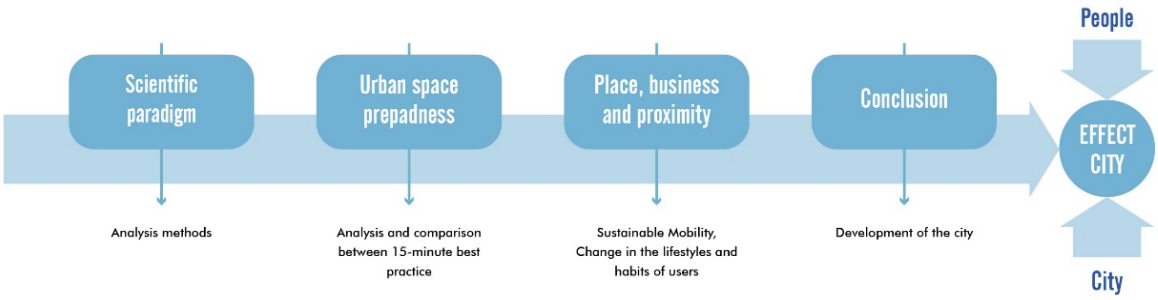


**Fig.1 Elaboration of author**

## 2. The scientific paradigm

Tomorrow's urban planning is expressed on the territory as an 'archipelago of self-sufficient neighbourhoods', enriched by 'neighbourhood activity centres'[1], connected by green structures, i.e. neighbourhoods of exchange and urban regeneration. In short, we need to think of these territories as places of experimentation to be integrated and not set against the rest (Biondillo, 2021).

The city has always been a machine for regulating idiorrhythms[2]: through physical and spatial, legal and institutional devices, it has constantly transformed the various idiorrhythms into articulated and often highly complex spatial, economic and social relations (Secchi, 2013).

If the city 15 minutes intends to work on the whole settlement system, without giving a clear spatial and applicative reference, it becomes a simple slogan with which to relaunch the strategy in the media. On the other hand, talking about a city or a neighbourhood directs reflection towards a dimension of vast area, metropolis or district.

The study by Dauny and Steuteville (2020) shows how, depending on the mode of travel (on foot, by bicycle, by car), the 15-minute city's area of influence changes in size and shape. Based on the study of displacement, with a time frame between 5 and 15 minutes, Dauny and Stauteville identify the housing units and population in the areas of interest. This research shows how the city:

- a 5-minute walk away, the radius of influence is about a quarter of a mile. The area has mixed-use public spaces and the presence of small businesses, with a population of about 2,600;
- a 15-minute walk away, the radius of influence is about three-quarters of a mile. The area has the main essential services, with larger parks serving the urban 'archipelago', with a population of approximately 23,000;
- 15 minutes by bicycle the radius of influence is about three miles. The affected area gives access to higher ranking services and could involve interurban displacement, with a population of about 350,000.

In reality, the 15-minute city is an 'ideal geography', which varies according to the means of transport used and the consequent implications of different shed levels.

1 'Neighbourhood activity centres' is the land-use planning term used to describe these local shopping centres. Community services and infrastructure are generally co-located with these places, planned and managed by local government. Source: 20-minute neighbourhoods, Plan Melbourne 2017-2050

2 The term 'idiorrhythmic' was coined by Roland Barthes and described in 'Commentre ensemble vivre?-Sur l'idiorrythmie', Cours au Collège de France – janvier-mai, 1977. The term, as interpreted by the French semiologist, indicated the relationship between the individual rhythm and that of collective life, that is the 'way of living together'. Secchi introduced the concept of 'idiorrhythm' into the discipline of urbanism to study the relationships between individuals and spatial aspects.

In fact, the 15-minute city (e.g. Paris, Milan) and the 20-minute districts (Melbourne) work on increasing the accessibility of essential services, encouraging slow mobility and – in particular Melbourne – creating a system of 'neighbourhood activity centres'.

Moreover, the city, even if interpreted through the new 15/20-minute paradigm, will inevitably continue to present urban problems and dynamics that develop and persist over longer time distances. It cannot represent an adequate institutional geography and administrative boundary, but a subset in the articulated governance that considers the multiple socio-economic and demographic components present. This situation is emphasised in the Italian context where there is still a substantial confusion of competences due to non-compliance with Law no. 56 of 7 April 2014 (known as the Delrio Law)[3].

However, approaching an organic development of the neighbourhood city has a lot of implications: on one side an equitable socio-economic environment, on the other hand the proximity of services, with consequent encouragement of public transport and less pollution.

Simultaneously, in terms of physical planning, 15-minute cities are heavily based on attributes that have been used as design flagships in the past, namely accessibility, walkability, density, land use mix and design diversity (Pozoukidou & Chatziyiannaki, 2021).

Indeed, in addition to accessibility, a further strength of the 15-minute city is the pedestrian experience, defined by architect Steve Mouzon (2012) as WalkAppeal. The latter concept is based on perceptual criteria, such as rapid changes of view, rest areas, large pedestrian and bicycle zones, a high sense of security provided by shop windows and elements (targets) in the medium distance (1 block to 2 miles) that are identified as areas where it is possible to do, for example, outdoor activities. The higher the WalkAppeal value, the more likely it is that people will not use a car to get around.

If we superimpose Walkability and the concept of the Pedestrian Shed on the model of the 15-minute city, life is marked by the metric of time. The preparation of our cities for possible extraordinary events begins with actions in the present capable of responding in different forms to the uncertainty that dominates the future (Lakoff, 2007), 15-minute cities become immediate responses and test benches for tomorrow.

## 3. Urban space preparedness: different names, same goals

The immobility of space has allowed us to reflect on living and on the city, which is now dilated and fragmented, where people live in a frenzy of change without feeling like actors in urban spaces. The loss of value and culture of urban space is evident in our reading of today's cities, where places and spaces are now incapable of creating synergies in the urban fabric: 'non-lieux' (Augé), 'junkspace' (Koolhaas), interstitial and green spaces without any functional connotation generate copy-paste cities.

Cities are composed of the time of the encounter and the time that precedes it (Nunes, 2010), within the street, where space is placed and branches out. The culture of being in urban space (public/private) was affected, limited, in some cases ceased, triggering a new way of use and ideas about the next evolution.

The urban space, symbol of relationship, shows its fragility under the incessant changes and uses dictated by time, regressing to a place of passage or parking. At the same time, it – the result of urban backdrop – loses its current limited vitality, defining the role of the house as 'place', a limited environment identified by specific characters (Strappa, 2020). If so far no attention has been to the conformation of urban spaces – an effect of the destructuring of the settlement – today it takes on a primary character, considering the relational-fruitive interactions between public space and city users as fundamental.

Will green space planning need new designs, uses and practices? What is the future of large public spaces? Will the temporary transformations seen during the crisis inspire more permanent changes? Will we observe

[3] Law no. 56 of 7 April 2014 dictated a wide-ranging reform of local authorities, providing for the establishment and regulation of metropolitan cities, the redefinition of the provincial system and new rules on unions and mergers of municipalities.

fewer people in public? Will we change what we do in public? (Honey-Rosés, 2020). With these words Honey-Rosés questions the future of public spaces as urban elements necessary to keep activities alive around built forms.

Furthermore, interrogating the city implies understanding the 'grana spaziale' and 'nicchie territoriali' (Pasqui, 2020) [4] that have been incorporated into the city over time. Public space, both in the historical and contemporary city and in the periphery has a political and symbolic value but, for those involved in planning, it has a functional and morphological relevance: it satisfies material needs, provides services to the community, expresses a public utility and can be defined as a set of 'precisely' placed, characterised and non-interchangeable areas that endow the city with a structure of collective places (Bianchi, 2018), determining a taxonomy of sociality.

Given the semantic and operational scarceness of public spaces in responding to the increasingly urgent need to provide different spaces for a changing society, the aim is no longer merely to build an effective urban form, but to investigate the relationships between mobility, collective spaces and private spaces (Aymonino, 2008). The pandemic thus highlighted the failure of planning to ensure accessibility to public services, and made visible the indifference to the location of facilities. It is clear that facilities have been placed in suburban locations, diminishing the quality and attractiveness of places previously defined as central. Therefore, the 15-minute city strategy is in line with the necessary rebalancing of the multipolar system, restoring dignity to urban parts that have become anonymous or disconnected from the polycentric system. This would make it possible to increase the space available to families forced to share crowded environments, reducing the psychological burden of isolation and the anxieties caused by the crisis (Ware et al., 2020).

Moreover, the transformations of 'urban forestation' and the recent ecological turn have underlined the need for the green component in the concrete landscape of the contemporary city. Green spaces play a crucial role during pandemic lockdowns, providing ecosystem services related to healt, well-being, recreation and (temporarily constrained) social life (Krzysztof & Drozda, 2021).

The dimension of the limit, the domestic environment and proximity become essential elements of the '1/4H city' or '15 minutes'. It is a polycentric settlement system able to offer essential and primary services in a few minutes. This strategy, devised in Paris and called 'Ville de quart d'heure' (Moreno), was then adopted by Milan with its 'Strade aperte' and 'Piazze Aperte' projects, by Melbourne, and by many others, which have placed quality of living at the heart of their strategic and operational proposals. These principles are in line with the 'Epidemic Prevention Area (EPA)' manual (Icomos China, 2020), which interprets the city as an integrated urban cluster, promoting spaces, functions and communities.

## 3.1 New scientific paradigm

The overlapping of the 15-minute city concept implies a reflection on accessibility and functions that can be reached in a few minutes. This leads to systematic changes in the patterns of spatial allocation of services and the use of public space. The scale of application, therefore, is that of the neighbourhood. However, each is linked to the other through networks of connections.

The issues on which the new urban strategies act, subsequently analysed through good practices, are: (i) urban well-being, (ii) socio-environmental sustainability and (iii) promotion of the local economy. These themes are expressed through the macro-themes identified by the proximity approach.

Capillarity, flexibility, variety and availability are therefore strategic requirements to identify, in the system of public spaces, the favourite place in which to experiment with adaptive solutions that mediate between the

[4] With the term 'grana spaziale' Pasqui indicates the conditions of hardship and the consequent inequalities of neighbourhoods or portions of the city that have lost satisfactory levels of social cohesion and quality of living. The same places, moreover, present 'nicchie territoriali', i.e. a building, an old settlement, an area close to railway stations, etc., often concentrated within the city centre, but difficult to identify.

adoption of risk containment measures and the indirect effects on the physical health and psychological well-being of individuals linked to them (di Martino et al., 2020). Today, the urban space, after undergoing sensory deprivation seeks again its performance and functional characteristics.

## 4. Example of new successful interventions

### Paris

Paris, one of the first to have focused on a strategic vision based on accessibility within a time frame of between 15 and 20 minutes, declining it in the topics of social innovation, climate neutrality, decentralisation of functions and quality of life to activate sustainable economic models and revitalise the territory. The concept of the 15-minute city, as understood by Moreno, can be summarised in four main pillars:

- density: the ability of a given area to support, in terms of service delivery, an optimal number of people;
- proximity: radial nodes that provide access to essential services, both in spatial and temporal terms;
- diversity: the need to consider both urban mixité (residential, commercial and entertainment components) and cultural and gender diversity;
- digitalization: the implementation of inclusive and participative processes, as well as offering real-time delivery of services, increasing employment opportunities and promoting sustainable mobility.

Thus, the vision of 'Paris En Commun' aims at a carbon-free economy and healthy living for its citizens (Euklidiadas, 2020). Paris, where a radical transformation of the capital is planned by 2024, will focus on the use of bicycles with the goal of a carbon neutral city by 2050. The French capital aims to refound the use and performance function of its public space, through a shift to sustainable mobility, with a simultaneous increase in green areas serving the city and the design of social, cultural and co-working spaces.

By virtue of its already well-developed transport system, Paris seeks to implement the central neighbourhoods by bringing services and green spaces at the service of the community. The risk of this operation is the creation of a hyper-centre, i.e. an excessive polarisation of the wealthy area of Paris, creating a lack of access for low-income groups.

| **Paris en Commun** | |
|---|---|
| Metrics | 15-minute |
| Urban well-being | Open air, schools, culture |
| Social and environmental sustainability | Care, sport and leisure |
| Promotion of the local economy | Work, healthy eating, shops |

**Tab.1 Evaluation of the 'Paris en Commun' plan**

### Milan

Following the path traced by the Parisian administration, Milan has launched strategies to convert current mobility into sustainable mobility, working on reducing urban traffic and identifying rapid and reversible adaptation solutions dictated by the current state of emergency. Among these strategies, the 'open squares' programme has experimented with applications of tactical urbanism, as in the case of Piazza Sicilia in the NoLo district (Fig. 2). This experience, although predating the pandemic, proved to be an excellent test case for the application of the Milan 2020 adaptation strategy and for encouraging the extraordinary use and occupation of public land. In fact, the Administration of Milan has set itself the objective of identifying a series of places for the construction of a network with a pedestrian vocation, in which to choose traffic calming and urban care interventions. These actions will have to bring new qualitative values, in coordination with the planning of public works and maintenance interventions (Municipality of Milan).

At the same time, Milan's main objective is to create a resilient city. To do so, it has worked on mobility and equipped the territory with new cycle routes, not only to cope with emergencies, but also to significantly increase the network. In addition, Milan has implemented Zone 30 zones, connected to the cycle network, in order to reduce atmospheric emissions caused by traffic and increase urban safety. This is in line with the idea of Jane Jacobs (1961), there must be eyes upon the street, eyes belonging to those we might call the natural proprietors of the street. These actions aim at reorganising the space for road traffic, redesigning public space and encouraging pedestrian movements. These actions take the form of temporary pedestrianisation to allow motor activity, outdoor games – with a focus on the children's city – and the expansion of public space available to residents and businesses. A strategy that seeks redefines urban space as a place of excellence for the social and economic sphere, evolving towards the configuration of places permeated by physical and psychological well-being, at the service of citizens and urban practices.

(a) (b)

**Fig.2 (a) Piazza Sicilia, Milan - before and (b) Piazza Sicilia, Milan - after**

| **Adaptation stratey** | |
|---|---|
| Metrics | Neighbourhood (15-minute city) |
| Urban well-being | Management of health containment measures, sustainable mobility, children's city |
| Social and environmental sustainability | Urban neighbourhood spaces, air quality, renaturation |
| Promotion of the local economy | Collaborative economies, short supply chains |

**Tab.2 Evaluation of the "Milan 2020" Adaptation strategy. Open document to the city's contribution**

## Melbourne

The Melbourne 2017-2050 plan aligns with the 15-minute city concept by emphasising that planning emphasis need to focus on ensuring streets in urban areas are organised in such a way that they promote accessibility to different parts of the city within 20 Minute walking radii, and such planning would sometimes require restricting or reorientation existing infrastructures (Moreno et al., 2021).The main pillars on which the strategy is built are: (i) density, (ii) diversity of land use, (iii) design, (iv) accessibility, and (v) distance to transit (Stanley, 2015). The expected catchment area is about 800 metres covered in 20 minutes and the strategy is divided into 7 strategies, 90 policies and 23 directions. The main elements of this approach are the 'neighbourhood activity centres', which are part of the 'activity centres' strategy (Tab. 3).

| Types of Activity centres | |
|---|---|
| Central activities districts | Centre of activity with the greatest variety of uses and the most intense concentration of development |
| Principal Activity Centres | Large centres with a mix of activities that are well served by public transport |
| Major Activity Centres | Centres with a mix of activities serving smaller catchment areas |
| Specialised Activity Centres | Centres with a mix of economic activities that generate high numbers of work and visitor trips |
| Neighbourhood Activity Centres | Centres with a limited mix of uses meeting local needs and are dominated by small businesses and shops and limited community services |

**Tab.3 Type of activity centres. Elaboration of author on information Activity centres toolkit (2010)**

Planning Melbourne introduces 'neighbourhood activity centres', i.e. retail services and goods (newsagent, bakery, supermarket), local entertainment facilities (bars and restaurants), health services and local facilities, to meet daily needs (Plan Melbourne 2017-2050) at the neighbourhood level and across the city, with their contextual and necessary systemisation. At the same time, they are places for social interaction and community participation, but can also play the role of 'pedestrian places' within the city.

Analyses show that not all neighbourhood activity centres are equally served or accessible by the public transport network, especially the outer suburbs. The challenge for Melbourne, which has relied on car use, is to complement and promote mixed mobility, both pedestrian and public transport, as a driver of a different 'lifestyle'. Indeed, the strategy, through the creation of a network of neighbourhoods, aims to reducing urban sprawl and provide employment and investment opportunities by giving each individual neighbourhood with a level of self-sufficiency.

The 20-minute city project started in January 2018 with the establishment of the first pilot project, which emphasised the importance of integrating bottom-up approaches in planning, as well as physical projects. The goal is sustainable development, placing itself in line with the goals of the UN Agenda 2030 (Goal 3: Good Healt and well-bing; Goal 11: Sustainable cities and communities), creating mixed-use environments and dynamic communities. Thus, the place-based approach underlying the 20-minute city focuses on 'place' as the result of different disciplines. The limitation of the 20-Minute City is not to identify a metric for reference and functions to develop the network of self-sufficient neighbourhoods.

| Plan Melbourne 2017-2050 | |
|---|---|
| Metrics | Neighbourhood - 20 minutes |
| Urban well-being | Walkability, safe street and space, local health facilities and services |
| Social and environmental sustainability | Community gardens, Local playground, ability to age in place, housing diversity |
| Promotion of the local economy | Activity centres, Local shopping centres, local employment opportunities, |

**Tab.4 Evaluation of the "Plan Melbourne 2017-2050"**

## 4.1 New concept

These best practices are strategies that focus on the quality of urban life and public space, not only as a space between buildings, but as an active component. It is embedded in an urban environment, innervated by a multi-polar system and connected by eco-systemic infrastructures, implementing the concept of 15-Minute City. This transformation would give rise to constellations of eco-neighbourhoods with a high functional mix, giving a new centrality to places that have lost their identity and urban appeal. The strategies aim, through macro-thematic actions, at the constitution of a preparation of the urban space in which the functional mix generates and develops multipolar centralities, capable of creating a city effect (Fig.3).

The reconfiguration of public space has stimulated a great debate on whether public space can be flexible and guarantee people's urban safety. As well as making the difference between public and private space almost

non-existent, the emergency has highlighted the need to extend services outside for the benefit of citizens, resulting in adjustments to the road system and the removal of space for cars. Thus, the design experiments 'Open Squares', 'Open Streets', the 15-minute city and the 20-minute city have not only promoted cycling and walking, but also facilitated the occupation of public space.

It is therefore clear that tactical urbanism projects have entered the urban discipline as effective temporary practices for rethinking public spaces and managing emergencies. It is evident that temporary transformations had different responses depending on the context in which they were applied. On the one hand, they could stimulate bottom-up practices and networking; on the other hand, when included in urban regeneration projects, they could favour their application in areas that are more profitable for real estate purposes.

The aim is to rethink urban spaces (and disused buildings) by giving them back their centrality, according to function, necessity and – if foreseen – temporariness of interventions, reshaping the network of movements. At the basis of this, the interaction between architecture, infrastructural planning and town planning represents the central strategy to create catalysing public spaces, usable and close to citizens, in order to achieve the highest level of quality of the habitat we live in (Faroldi, 2015).

The boundary dimension (expressed by facades and the spaces between buildings), the proximity dimension (accessibility, business, services, polycentric system) and the domestic dimension (the home as a city) become strategic and complementary in rethinking the urban system, with each element having a renewed urban and functional value.

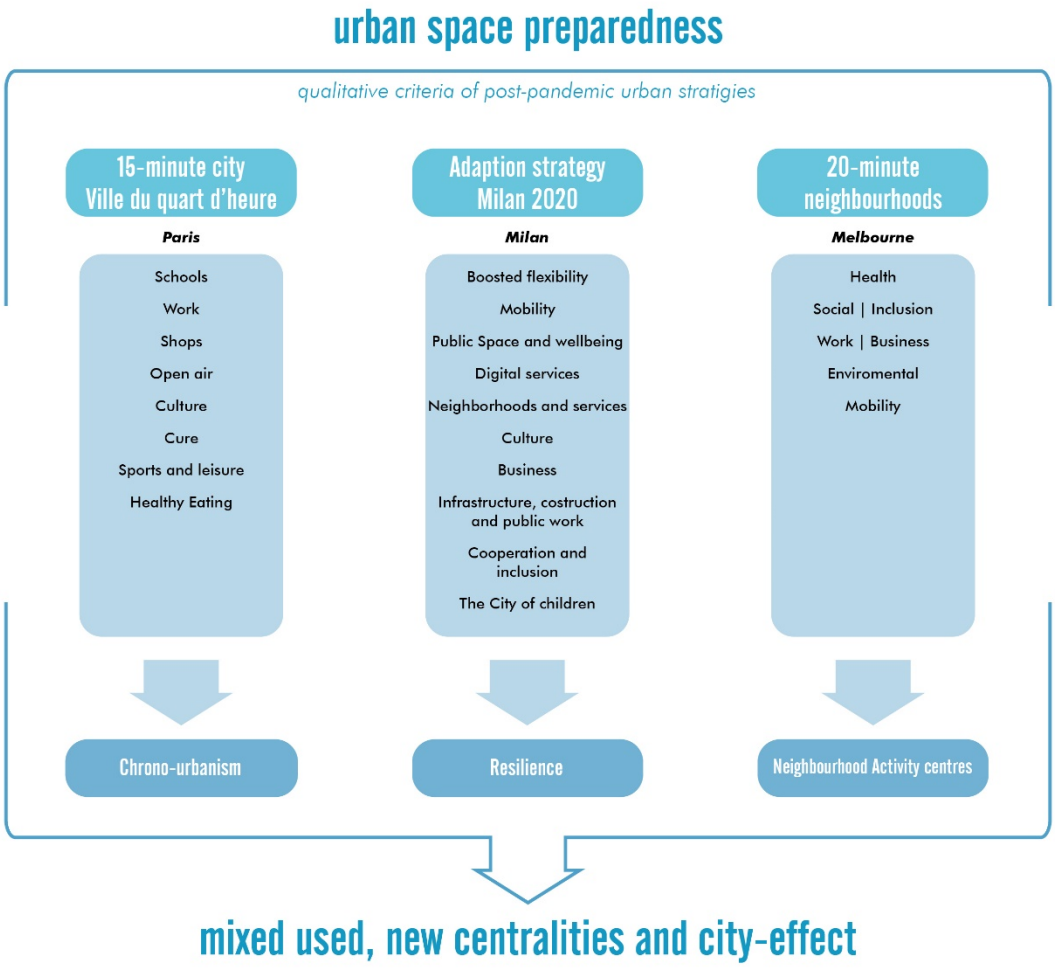


**Fig.3 Urban strategies, new centralities and city-effect**

## 5. Place, business and proximity

Reasoning on the theme of territorial revitalisation and simultaneously counteracting disinvestment, gentrification and displacement, possible 'activity centres' (e.g. Melbourne) in the city assume the role of structural elements for the construction of inclusive economies. Recent research by Bartik shows that moving activities from distressed locations to more attractive and dynamic environments is wrong. The abandonment of such areas causes a loss of local economic demand and the ability of the neighbourhood or piece of town to provide essential public services. On the contrary, it is necessary to help revitalise the economy of such areas by suggesting a reorganisation of the policies for locating businesses and companies. This will trigger processes of regeneration and revitalisation of places in difficulty, working on local skills. The additional jobs created in distressed places draw people into productive employment, raising the overall effective national labour supply and economic output (Bartik, 2019).

It's not enough to have just one great place in a neighbourhood – you need a number of them to create a truly lively community. It's not enough to have one great neighbourhood in a city – you need to provide people all over town with close-to-home opportunities to take pleasure in public life. And it's not enough to have one liveable city or town in a region — you need a collection of interesting communities (PPS, 2009).

The idea behind dynamic environments and communities is that the urban place has a power of attraction through functions and uses. The idea is the enhancement and development of placemaking at different scales (Fig. 4). The concept also gives people incremental and tangible goals, and it helps them to visualize, and collectively work towards, a truly great end result (PPS)[5].

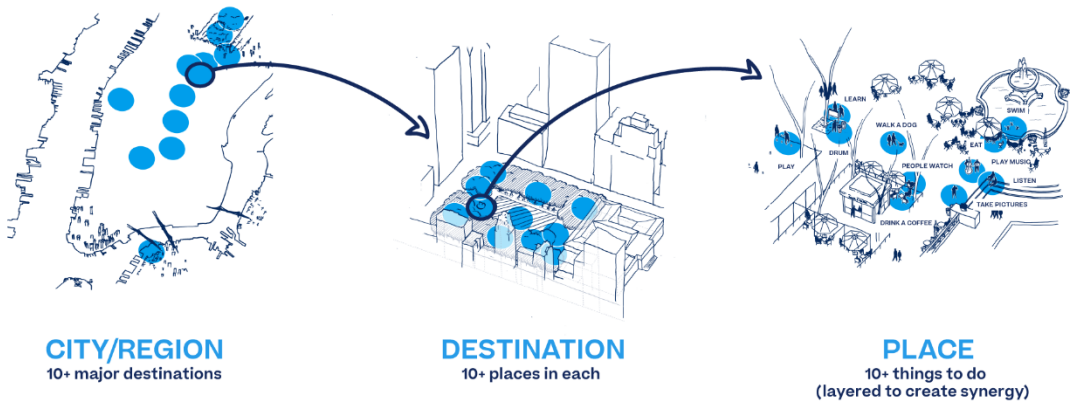


**Fig.4 PPS. How Cities Trasform Through Placemaking**

The focus is therefore on cities on a human scale, i.e. flexible places and entities able to offer and enable adequate urban experiences, both social and economic. Also, 15-minute cities are partial answers to today's problems. They seek to create a polycentric network of eco-sustainable and self-sufficient neighbourhoods, thinking above all about urban amenities. At the same time, such an approach combined with the strategy of transformative placemaking can reshape the contours of the economy, flows and space that insist on cities. Transformative placemaking can be integrated into the 15-minute city if it is used appropriately. Such as the 15-minute city, transformative placemaking works to achieve inclusion within the city. Transformative placemaking does not identify a geographical dimension, but seeks to enhance the specificities of a place and its latent possibilities.

The difference between transformative placemaking and the 15-minute city is that the first approach seeks to reactivate urban environments plagued by neglect and does not focus exclusively on the city centre as the

[5] The idea of identifying what determines the attractiveness of a place was addressed by PSS. The research work led to the concept "Power of 10+". The research, through placemaking, seeks to focus on the human experience in defining functions.

second strategy does (e.g. Paris). Thus, it aims to counter territorial inequalities and support the creation of local and inclusive networks. It could be said that the 15-minute city, on the basis of the analyses presented so far, can also be declined as a placemaking strategy. *Transformative placemaking*, therefore, are functional entities working on three main qualities:

- scope, the reconstruction of the relationship between place and economy;
- scale, the spatial dimension defined by opportunities and market realities;
- integration, a 'place-based' and multidisciplinary view.

Transformative placemaking seeks to initiate the emergence of an ecosystem an *economic ecosystem* that is regionally connected, innovative, and rooted in the assets of its local residents and businesses; a *built environment* that is accessible, flexible, and advances community health and resiliency; a vibrant, cohesive *social environment* that is reflective of community history and identity; *civic structures* that are locally organized, inclusive, and support network building (Vey & Love, 2019).

In the classical configuration, placemaking it helps them to re-imagine everyday spaces, and to see anew the potential of parks, downtowns, waterfronts, plazas, neighborhoods, streets, markets, campuses and public buildings. On the other hand, transformative placemaking, as conceived by the Bass Center of the Brookings Institution, extends the classic concept of placemaking coined by the Project for Public Space – understood as the set of operations aimed at improving social well-being – to integrate the idea of clusters capable of creating a critical mass of economic resources. The objective pursued is the creation of dynamic and lively realities and communities capable of counteracting the incessant change and implementing innovative land management policies in favour of a socio-economic prosperity at local level (Tab.5).

| **Trasformative placemaking aims to** | | | |
|---|---|---|---|
| **Economic ecosystem** | **Built environment** | **Civic structures** | **Cohesive social environment** |
| Regionally connected | Accessible | Locally organized | Vibrant |
| Locally empowering | Flexible | Inclusive | Cohesive |
| Innovative | Healthy and sustainable | Networked | Reflective |

**Tab.5 Transformative placemaking framework. Elaboration of author on information Bass Center for transformative placemaking (2019)**

The 15-minute city policy, the identification of the city effect instances and the outcomes produced by activity centres, lead to a reduction in the socio-economic and qualitative inequalities inherent in the contemporary city. The theme of centrality evolves from a geographical to a directional concept, becoming infrastructural and cognitive. It distances itself from the pole, to become multiple and diffuse over the territory, composed of innovative elements in social, economic and spatial terms. In this way, urban trends and transformations activate development dynamics in which neighbourhoods are part of a system rather than simple hierarchies or single entities (Pozoukidou & Chatziyiannaky, 2021). Therefore, we try to avoid strictly homogeneous social islands, which cause marginalisation, in favour of a culturally complex system (Fasolino et al., 2020).

The city of greater proximity is made up of living spaces amplified by a sort of osmotic belt that enriches living spaces through a true polycentric city project, providing neighbourhoods with places for care and culture, gardens and playgrounds, productive and commercial activities and spaces for a relational life that is safer because it is distributed and not assembled (Carta, 2021). Designing proximity implies strengthening bicycle and pedestrian mobility networks. It is not a question of redefining city boundaries, but of promoting settlement systems on a human scale without sacrificing the city effect.

However, if micro-mobility and walking are desired, then major rethinking of street infrastructure, and of the way the space is shared (Lai et al., 2020: 237). These latter considerations have an impact on changing the lifestyle and habits of users, leading to the use of sustainable mobility. It is clear that it is difficult to define the topic of mobility in a univocal way, because of the variables involved (urban morphology, accessibility,

intermodal offer, etc.). It must be seen as an integration of the available solutions, both as a physical issue and as a driver of urban development. The idea of the street as an incubator of health and well-being means a space in which the noise, air quality, and other environmental risks are kept below a healthy maximum, in which streets become places to live rather than merely spaces to move through (Lindelöw et al., 2021). Sustainable mobility is therefore enriched with different intensities and speeds according to travel needs. The theory of the 'Walkable City' is in fact based on the concepts of sustainable mobility such as coherence, continuity, balance, safety, comfort, accessibility, efficiency and attractiveness of places, as key characteristics to promote transport choices capable of promoting correct styles of life (Balletto et al., 2020). The improvement of public space, supported by the creation of inclusive environments, will allow sustainable mobility, both walking and cycling, to establish itself as one of the main pillars of urban development. Moreover, safer streets and attractive sightings also have an effect on psychology, fostering mental health beyond an augmented sense of community (Núñez-González et al., 2020).

The challenge to take up, in order to take full advantage of changing user lifestyles, is to keep the focus on the importance of green infrastructure for outdoor activities and cycling, counteracting a return to car-only use. The goal is a multi-scalar infrastructure, which functions both local and regional level, a sort of hybrid infrastructure that brings together functions which are not in direct related to one another, taking advantage of their proximity to the mobility network, sharing mobility networks, [...] an opportunity for redemption for the neglected places of the city in the twentieth century (Daprà, 2016).

# 6. Conclusion

## 6.1 Discussion

Until now the city effect has been an expression of the capacity to offer services, often assimilated to a pole; today we are going in a different direction: there is no longer an exclusive centre, but multiple inclusive and sustainable centres at different urban scales. The distinction of the space for centrality from the generic potentially transformable space derives from the reading and interpretation of the morphological characteristics and relational behaviour between the various structural components of the field of centrality (Strina, 2013).

The city has reached a crossroads in which it is necessary to take note of what it is – an urban simulacrum – and what it could be – a multiform soul, the sum of creativity, innovation and sustainability – in order to enter a new era with unprecedented characteristics, not only in form, but above all in the declination of use. The city requires action to remedy its shortcomings: we need to rethink its use and role, new forms of tourism in coexistence with the residential aspect, reduce inequalities and calibrate the supply of services. It is unthinkable to think of abandoning the city, but the reconversion of the office towers and the many offices within them is not entirely unthinkable. So, if these are the premises, the challenge is to understand which elements qualify the city as such: it aims at spaces 'between things' that are significant because they are equally used by those who live there, whether they are places and provide opportunities for meeting, attendance and 'aggregation' (Secchi, 1993).

Urban awareness, understood as a 'sustainable habitat', will prove to be strategic in a period of transition and change in which the 'city space' is called upon to change: the first difficulty in thinking about the future is to think about the present (Morin, 2001). We are not faced with a single way of conceiving space, time, and architecture; rather, the terms require their evident terminological pluralization. The built space, its form, the language undoubtedly represents the barometer of an era, the result of economic, social, technical, and cultural variables that come together synergistically to define the architectural meaning (Faroldi, 2020).

There is a need for conformity between the different layers that make up the city system. Conformity is more than 'transcalary'; that the strategic approach to urban planning should consider different scales

simultaneously is a fundamental and accepted concept. That the design of networks and places should look for bi-unique relationships and possible synergies is an innovation yet to experiment with (Mascarucci, 2020). It is clear that the lack of interest in past and current urban issues, now amplified by the pandemic and climate conditions, makes it evident how 'building' has prevailed over 'living', derogating the design of planning interventions from the obsolete regulations in force. The natural consequentiality between building and living is overturned in order to restore well-being and create 'urban artefacts' (Rossi, 1982). The result is areas devoid of identity and city effect, and unable to play the role of centrality. The debate on the loss of the center has been fuelling urban planning and urban composition for years: there are those who accept it as modern form that supports the expansion of the forma Urbis towards the shapeless suburbs, and those who counteract this trend by means of redevelopment and reconversion actions aimed at reshaping space according to contemporary ways of living (Faroldi, 2020). Thus, the 15-minute city is a partial answer to redesigning urban welfare and restoring the role of centrality. The functioning of the contemporary city has definitely exploded, laying bare the shortcomings of land management: if the periphery is to become central, it is necessary to relate centralities and the city effect with settlement models, commensurate and calibrated with the sustainable design paradigms of the future.

## 6.2 Prospective of research

Urban planning must reassert its role, rediscover the intrinsic value of forms and spatial management, and embrace real and virtual nuances. All too often the creation of squares, streets and voids has generated an 'urban space' that is already obsolete before it is finished, responding to urban planning standards that have been circumvented. In the current context, financial resources are scarce: with the Next Generation (Recovery Plan) in the background – and the need to contain land consumption by recovering underused buildings and empty space – it becomes a priority to innovate and enhance urban appeal, to innervate the territory with an integrated system. The aim of urban interventions is not only to solve the problem of abandoned buildings, but also that of large working spaces that are currently underused. This inversion can be achieved by transforming these spaces into places where co-working and remote working can be promoted to attract businesses and young people, in order to address 'the structural weaknesses of the Italian economy' and 'repair the economic and social damage of the pandemic crisis' (PNRR Italy). Specifically, we must design the regeneration of our cities so that they are antifragile, capable of using crises to innovate, shape-shifting places able to adapt to the different needs of anti-union cities (Carta, 2021).

Despite initial results, the 15-minute city vision is characterised as an extremely versatile and useful strategy. The concept of the 15-minute city is a 'cosmopolitan localism' where the network of small distances is in synergy with the network of long distances. It is clear that the network of short distances cannot replace long-distance relations in the area, but it can guarantee a sense of community, identity and belonging to the neighbourhood. In fact, the city of proximity has always existed within the urban hyper-center; today it is a question of expanding the positive effects of proximity in marginal areas.

The 15-minute city, green and 'on a human scale' offers the possibility of giving a new definition to the city according to parameters of functional reconfiguration parameters, based on the existence of a network of spaces between the socio-economic dimension and the quality of living. Redesigning and reconfiguring a post-pandemic city, stripped of rhetoric and 'false' sustainable strategies, would redefine the role of Urban Planning and Architecture, rebalancing the urban quality and the speed of development between city and periphery. This approach should aim at the creation of hybrid places capable of innovating the urban structure in socio-economic and environmental terms.

The future will be marked by a growing awareness of our responsibilities towards the environment, both in its more general and pervasive aspects, usually referred to as global change, and in its more specific and local aspects, such as protection against hydrogeological risk or defence against all forms of pollution. [...] This will

introduce new materials into the dilated space of the contemporary city and change its image (Secchi, 2000). The Covid-19, therefore, must be declined as an opportunity to rethink places and spaces. Rebalancing of inequalities inherent in settlement systems could initiate a development process for the city of tomorrow in an increasingly healthy and liveable way, with effective, transcalar and multidisciplinary urban planning.

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## Image Sources

Fig.1: Elaboration of author;

Fig.2: Piazza Sicilia (Milan, Italy) Pedestrianisation project. Source: Comune di Milano. Retrieved from: https://www.comune.milano.it/documents/20126/992518/Strade+Aperte_IT_200430_rev.pdf/a100d04c-6b55-ae74-e0f8-b52563e07822?t=1589460655416 ;

Fig.3: Elaboration of author on urban strategies of Paris, Milan, Melbourne;

Fig.4: Project for public spaces. Retrieved from: https://www.pps.org/article/the-power-of-10.

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# Characterization of drivers of agricultural land use change

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**Abstract**
Major factors driving agricultural land use in Malaysia were characterized with Principal Component Analysis (PCA). Discrete variables assumed to drive agricultural land use were converted into spatial data. Vector data subsequently obtained from these conversions were later rasterized before being disaggregated. ASCII data of each of the disaggregated was derived using ArcGIS 10.3.1. A MatLab program was thereafter used to convert the ASCII data into vector column where systematic sampling was performed after Moran I test to select the samples for PCA analysis in SPSS/IBM version 23. The result of the PCA analysis finally aggregated variables driving agricultural land use into: urbanization, availability, ageing and cross sectoral mobility of labour, geophysical, accessibility, and climatic factors. These factors explained about 88 % of the cause of agricultural land use in the study area. The proposed transition of Malaysia to a high income nation will no doubt put additional pressures on the identified drivers (factors) of the agricultural land use, therefore, it is expected that the policy makers put in place measures that will minimize environmental effects of these pressures in order to make the proposed transition sustainable.

**Keywords**
Agricultural land use; Principal Component Analysis (PCA); Spatial data.

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# 1. Introduction

Land use and land use change (LULUC) is one of the manners by which mankind influences the natural landscape (Hu et al., 2019; World Bank, 2008; Lechesten et al., 2005) and the processes have been linked to the human socio – economic activities (FAO, 1996; Kleemann et al., 2017; Marchant, 2018; Dinç, & Gül, 2021) with implications on food, water and energy security (IPBES, 2019; Näschen et al., 2019); urban spatial structure (Nuissl et al., 2021) biodiversity loss (Kuemmerle et al., 2016), climatic change (Zucaro & Morosini, 2018) and direct impacts on oceans, terrestrial and freshwater ecosystems (IPBES, 2019; Näschen et al., 2019). Several attempts have been made by researchers to identify the drivers and the dynamics of land use processes with the use of different methodologies and models (Huang et al., 2007; Vasco and Eric, 2010; Qasim et al. 2013), the attempts have not generated specific model that will be suitable for and in all situations (Verburg et al., 2004; Leta et al., 2021). Generally, models of land use change serve as useful tool for assessing the mechanisms (Veldkamp and Fresco, 1999); identifying the drivers (Batty and Longley, 1994; Alexander et al., 2015; Hu et al., 2019); projecting the impacts of land use change (Theobald et al., 1997) and evaluating the effects of alternative policies and management opportunities (Bockstael, 1996; Verburg et al., 2004) due to land use change.

## 1.1 Models in land use change analysis

Generally land use models are useful for selection of specific drivers (independent variables) for a particular land use class (dependent variable) at a specific scale from several hypothetical driving factors (Kok and Veldkamp, 2000; Verburg et al., 2004). Therefore, the choice of a particular methodology is dependent on what research questions to be answered, the available data and the application of the research outcome (Nelson, 2002; Wester - Herber 2004). Previous researches on land use and land use change analysis have focused on assessment of drivers (Alexander et al., 2015; Wang et al., 2016) and effects of LULUC on climate change (Lambin et al., 2001) soil erosion 11, biodiversity loss (Lambin et al., 2003), food security (Lambin et al., 2003), public health (Shi et al., 2018) and urban spatial structures (Nuissl et al., 2021). However, in this study, attempts were made to describe and validate the methodologies involved in the use of Pricncipal Component Analysis (PCA) for identifying and characerizing important factors driving agricultural land use in the study area with a view to gaining deeper understanding of the process, the drivers, the dynamics and the potential implications for attaining sustainable development in the study area.

## 1.2 Application of Pricncipal Component Analysis (PCA) in environmental analysis

PCA is a simple and non-parametric test that has been applied over a century (Hotelling, 1933; Pearson, 1901), on socio - economic (Lordan et al., 2012; Nyaga & Doppler, 2009; Fujii, 2008); geophysical datasets (Hassanzadeh et al., 2016; Parker et al. 2013) and environmental datasets (Hassanzadeh et al., 2016) aside the conventional regression analyses, to characterize, model (Jobson, 2002; Jolliffe, 2002; Legendre & Legendre, 1998; Jongman et al., 1995); classify (Cochard-Picon et al., 2012; Jayawardana et al., 2012; Richards et al., 2012) and identify hidden structure/dimension in a dataset (Hassanzadeh et al., 2016; Lordan et al., 2012). PCA is series of linear regressions where a vector line is drawn through an n - dimensional dataset such that the sum – of - squares (n-dimensional) distances from the line to all the points in the dataset are minimal (Jolliffe, 2002) thus significantly reducing the number of dimensions in the dataset before using the datasets for further analysis. The decision of the numbers of components to retain are usually guided by the scree (or broken-stick) test; Kaiser's rule (that eigenvalues should be greater than 1), and the principle that components should explain at least 70 – 80% of the retained variance (Jackson, 1993).

A scree plot helped to determine the maximum number of factors (usually indicated by the point before the eigenvalues plot flattens out) that can be extracted from a dataset. While communalities measured the

percentage variability in a data and it is regarded as high when its value is greater than 0.8 (Velicer & Fava, 1998); moderate when 0.7; low when 0.4 and considered not related when less than 0.4 (Costello & Osborne, 2005). Thus, factor loading threshold is 0.4 (Costello & Osborne, 2005) and the criteria used in differentiating between different component (drivers of agricultural land use) is Kaiser's rule which involves retention of any component whose eigenvalue is greater than 1 (Wiktorowicz, 2016). Correction for spatial auto - correlation is an important procedure in land use change analysis because spatially - autocorrelated data contradicts the assumption of independence between data points (Anselin, 2002; Millington et al., 2007) and can undermine the power of the regression coefficients (Kok & Veldkamp, 2001; Chou, 1991).

Like several other statistical techniques, PCA, has limitation of being affected by variable scaling thus automatic data normalization is a required operation before conducting PCA (Abdi & Williams, 2010). Secondly, PCA results could be misleading particularly where the data contain outliers (Sapra, 2010). Essentially, the conduct of PCA becomes necessary where large number of variables exist and for initial reduction in dimensionality of the datasets before further statistical analysis are conducted (Johnstone & Lu, 2009).

# 2. Methodology

## 2.1 Study area

Selangor is one of the 13 states that constitute Malaysia. Selangor is located between latitudes 2.580N and 3.830N and longitudes 101.170E and 102.000E covering about 8000 square kilometers (Fig. 1). The average daily temperature of the state ranges between 210C to 320C while the mean relative humidity is above 80% (Jasim et al., 2013; Suhaila & Deni, 2010). Of the 13 states in Malaysia, Selangor is the most populous (Fig. 2), most urbanized (Fig. 3) and the richest state (Fig. 4) (Alias et al., 2010). Agricultural sector has contributed significantly to the economic development of the state (Alias et al., 2010; Abdullah and Nakaghozi, 2007). Despite the economic transformation of the state, agricultural sector still remained important in the production of food for the growing population (EoN, 2010) and major source of economic stability to Malaysia during the global economic meltdown thus making the sector a major cause of land use change in Malaysia (Abdullah & Hezri, 2008; Abdullah & Nakaghozi, 2007).

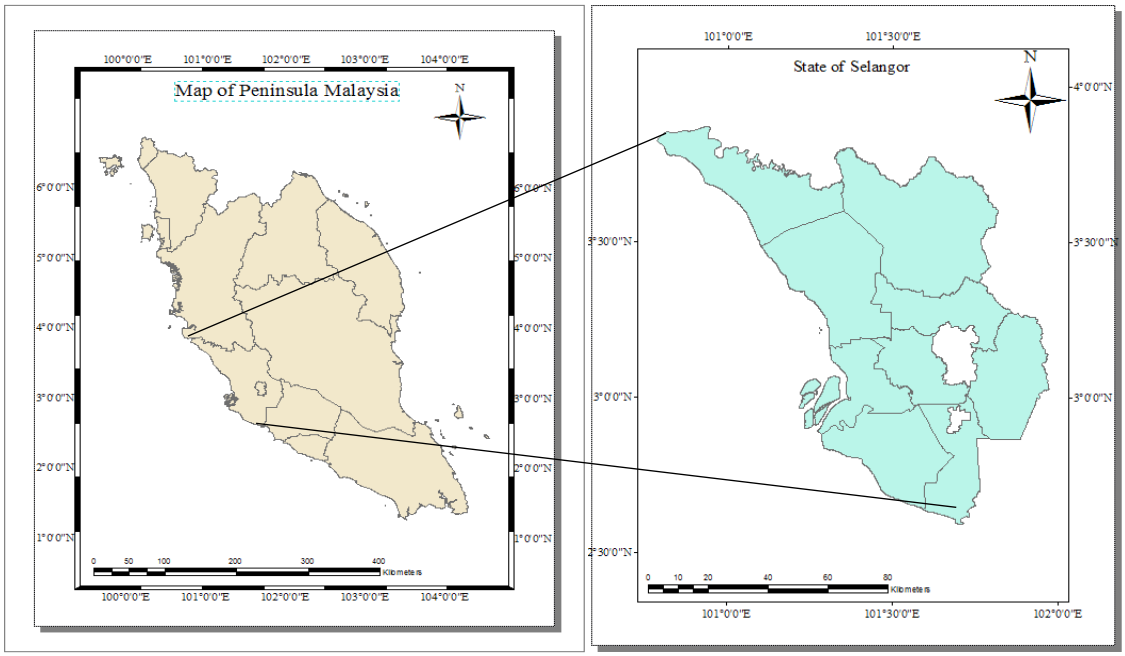



**Fig.1 Study area**

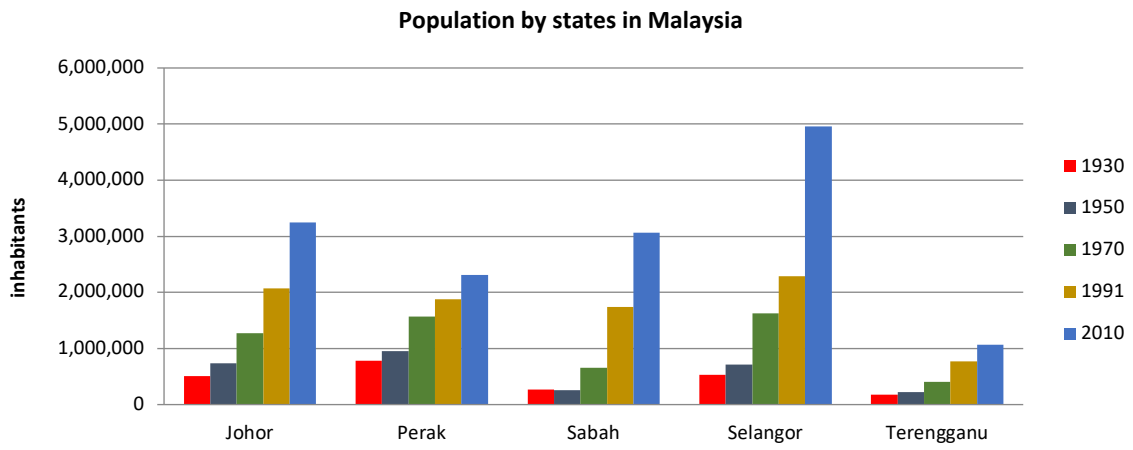



**Fig.2 Population data of selected states in Malaysia 1930 – 2010**

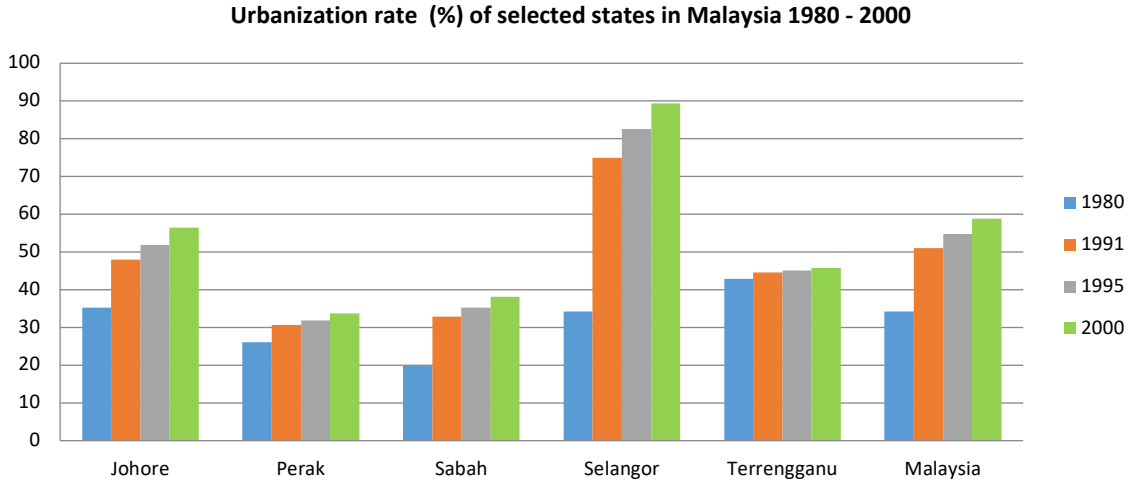



**Fig.3 Urbanization rate of selected states in Malaysia 1980 – 2000**

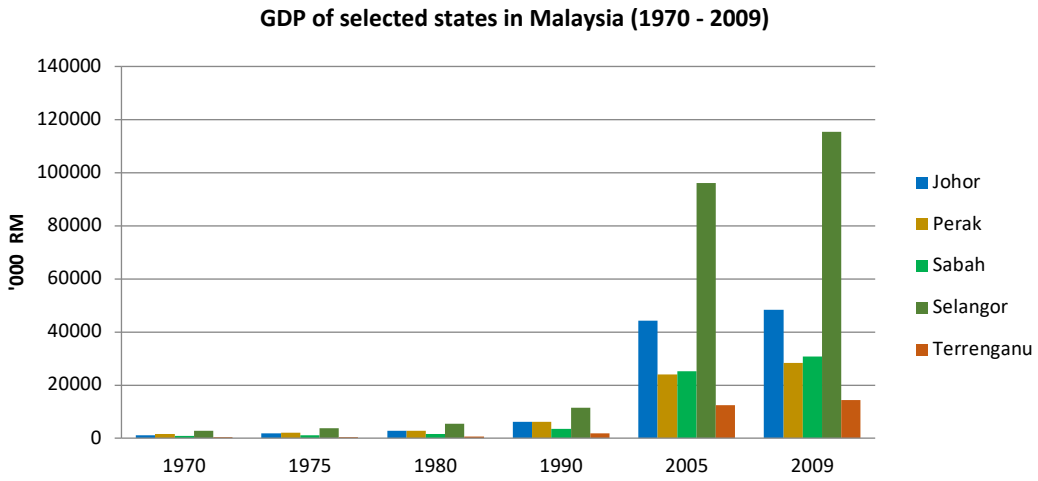



**Fig.4 GDP of selected states in Malaysia 1970 – 2009**

## 2.2 Data sources

In conducting this study, it was assumed that the agricultural land use is mainly driven by economic decision (McMorrow and Talip, 2001) therefore locations with low slope, moderate elevation and good soils (Müller et

al., 2009; Ioffe et al., 2004) are the most preferred location for agricultural land use (Olaniyi et al., 2013). Climatic factors such as relative humidity, rainfall, temperature and numbers of raining days that are likely to influence agricultural land use were equally selected into the model (Tab.1) (Ge et al., 2008).

## Geophysical data derivation

The slope data for the study area were derived from the 1:50,000 contour data using ArcGIS 10.3.1 software and were then converted into a multilayer binary raster data of size 300m (Deng, 2011) to represent the spatial distribution of the landforms (Deng et al., 2006).

Since these data were in form of point, second order inverse distance weightings (IDW) was used to interpolate them to produce a spatial elevation and slope data for the study area (Müller et al., 2008).

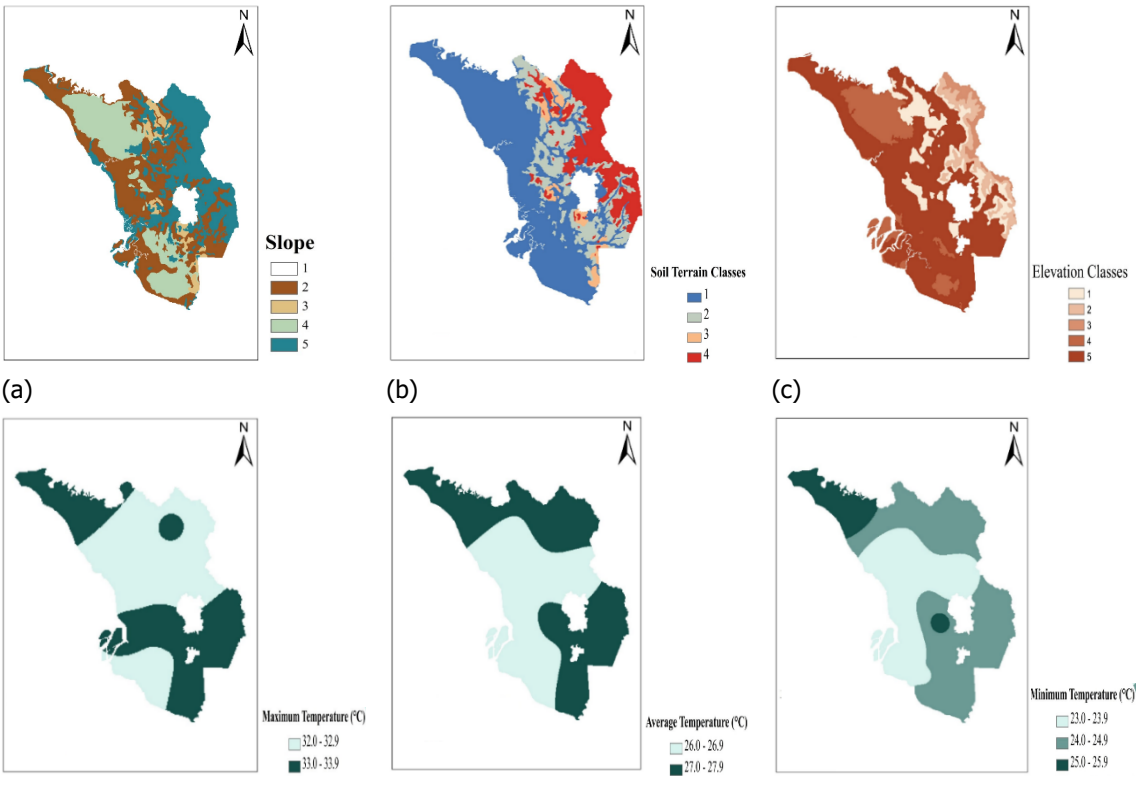
The slope data produced by this method is continuous and was reclassified to several classes (Fig. 5a – 5c) that have been used in related studies (Vasco & Eric, 2010; JUPEM, 2010).

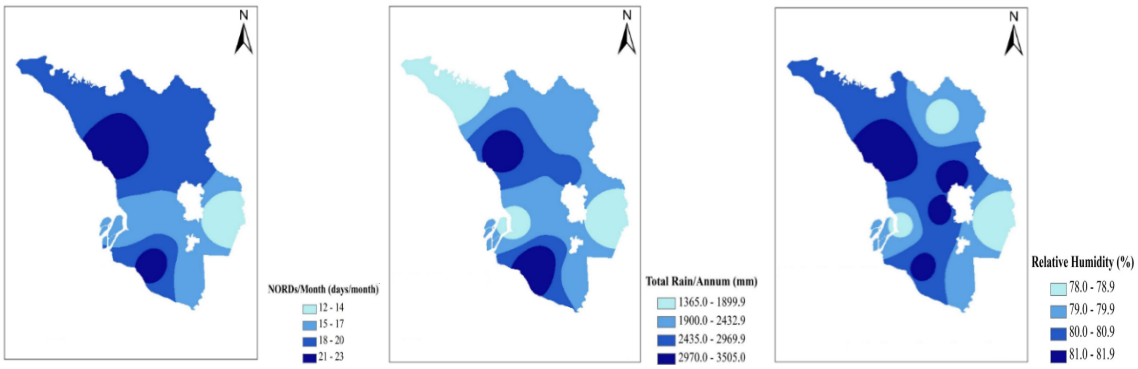
## Climatic data

Climatic data such as average annual relative humidity, minimum, maximum, average temperatures and the number of raining days were used to indicate the effects of climate on agricultural land use in the study area (Backlund et al., 2008; Deng et al., 2006).

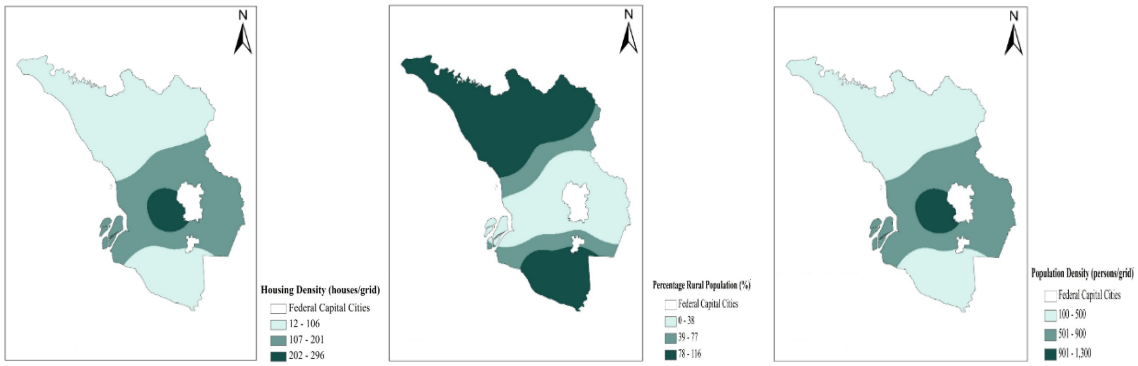
Kriging spatial interpolation algorithm was used to calculate the value of the variables on each grid before it is imported into the model as parameters (Fig. 5d. – Fig. 5i.) (Deng, 2011). Available evidence from literatures suggest that IDW was the best method for slope interpolation whereas kriging and spline were preferred for climatic dataset because IDW assumes that each measured point has an influence that diminishes with distance (distance decay influence).

However, several studies indicated better performance of kriging over IDW in point estimates (Nusret & Đug, 2009).

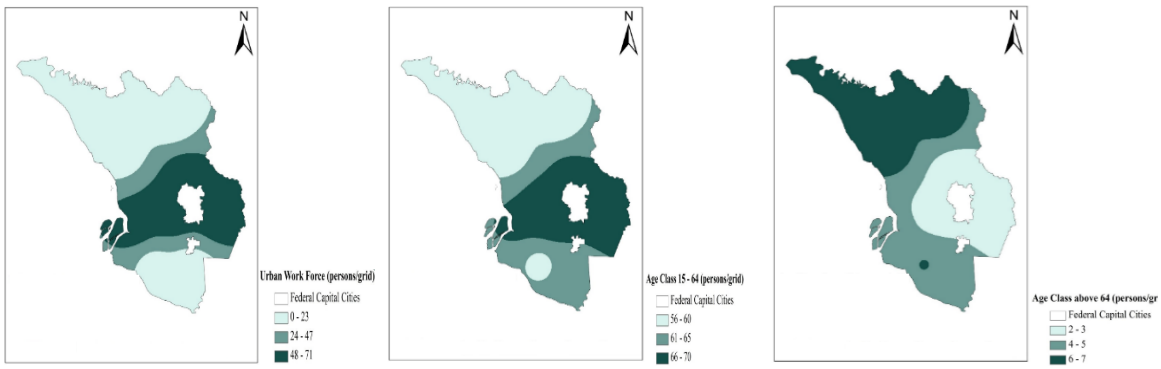




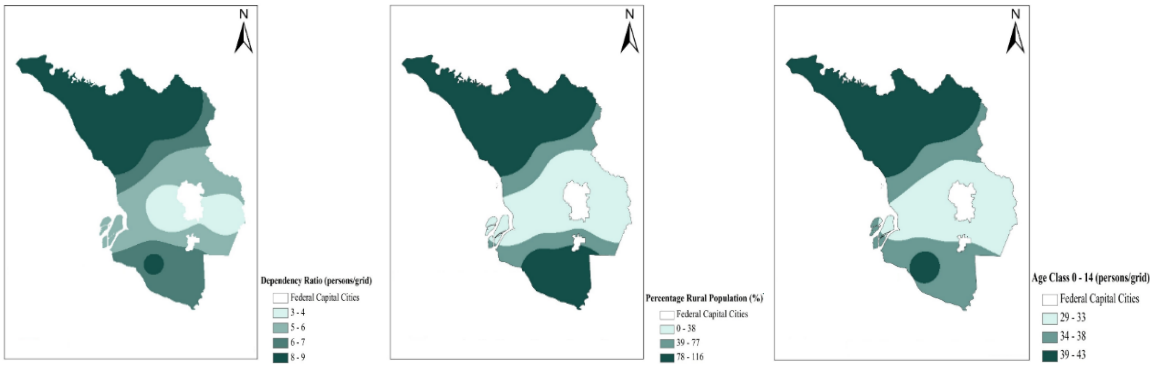

(g) (h) (i)




(j) (k) (l)




(m) (n) (o)




(p) (q) (r)

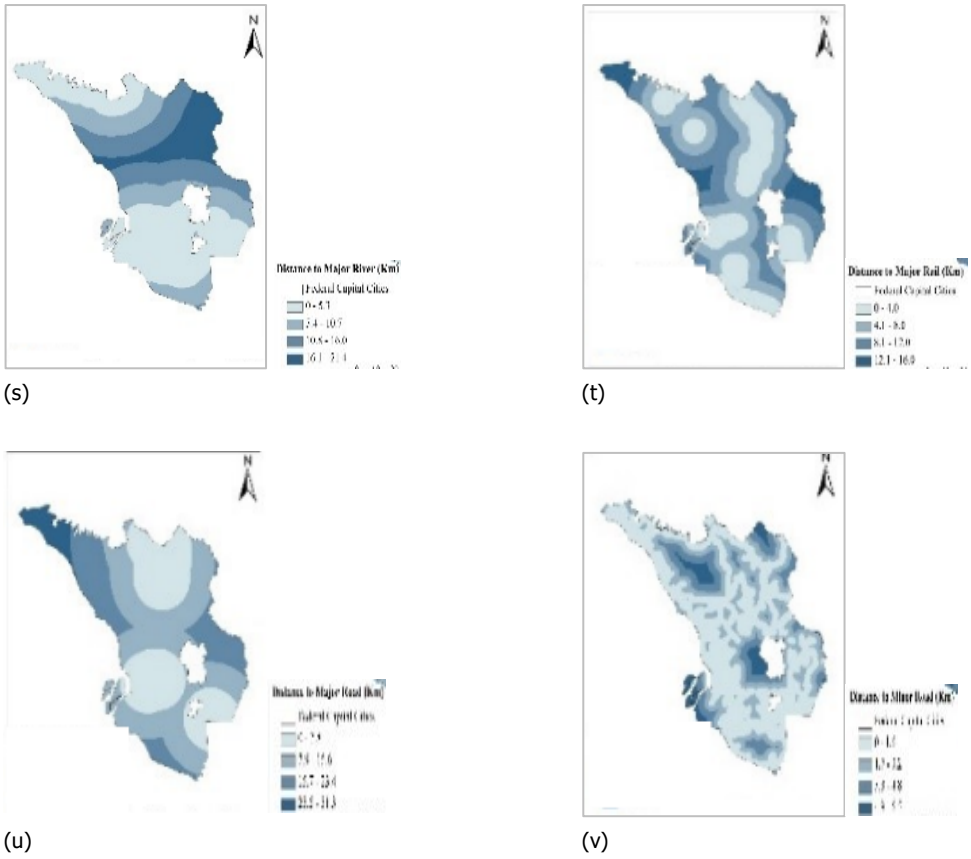


**Fig.5 (a) Slope classes (b) Terrain classes (c) Elevation classes (d) Maximum Temperature (e) Average Temperature (f) Minimum Temperature (g) No of raining days (h) Total Rain (i) Relative Humidity (j) Housing density (k) % Rural Population (l) Population density (m) Urban work force (n) Age class 15-64 (o) Age class >65 (p) Dependency ratio (q) % Rural population (r)Age class 0-14 (s) Distance to major river (t) Distance to rail (u) Distance to major road (v) Distance to minor road**

## Socioeconomic factors

Socioeconomic variables applied in this study were age category, housing density, urban work force, rural work force, agricultural GDP and non-agricultural GDP.

The socioeconomic variables were disaggregated into district levels. Spline interpolation algorithm (Muller & Zeller, 2002) was employed to convert socio – economic data into a 300m grid cells (Zhuang et al., 2002; Gao & Deng, 2002; Deng et al., 2008).

Spline interpolation was used for spatializing the socio - economic dataset because of the need to retain the observed measurements at points where they were measured (Deng, 2011).

Effects of accessibilities on agricultural land use in this study area were determined by estimating the densities of each mean of transportation (road, rail and river) within each grid cell (Simone et al., 2010; Dai et al., 2005). This was done by estimating the road, rail, and river lengths per square grid cell to obtain road, rail and river densities respectively (Simone et al., 2010; Deng et al., 2008).

All these were digitized from 1:50,000 topographic maps with the ArcMap module of ArcGIS 10.3.1

The impact of urbanization as a proxy for availability of labour and market for agricultural produce was estimated using housing, population densities per grid cell, road densities and percentage urban population. The agricultural productivity in this study area was estimated using spatial distribution of agricultural and non - agricultural GDP.

These variables were estimated from the amount of available labour per unit cell in the rural and or in urban location with assumption of zero mobility of labour and locational productivity of labour. The values were then interpolated using IDW method (Fig.5j – Fig.5v) (Olaniyi et al., 2012). All data were resampled to grid size

(300m) to make them have common spatial extent and resolutions (Huang et al., 2007) thus resulting in 206,736 pixels per disaggregated variable.

## 2.3 Data preparation for statistical analysis

### Conversion of ASCII data into vector columns

The raster format of each variable used in this study was converted into ASCII format. The matrix – based ASCII data were converted to vector column using a code written in matlab program. The total number of columns in this file equalled to the sum of all variables hypothesized to influence agricultural land use (Luijten et al., 2006).

### Spatial autocorrelation test

Spatial autocorrelation is a metric used to describe and compare the structure of a spatial dataset (Niu et al., 2018; Hu et al., 2021). Correcting problem due to spatial autocorrelation is an important operation in spatial analysis (Hu et al., 2019; Griffith, 2003; Anselin, 2001) because spatial autocorrelation contradicts the assumption of independence between data points (Millington et al. 2007; Anselin, 2002; Munroe et al. 2002; Lennon, 2000); leads to underestimation of uncertainty thus undermining the power of regression coefficients (Griffith, 2003; Wikle, 2003; Ver Hoef et al. 2001; Kok & Veldkamp, 2001; Chou, 1991; Anselin & Griffith, 1988). Therefore, spatial autocorrelation was conducted in this study with the use of Moran's I test (Millington et al. 2007; De Pinto and Nelson, 2002; Cliff & Ord, 1973) to indicate locations (and this (above twenty eight pixels where samples were selected by systematic sampling techniques (Prishchepov et al., 2013; Millington et al. 2007).

### Spatial sampling

After Moran I test (which assist to detect location where samples are to be picked; such as to eliminate spatial autocorrelation), a systematic sampling technique implemented in matLab software was used to select 68,962 pixels from the available 206,736 pixels from both the dependent and independent variables (Prishchepov et al. 2013; Prishchepov et al. 2011). The samples selected represented 30% of the available total number of pixels (Prishchepov et al. 2013; Millington et al. 2007; Verburg et al. 2002). This sampling technique and size was equally applied by Prishchepov et al. 2011 who picked 132,015 (0.25%) samples from 52million pixels in their studies (Prishchepov et al. 2013; Millington et al. 2007; Verburg et al., 2004; Cheng & Masser, 2003; De Pinto & Nelson, 2002; Muller & Zeller, 2002; Carmel et al. 2001; Overmars, 2000).

### Disaggregation of hypothesized drivers of agricultural land use

The factors hypothesized to drive agricultural land use applied in this study were spatially explicitly disaggregated into 88 (Tab.1). Xie et al., (2005); Easterly et al., (2003); Brumm et al., (2003); Burnside and Dollar, (2000) have also utilized large variables in similar studies. Of these 88 hypothesized drivers of agricultural land use, Hierarchical Partitioning (HP) statistics was used to rank variables according to their predictive power on the dependent agricultural land use (Millington et al., 2007; Aspinal, 2002).

## 2.4 Data analysis

### Correlation coefficients

In land use change analysis, independence between predictor variables is an important criterion for the application of statistical method. Independence (frequency tables and measures of association) of variables hypothesized to drive agricultural land use was assessed using descriptive statistics (Gobin et al., 2002). This procedure is important to remove redundant datasets (Goetzke et al., 2008; Millington et al., 2007; Menard, 2002) thus, highly correlated variables were rather retained.

## Factor analysis

Factor analysis, was performed with the use of principal component analysis (PCA) in order to identify specific dimension in the independent variable (IVs) (Cu Van Pham et al., 2009; Demirci et al., 2006; Agilent Technologies, 2005) using varimax rotation so as to differentiate IVs by factors and to obtain maximum variance (Cu Van Pham et al., 2009). The criterion used in retaining variable was component having eigenvalues greater than 1 - Kaiser's rule.

| | IVs | Level of measurement | Unit of measurement | References |
|---|---|---|---|---|
| | Age above 64 | | | |
| 1 | | " | 2 - 3 | Olaniyi et al. 2012 |
| 2 | | " | 4 - 5 | Olaniyi et al. 2012 |
| 3 | | " | 6 - 7 | Olaniyi et al. 2012 |
| | Age 15 to 64 | | | |
| 4 | | " | 56 – 60 | Olaniyi et al. 2012 |
| 5 | | " | 61 – 65 | Olaniyi et al. 2012 |
| 6 | | " | 66 – 70 | Olaniyi et al. 2012 |
| | Age 0 to 14 | | | |
| 7 | | " | 29 – 33 | Olaniyi et al. 2012 |
| 8 | | " | 34 – 38 | Olaniyi et al. 2012 |
| 9 | | " | 39 – 43 | Olaniyi et al. 2012 |
| | Housing Density | | | |
| 10 | | " | 12 – 107 | Olaniyi et al. 2012 |
| 11 | | " | 107 – 202 | Olaniyi et al. 2012 |
| 12 | | " | 202 – 296 | Olaniyi et al. 2012 |
| | Rural Work Force | | | |
| 13 | | " | 0 – 23 | Verburg & Chen, 2000 |
| 14 | | " | 24 – 47 | Verburg & Chen, 2000 |
| 15 | | " | 48 – 71 | Verburg & Chen, 2000 |
| | Urban Work Force | | | |
| 16 | | " | 0 – 21 | Deng, 2011 |
| 17 | | " | 22 – 43 | Deng, 2011 |
| 18 | | " | 44 – 65 | Deng, 2011 |
| | Population Density | | | |
| 19 | | " | 100 – 500 | Deng, 2011 |
| 20 | | " | 501 – 900 | Kok & Veldkamp 2001 |
| 21 | | " | 901 – 1,300 | Kok & Veldkamp 2001 |
| | Percent Urban Population | | | |
| 22 | | " | 0 – 31 | Deng, 2011 |
| 23 | | " | 32 – 63 | Kok & Veldkamp 2001 |
| 24 | | " | 64 – 95 | Kok & Veldkamp 2001 |

| | | | | |
|---|---|---|---|---|
| | Percent Rural Population | | | |
| 25 | | " | 0 – 38 | Verburg & Chen, 2000 |
| 26 | | " | 39 – 77 | Verburg & Chen, 2000 |
| 27 | | " | 78 – 116 | Verburg & Chen, 2000 |
| | Distance to Major Rail | | | |
| 28 | | " | 0 – 4.0 | Deng, 2011 |
| 29 | | " | 4.1 – 8.0 | Deng, 2011 |
| 30 | | " | 8.1 – 12.0 | Deng, 2011 |
| 31 | | " | 12.1 – 16.0 | Deng, 2011 |
| | Distance to Major Road | | | |
| 32 | | " | 0 – 7.8 | Deng, 2011 |
| 33 | | " | 7.9 – 15.6 | Deng, 2011 |
| 34 | | " | 15.7 – 23.4 | Deng, 2011 |
| 35 | | " | 23.5 – 31.3 | Deng, 2011 |
| | Distance to Major River | | | |
| 36 | | " | 0 – 5.3 | Deng, 2011 |
| 37 | | " | 5.4 – 10.7 | Deng, 2011 |
| 38 | | " | 10.8 – 16.0 | Deng, 2011 |
| 39 | | | 16.1 – 21.4 | Deng, 2011 |
| | Distance to Minor Road | | | |
| 40 | | " | 0 – 1.6 | Deng, 2011 |
| 41 | | " | 1.7 – 3.2 | Deng, 2011 |
| 42 | | " | 3.3 – 4.8 | Deng, 2011 |
| | | | 4.9 – 6.5 | Deng, 2011 |
| | Total rain (mm) | | | |
| 43 | | " | 1,900 | Kok & Veldkamp 2001 |
| 44 | | " | 2,435 | Kok & Veldkamp 2001 |
| 45 | | " | 2,972 | Kok & Veldkamp 2001 |
| 46 | | " | 3,510 | Kok & Veldkamp 2001 |
| | Terrclass | | | |
| 47 | | " | 1 | Deng, 2011 |
| 48 | | " | 2 | Deng, 2011 |
| 49 | | " | 3 | Deng, 2011 |
| 50 | | " | 4 | Deng, 2011 |
| 51 | | " | 5 | Deng, 2011 |
| | Soil Group | | | |
| 52 | | " | 1 | Deng, 2011 |
| 53 | | " | 2 | Deng, 2011 |
| 54 | | " | 3 | Deng, 2011 |
| 55 | | " | 4 | Deng, 2011 |
| 56 | | " | 5 | Deng, 2011 |
| | Soil Suitability Classes | | | |
| 57 | | " | 1 | Verburg & Chen, 2000 |
| 58 | | " | 2 | Verburg & Chen, 2000 |
| 59 | | " | 3 | Verburg & Chen, 2000 |
| 60 | | " | 4 | Verburg & Chen, 2000 |
| | Slope Class | | | |
| 61 | | " | 1 | Mottet et al. 2006 |
| 62 | | " | 2 | Mottet et al. 2006 |
| 63 | | " | 3 | Mottet et al. 2006 |
| 64 | | " | 4 | Mottet et al. 2006 |

| | | | | |
|---|---|---|---|---|
| 65 | | " | 5 | Mottet et al. 2006 |
| 66 | | " | 6 | Mottet et al. 2006 |
| | Relative Humidity (%) | | | |
| 67 | | " | 79 | Verburg & Chen, 2000 |
| 68 | | " | 80 | Verburg & Chen, 2000 |
| 69 | | " | 81 | Verburg & Chen, 2000 |
| 70 | | " | 82 | Verburg & Chen, 2000 |
| | Average Temperature $^0$C | | | |
| 71 | | " | 27 | Verburg & Chen, 2000 |
| 72 | | " | 28 | Verburg & Chen, 2000 |
| | Elevation Class | | | |
| 73 | | " | 1 | Vasco and Eric, 2010 |
| 74 | | " | 2 | Vasco and Eric, 2010; |
| 75 | | " | 3 | Vasco and Eric, 2010 |
| 76 | | " | 4 | Vasco and Eric, 2010 |
| 77 | | " | 5 | Vasco and Eric, 2010 |
| 78 | | " | 6 | Vasco and Eric, 2010 |
| | | " | 7 | Vasco and Eric, 2010 |
| | Maximum Temperature $^0$C | | | |
| 79 | | " | 32 | Serra et al. 2008 |
| 80 | | " | 33 | Serra et al. 2008 |
| | Minimum Temperature $^0$C | | | |
| 81 | | " | 23 | Serra et al. 2008 |
| 82 | | " | 24 | Serra et al. 2008 |
| 83 | | " | 25 | Verburg & Chen, 2000 |
| | NORDs(days/mth) | | | |
| 84 | | " | 13 | Kok & Veldkamp 2001 |
| 85 | | " | 15 | Kok & Veldkamp 2001 |
| 86 | | " | 18 | Kok & Veldkamp 2001 |
| 87 | | " | 20 | Kok & Veldkamp 2001 |
| 88 | | " | 23 | Kok & Veldkamp 2001 |
| | Spatial Effects | Every 30$^{th}$ | Every 30$^{th}$ | Muller and Zeller, 2002 |

NORDs: Number of Raining Days; Max Temp: Maximum Temperature; Min Temp : Minimum Temperature

**Tab.1 Hypothesized drivers of agricultural land use in Selangor**

## 3. Findings

The result on Tab.1 showed the hypothesized drivers of agricultural land use in the study area. From the table, about 27 potential factors driving agricultural land use were selected into the study. These 27 hypothesized variables were later disaggregated into 89 (Tab.1).

From the 89 variables, hierarchical partitioning test selected and identified 26 most significant variables influencing agricultural land use in the study area. The descriptive statistics of the 27 significant variables were presented on Tab.2.

The PCA extracted 7 principal components which explained 88.1 % of the agricultural land use in the study area (Tab.3 and 4). PC 1, explained 33.3 % of the variance, with loadings between 0.679 and 0.892. This component indicated influence of urbanization on agricultural land use (Tab.3 and 4).

PC 2 showed impacts of availability of farm labour with highest loading being 0.825 and least being 0.531. This factor explains 21.2% of the total variation (Tab.3 and 4). PC 3 is highly correlated with three variables representing ageing of the farm labour with highest loading being 0.844 and least being 0.709.

This factor explained 12.2% of the driving forces behind agricultural land use (Tab.3 and 4). The component 4 indicated the transfer/release of labour from the agricultural sector to the industrial sector. This factor explained 7.3% of the reason behind agricultural land use with loading varying from 0.766 to 0.867 (Tab.3 and 4).

PC 5 is a factor that can be used to represent the effects of geophysical factors in agricultural land use. This factor was captured by elevation, terrain and slope class.

This factor explained 5.8% of the total variation of the original data (Tab.3 and 4)with loading between 0.705 to 0.851. PC 6 indicated importance of accessibility on agricultural land use.

This factor explains 4.4% of the total variance and it was captured by distance to minor road, distance to major road and distance to major river (Tab.3 and 4). PC 7 can be used to describe the effects of climate variables on agricultural land use in the study area. This factor explained 4.0% variation in agricultural land use (Tab.3 and 4) with variables such as maximum temperature, total rainfall and relative humidity being most important variables.

| S/No | IVs | Min | Max | Mean | Std Dev |
|---|---|---|---|---|---|
| 1 | age above 64 | 2 | 5 | 4 | 1 |
| 2 | age 0 to 14 | 29 | 40 | 37 | 3 |
| 3 | average Temp | 27 | 28 | 27.89 | 0.84 |
| 4 | dep ratio | 5 | 8 | 7 | 1 |
| 5 | ds2majral | 0 | 75,240 | 21,473.9 | 15,802.7 |
| 6 | ds2majrd | 0 | 89,120.2 | 35,056.2 | 20,048.2 |
| 7 | ds2minrd | 0 | 73899.9 | 12,813.2 | 15,719.2 |
| 8 | ds2majrv | 0 | 63,488 | 11,562 | 13,654 |
| 9 | elevation | 1 | 9 | 6.97 | 3.05 |
| 10 | age 15 to 64 | 56 | 68 | 59 | 4 |
| 11 | housing density | 12 | 296 | 67 | 77 |
| 12 | maxtemp | 32.3 | 35.6 | 33.6 | 0.71 |
| 13 | mintemp | 23 | 25 | 22.3 | 0.69 |
| 14 | NORDs | 13 | 23 | 18.8 | 4.8 |
| 15 | percent rural | 7.1 | 100 | 58.9 | 3 |
| 16 | percent urban | 0 | 92.9 | 40.8 | 34.7 |
| 17 | pop density | 100 | 1,400 | 300 | 40 |
| 18 | rel.humidity | 79 | 82 | 81.98 | 0.89 |
| 19 | rural GDP | 49 | 194 | 109 | 37 |
| 20 | Ruralwkfc | 4 | 59 | 33 | 20 |
| 21 | Slope | 1 | 4 | 2.3 | 1.42 |
| 22 | soil class | 1 | 5 | 3.43 | 1.33 |
| 23 | soil suitability | 1 | 4 | 2.29 | 1.31 |
| 24 | Terrain | 1 | 5 | 3.45 | 1.32 |
| 25 | total rain | 1,360 | 3,510 | 2,489 | 6.74 |
| 26 | urban GDP | 0 | 8,935 | 1,282.4 | 2,606.2 |
| 27 | Urbanwkfc | 0 | 64 | 26 | 23 |

Average temp: average temperature; dep ratio: dependency ratio; ds2majral: distance to major rail; ds2majrd: distance to major road; ds2minrd: distance to minor road; ds2majrv: distance to major river; NORDs: number of raining days; pop density: population density; rel humidity: relative humidity; ruralwkfc: rural work force; rural GDP: rural gross domestic product; urban GDP: urban gross domestic product; urban wkfc: urban work force.min: minimum; max : maximum; std dev: standard deviation

**Tab. 2 Summary of the hypothesized drivers of agricultural land use**

**Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 8.665 | 33.327 | 33.327 | 8.665 | 33.327 | 33.327 | 7.154 | 27.516 | 27.516 |
| 2 | 5.499 | 21.151 | 54.478 | 5.499 | 21.151 | 54.478 | 3.967 | 15.258 | 42.775 |
| 3 | 3.178 | 12.222 | 66.700 | 3.178 | 12.222 | 66.700 | 2.787 | 10.718 | 53.493 |
| 4 | 1.892 | 7.279 | 73.978 | 1.892 | 7.279 | 73.978 | 2.369 | 9.110 | 62.603 |
| 5 | 1.497 | 5.759 | 79.738 | 1.497 | 5.759 | 79.738 | 2.318 | 8.914 | 71.517 |
| 6 | 1.144 | 4.400 | 84.137 | 1.144 | 4.400 | 84.137 | 2.243 | 8.626 | 80.143 |
| 7 | 1.031 | 3.965 | 88.102 | 1.031 | 3.965 | 88.102 | 2.069 | 7.959 | 88.102 |
| 8 | 0.802 | 3.083 | 91.186 | | | | | | |
| 9 | 0.637 | 2.448 | 93.634 | | | | | | |
| 10 | 0.544 | 2.092 | 95.726 | | | | | | |
| 11 | 0.366 | 1.408 | 97.134 | | | | | | |
| 12 | 0.294 | 1.130 | 98.264 | | | | | | |
| 13 | 0.233 | 0.896 | 99.160 | | | | | | |
| 14 | 0.120 | 0.462 | 99.621 | | | | | | |
| 15 | 0.037 | 0.141 | 99.762 | | | | | | |
| 16 | 0.027 | 0.105 | 99.868 | | | | | | |
| 17 | 0.015 | 0.058 | 99.925 | | | | | | |
| 18 | 0.013 | 0.049 | 99.974 | | | | | | |
| 19 | 0.005 | 0.019 | 99.993 | | | | | | |
| 20 | 0.002 | 0.006 | 99.999 | | | | | | |
| 21 | 0.000 | 0.001 | 100.000 | | | | | | |

Extraction Method: Principal Component Analysis

**Tab.3 Variance explained by the identified components**

**Rotated Component Matrix[a]**

| IVs | Component | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ds2majrd_1 | 0.278 | -0.372 | -0.202 | -0.005 | 0.210 | **0.807** | 0.041 |
| ds2minrd_1 | -0.001 | 0.222 | 0.268 | -0.009 | 0.165 | **0.772** | 0.132 |
| ds2majrv_1 | -0.001 | 0.222 | 0.668 | -0.009 | 0.165 | **0.762** | 0.132 |
| elev _3 | 0.388 | 0.083 | 0.531 | 0.118 | **0.851** | 0.214 | 0.567 |
| terrclas_1 | 0.275 | -0.034 | 0.453 | 0.343 | **0.773** | 0.125 | 0.785 |
| slopeclass_2 | 0.562 | 0.461 | 0.212 | 0.407 | **0.717** | 0.224 | 0.249 |
| suit_1 | 0.119 | 0.164 | 0.992 | 0.231 | **-0.705** | 0.015 | 0.845 |
| ubnwkfc21_42 | **0.892** | -0.100 | 0.947 | -0.014 | -0.08 | 0.132 | 0.169 |
| ubnwkfc42_64 | **-0.881** | -0.040 | -0.073 | 0.466 | 0.838 | 0.131 | 0.089 |
| ubnwkfc0_21 | **0.846** | 0.235 | -0.133 | -0.064 | -0.073 | 0.016 | 0.107 |
| pctubn31_62 | **0.805** | 0.540 | 0.582 | -0.017 | -0.129 | 0.227 | 0.194 |
| popden100_500 | **0.799** | 0.177 | 0.316 | -0.067 | -0.107 | 0.077 | 0.179 |
| hden12_107 | **0.679** | 0.177 | 0.316 | -0.067 | -0.107 | 0.077 | 0.179 |
| rurwkfc0_33 | -0.176 | **0.825** | -0.073 | 0.464 | 0.837 | -0.041 | 0.090 |
| age15to64_56_60 | 0.288 | **0.773** | 0.308 | **-0.867** | -0.963 | 0.177 | 0.185 |
| age15to6460_64 | -0.119 | **0.723** | -0.092 | **0.859** | 0.217 | -0.015 | 0.129 |
| age15to6464_68 | -0.122 | **0.694** | -0.007 | **-0.766** | 0.914 | -0.035 | -0.006 |
| ag0to14_37_40 | 0.199 | **0.677** | 0.316 | -0.067 | -0.107 | 0.177 | 0.179 |
| agabv64_3_4 | 0.160 | **0.635** | **0.844** | -0.051 | -0.008 | 0.112 | 0.096 |

| IVs | Rotated Component Matrix[a] | | | | | | |
|---|---|---|---|---|---|---|---|
| | Component | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| agabv64_4_5 | 0.287 | **0.603** | **-0.803** | -0.041 | -0.112 | 0.118 | 0.135 |
| pctrur69_100 | 0.195 | **0.588** | **-0.709** | -0.065 | -0.022 | -0.216 | 0.057 |
| pctrur0_38 | -0.180 | **0.531** | -0.073 | 0.466 | 0.838 | -0.040 | 0.089 |
| maxtemp_32 | 0.318 | -0.463 | -0.142 | -0.008 | -0.050 | 0.077 | **-0.837** |
| maxtemp_33 | 0.105 | 0.581 | -0.079 | -0.033 | 0.671 | 0.315 | **0.834** |
| totalrain_2435 | -0.045 | -0.002 | 0.034 | 0.886 | 0.106 | -0.161 | **-0.732** |
| relhum_80 | 0.334 | 0.185 | 0.002 | -0.045 | -0.029 | 0.182 | **0.649** |

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization

a. Rotation converged in 8 iterations.

**Tab.4 Components extracted by principal component analysis and varimax rotation method**

# 4. Discussion

## 4.1 Impact of urbanization

Industrialization and urbanization are very important determinant of the rate of agricultural land conversion into non - agricultural uses. Futhermore, high population densities might result to increase in agricultural land use for horticultural products and animal protein which may lead to the conversion of arable farmland into orchards and fish ponds (Olaniyi et al., 2012; Mottet et al., 2006) or lead to rural dwellers abandoning their farmlands for more profitable and non – agricultural activities (Mazzeo & Russo, 2016; Rigg, 2006; Rigg & Nattapoolwat, 2001).

## 4.2 Availability of agricultural labour

This study indicated that availability of labour for agricultural production is the most important factor in agricultural land use in the study area accounting for 40 – 60% of the cost of production (Arshad et al., 2007). Despite the high labour requirement in agricultural production, available agricultural labour in Malaysia has been decreasing from 1980 till date as a result of economic transformation (Arshad et al., 2007; Vincent and Rozali, 2005). Since 1990, the average and marginal return per labour in the agricultural sector is below what is obtained in the other sectors, outflow of labour from agricultural to non-agricultural sectors will continued to be experienced in Malaysian agricultural economy (Arshad et al., 2007) thus leading to observed aging of agricultural labour (Olaniyi et al., 2011; Arshad et al., 2007; MDoA, 2003).

## 4.3 Ageing of farm labour

Malaysian agricultural production like every other country's agricultural production is suffering due to ageing of the farm labour (Hayrol Azril et al., 2009; Ezhar et al., 2007). While agricultural transformation has been acknowledged to assist the country to achieve the expected economic growth and development to a high income country National Transformation 2050 (2021 - 2050), ageing of the farmers would be impediments to achieving this ambition. The ageing problem will exacerbate the rural-urban income differential. Government's reactions to the farmers ageing condition defer. For instance, in France and Korea, the government were buying out ageing farmers and granting them secure lifelong pensions and thereafter attract youth agropreneurs after farm consolidation. In Malaysia ageing of farmers has led to the reliance on migrant labor as a source of labour.

## 4.4 Cross sectoral mobility of labour

Several factors are responsible for inter sectoral mobility of labour. Geenaway et al. 2000 argued that globalization, trade, technological changes and differences in inter sectoral returns on labour investments are the major factors causing labour mobility. Significant agricultural transformation as a result of technological advancement witnessed in Malaysia has led to the release of farm labour to the industrial sector due to higher rate of return on labour in the secondary and the tertiary sectors has equally favoured the release (Bakar, 2021; World Bank, 2019). However, as land is also becoming scarce because of the government's policy of restraining the expansion of farmland to forest areas. There is an indication that the future of agriculture in the country will be dependent on intensive farming (Sidique & Shaharudin, 2019).

## 4.5 Geophysical factors

This study has found the location of the agricultural land use to be closely related to the geo-physical condition of the area. Elevation and slope are two important geophysical factors influencing suitability of a location for agricultural usage. For example, Huang et al., 2007 reported a decrease of 0.50C – 0.60C in temperature and an increase of 92mm in rainfall for every 100m increase in elevation. Also, at a higher elevation, agricultural land use is less probable because, the difficulty of the terrain will make the agricultural activities on such land not to be feasible (Qasim et al., 2013). Likewise, agriculture on steeper slopes and poorer soils will be more difficult and less profitable (Bender et al., 2005; Mottet et al., 2006).

Drivers of agricultural land use include availability of suitable agricultural land (FAO, 1976). Variables used to capture this factor in this study include soil suit_1; terrain class 1, elevation class_3 and slope class_2. Agricultural land uses were found to be prominent on flat or relatively gentle slope. These areas are locations where agricultural practices could be done with ease and (Qasim et al., 2013; Koulouri and Giourga 2007). Suitable agricultural land is the land that is characterized by elevation between the range of 750m – 1000m; slope between 0 - 150 and terrain class 1 (Qasim et al., 2013).

## 4.6 Accessibility

Distance to transportation infrastructures has been identified as a major driver of agricultural land use. (Deng, 2011; Vasco and Eric, 2010) since accessibility serves as the means of transportation of agricultural produce to the local markets and inputs to the farm. Available literatures have indicated that land use is related by the transportation systems through the movement of passengers and freights. The influence mechanism of accessibility on land use and landscape pattern is complex and is a function of socio – economic, demographic and cultural factors, land availability, land demand and spatial policy (Yongwei et al., 2020) and has been linked to the land fragmentation (Yongwei et al., 2020; Kaphegyi et al., 2012) and landscape pattern.

## 4.7 Climatic factors

Effects of climatic factors is crop specific and dependent on the stage of growth of the crop and could be synergistic with other non - climatic factors to produce greater impacts (Siwar et al., 2011; Anete & Amusa, 2010). In Malaysia, where temperature of most planted areas is already at the optimum range, slight fluctuation in temperature is not likely to the affect yield but rainfall variability would limit agricultural productivity (MMD, 2009). While, oil palm and coconut prefer warm and humid conditions (Kumar et al., 2009). However, excessive humid condition would impact their development because of the reduction in the transpiration ability, reduce pollination, embryo and fruit development (Kumar et al., 2009); provide suitable condition for the spread of bud rot diseases in oil palm (Arshad et al., 2012). High temperature would diminish rainfall, reduce soil moisture due to increase in evaporation, impair the growth of crops in non – irrigated areas and increase the risk of pests, diseases and weeds on crops (Siwar et al., 2011; Al - Amin & Siwar, 2008).

## 5. Conclusion

The drivers of agricultural land use in Selangor, Malaysia have been identified and characterized with the use of PCA. Use of PCA as a statistical tool in this study is based on its ability to reduce and categorize the variables into their components. Significant variables retained in the study were chosen by inspecting the components with eigenvalues higher than the unity. The appropriateness of PCA for these datasets were determined with Kaiser – Meyer – Olkin (KMO) and Bartlett's tests. Kaiser-Meyer-Olkin (KMO) measure was used to test whether the partial correlations among variables are minimal. While Bartlett's test was used to ascertain whether the correlation matrix was an identity matrix or not. Eventually, major drivers of agricultural land use that were identified in this study include availability of agricultural labour, urbanization, accessibility, climatic factors, geophysical factors and availability of suitable agricultural land. These six variables driving agricultural land use in the study area can be broadly categorized into geophysical, climatic and socio - economic factors. For the geophysical factors, variables such as slope, soil series, elevation and land suitability, climatic variables include number of raining days, relative humidity, maximum and average temperatures while for the socio – economic factors, variables such as availability of farm labour, accessibility and urbanization are very important. The story of Malaysian transition from low to middle - income country is one of the world's most successful one. However, the government target of achieving high income status by the year 2030 may not be possible without inclusive growth in the agricultural sector. This proposed economic growth would bring about increased pressures on the agricultural resources in the study area (FAO, 2020 & 2002). Expected demographic increase consequent upon the economic growth would further increase pressures on the agricultural resource inputs (land, labour, capital and management) therefore the need for the policy makers to put in place measures that would minimize environmental effects of these impacts in order to make the proposed transition sustainable.

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# Logit and probit models explaining perceived cycling motives, barriers, and biking trip generation in Lahore, Pakistan

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**Abstract**
Cycling as an attractive mode of transport is a challenge, especially in developing countries like Pakistan. Previous research on cycling in developing countries is insufficient to answer that how people can be encouraged to bike in different regions and cultures. This research, therefore, directs two research questions based on the perceptions of the people of Lahore. The first research question addresses the perceived motives of everyday biking trip generation and the second question addresses the perceived barriers in biking in the city of Lahore. The data sample of 379 subjects was collected through self-reported questionnaire across different socioeconomic groups. The questionnaire was designed to discuss the motives for biking such as affordability, reliability, and accessibility as well as to identify the barriers such as cultural issues, gender problems and non-availability of infrastructure for biking. Along with descriptive statistics, Multinomial Logistic was used to analyze perceived motives, Binary Logistic for perceived barriers and Ordinal Probit for biking trip generation. The obtained results are very interesting and provide various insights about the perceptions of people regarding biking trip generation, motives, and barriers with various factors involved. The results are beneficial to urban developers, city planners, transport planners, policy makers and other stakeholders.

**Keywords**
Bicycle; Biking perception; Sustainable transport; Urban mobility; Pakistan.

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# 1. Introduction

In the recent years, biking has emerged as the most sustainable mode of transport, yet, in developing countries such as Pakistan, it has always been a challenge to compel public to use it as a preferred mode of travel. Even though a lot of research on biking determinants has already been a topic of interest among researchers, practitioners, and policy makers, but the influence of region-specific barriers, motives and biking-trip generation factors that daunt back common public to use bicycle as a preferred mode are understudied, hence, need a due consideration. The population of the city of Lahore is diverse with a mixed land use, high commuting and urbanization rate and a wide range of modes of traffic used by common public. Unlike many other metropolitan cities of low-income countries, biking is neglected for a long time and is not taken into account whilst planning for common public living in urban areas of Pakistan. There could be many reasons behind its' unpopularity particularly in the context of Lahore. Therefore, this paper focuses on the perceptions regarding barriers, motives, and biking trip generation in Lahore, Pakistan, to promote the use of bicycle whilst supporting sustainable urban transport policies.

Among many others, usually, in high-income countries such as UK, three main factors i.e. environment, health and wellbeing, and mobility are considered as motives in promoting biking (Jones et al., 2016). Also, in high-income countries such as US, roads' infrastructure, passenger safety and environmental factors are considered as barriers in biking (Fowler et al., 2017). Other than this, there could be many other aspects such as social and personal barriers and motives, bicycling skills and lack of confidence (Grimes et al., 2020), differences in trends of biking between genders, health conditions, physical travelling distances and time to destinations, provision of bicycling facilities, cultural norms, safety and personal preferences (Snelgrove & Wood, 2010; Yin et al., 2018) are prominent biking determinants.

Studies from the neighboring countries of Pakistan show that, the importance of bike as a sustainable mode is either completely neglected or poorly underestimated, which in result caused very less availability of published literature. The situation is no different in Pakistan. A usual belief is that when people do not have access to public transport or power to afford any other traffic modes then people walk or bike. Same applies to Pakistan as well where low-income socioeconomic groups are more inclined towards biking compared to other socioeconomic groups (Aslam et al., 2018) and have very limited to almost no option available to use other modes of transport. Therefore, one way or the other, they are compelled to use bicycle as a travel mode which is not "by choice biking". It is worth considering that how people can be motivated to bike (or not) who do not have biking as the only available option.

In low-income countries like India, studies show that biking itself is considered as a health determinant, but is not given due attention (Moser et al., 2017). In China, it is recently realized that bike-sharing is a considerable determinant to bike, therefore, the trend of bike sharing is booming at a high pace with the newly developed interest of policy makers and city planners (Guo et al., 2017). In Iran socioeconomic behaviors of public, authorities' use of system, availability of infrastructure and involvement of needs of people whilst planning for biking are the main biking determinants (Jahanshahi, Van Wee, & Kharazmi, 2019).

Past studies have considered many variables such as socioeconomics, education, owning a bicycle, commuting needs and distance, cultural values, gender, social perspectives of gender, presence of infrastructure to support biking, health, well-being and physical activity, sustainable environment, purpose of trips and respective travelling distance etc. as the most influential factors in promoting or demoting the use of biking (Cai et al., 2019; Grimes et al., 2020; Jain & Tiwari, 2019; Raustorp & Koglin, 2019). Yet, there is no definite answer to date to understand that how people can be encouraged to cycle because it varies across cultures, regions, and personal characteristics. Biking determinants are different in different contexts and are region specific too. Therefore, it is important to understand behaviors, needs, capabilities, perceptions, resources, and personal abilities of people living in specific areas along with other prevailed conditions to determine that what factors engage people in biking through certain incentives. This study focuses on cycling motives, barriers

and trip generation from the people's perspectives to understand the causes that are refraining people from biking and what is lacking in urban policies that if looked after effectively, then can encourage people to bike frequently.

The objective of this study is to investigate about perceived motives, barriers, and indicators of biking trip generations in the metropolitan city of Lahore (Pakistan) that encourage or discourage people to use bicycles whilst having multi-purpose trips. The marginal task is to compare results with the differences and similarities of high-income countries in terms of perceived barriers to cycling, motives of cycling and biking trip generation in Lahore.

The first section gives a general overview of the topic and motivation behind conducting this study. It also highlights the main objective of the study. In the second section, a review of the literature presenting the results from the past studies on the topic of biking motives and barriers. It also covers the methodological considerations of similar past studies from the developing, south Asian and neighboring countries to report on the methodological consistencies and variations of this study that directs to the next section of the methodology. The next section presents the study findings based on the inferential analyses. The findings lead to generate a discussion section where the results of this study are compared with the literature findings, particularly those emerging from the developed world. The last section concludes this study based on findings and discussion.

## 2. Literature Review

There could be many types of motives that can affect cycling and generate trips. Some of the motives involve psychological, physical, social, health and goal achievement motives but they may value differently for genders and cross-cultures (LaChausse, 2006). Facilities and technology such as GPS and maps are helpful in preferment of cycling to provide online delivery services (Korver, 2018). A study from Poland (Biernat, Buchholtz, & Bartkiewicz, 2018), mentioned that people who are poorly educated, less wealthy and rural area dwellers are the ones who bicycle because of their certain socio-economic conditions and that they cannot afford or approach other modes of transport. Hansen suggested that some of the main determinants to biking for longer distances are that commuters prefer to cycle to enhance their physical activity followed by reduced cost and time of travel (Hansen & Nielsen, 2014). Charity cycling is also used to promote cycling activities (Snelgrove & Wood, 2010). Sports related or special event cycling can be supported by considering determinants such as socialization, event attractiveness, personal motivation, escape and relaxation and event attributes (Streicher & Saayman, 2010). Some developed countries are persuading common public to use e-bikes for commuting as a substitute to other motorized vehicles (Plazier et al., 2017). There exists a school of thought that e-biking could be a solution to indulge people in cycling. Also, that e-biking is desirable compared to conventional biking because it does not take much of an effort to ride / drive and produces no carbon but does not serve the purpose of health because it is treated as another vehicle to ride and people have to put very less effort in it compared to the conventional biking (Jones et al., 2016). Therefore, the focus of this paper is limited to conventional biking.

Studies from developing countries show that they usually lack proper physical planning and infrastructure in their cities and built neighborhoods which could be a barrier in biking. For example, a study (Erik De Castro, 2013) shows that how specific details of built environment can motivate or demotivate people to cycle or walk. There are many other barriers and motives of biking in developing countries. The problem exists with the non-realization of importance of biking which has led this mode as understudied in developing countries. In the recent times, developing countries have started exploring strategies to investigate biking determinants to make this mode popular and wishful by common people. It is found that with a focus on biking in developing countries, well designed and easily available facilities, short distance travels, increased accessibility, improved personal security and safety (such as transport safety and reduced fear of injuries and accidents), improved

esthetics and natural sceneries, increased comfort levels and bike supporting facilities are significant motives (De Castro, 2013). Also, lack of space and poor socioeconomic conditions are managed through bike sharing schemes (Bauman et al., 2017). Tan (Tan et al., 2019) found that smaller trip distance and lesser biking frequency are motives to bike because they are desirable traits whilst longer travel durations are not welcomed through biking. Zhao ( Zhao et al., 2018) found that high mixed level of land use and good proximity environments increase biking. In addition, younger generation requires substantial encouragement to guide them to cycle more. Similarly, low education, low- and middle-income groups should be encouraged to keep on biking too. To encourage biking, these aspects as motives and barriers are commonly applicable to most of the developing countries and need to be addressed in detail.

Developed countries have overlooked the benefits of biking for a very long time too and focused more on planning for motorized transport and building infrastructure accordingly. Since a decade, policy makers and researchers have acknowledged that biking is the most sustainable mode of travelling with environment and health friendly profile (Pucher & Buehler, 2017). Studies from developed countries are laying basis for developing countries to consider biking as an important part of transport policy. Developing countries like Pakistan have not defined sustainable modes for travel-oriented policies so far. In contrast, developed countries are designing transport policies with a significant focus on walking and biking. Also, the recent biking policies focus on the safety of bikers especially when they interact with fast pacing motorized vehicles and for longer travel distances with the provision of exclusive biking lanes/right of ways and synchronized signals. In neighborhoods, safety is ensured by providing traffic calming devices and implementing required restrictions such as speed to make biking more efficient and safer (Tan et al., 2019). Sun (Sun, 2017) suggests that biking on shared basis, if included in policies can solve last mile problem in public transport and may encourage people to bike more. There is need to revisit and redefine policies with the inclusion of biking. Bike focused policies are also required to consider the needs of social inclusion and equity, especially for women, children and senior citizens to persuade and facilitate them to bike too.

South Asian countries are denser in population and are expanding haphazardly with significant growth in urbanization and transportation. According to global report on human settlements 2009 (Ansari, 2009) South Asian countries as being developing countries have lesser resources, more population, poor urban transportation policies and inconsistent land use, therefore, requires revisiting of urban planning. The trends of biking are not same in all South Asian countries but varies because of many factors such as national policies of each country. It is also important to understand that the needs of the bikers are taken well care of whilst devising policies for biking because a better biking experience will make the rider more willing to bike.

Literature from South Asian countries shows that the importance of biking as a reliable transport mode is well appreciated by some of them. However, barriers such as environment, safety and security, integration of transport modes, mixed urban traffic, convenience, weather, health and poor infrastructure are biking discouragers (Nawaz, 2015). A study from Bangladesh emphasizes to amend transport policies to accommodate increasing rate of bikers despite of many biking barriers such as poor road performance, high traffic density and from very less to almost no room for bikers in the existing infrastructure (Rana et al., 2017). Nawaz (Nawaz, 2015) also suggests that In a poor and overly populated country like Bangladesh, bicycling can give a congestion free roads, therefore, urban planners should avail this opportunity whilst planning for cities.

Taiwan itself is considered as a biking tourist destination. A study from Taiwan suggests that with the provision of comfortable environment, segregated biking facilities and improved road surface and pavement more biking tourism can be attracted in comparison to the neighboring tourism attraction countries (Lee & Huang, 2014). Chen (Chen & Lee, 2017) from the study of biking in Taiwan, draws an example, and offers many ways to promote bike tourism globally. This can be done by prioritizing bike service enhancements and improvements such as renting a bike at one station and dropping off at another designated location. In addition to these, provisions of nanny vans to accommodate bikers, biking related information centers, bike trainings and guides,

guided tours, creative bike touring routes according to the rider's capabilities, friendly environment and travel insurance policies are huge biking trips generators.

In China and similar countries, along with rising concerns about health, fitness and wellbeing, biking is considered as a tool to achieve health goals. Therefore, biking encouraging motives are included as a part of national policy. In China, bike sharing was introduced in 2008 to promote biking in major cities, which declined later in 2010 because of the barriers such as poor maintenance of bikes, larger distances between biking stations and poor infrastructure. Later, bike sharing was taken on IT based system that gave an immediate boom to biking. The reason behind were the motives such as improved infrastructure, easy check-in and check-out, efficient biking docks and easy credit card payments (Guo et al., 2017; Useche et al., 2019; J. Zhao et al., 2014). Thailand is adopting IT based biking too, to facilitate tourists and its own public (Islam et al., 2018).

A Korean study shows that social, physical, economic and environmental factors and perspectives are not enough to define biking trip generations, motives and barriers but there are psychological perspectives too (Kim et al., 2017). The study (Kim et al., 2017) also suggests that psychological factors can impact public bike sharing user's attitudes and revealed that environmental concerns influenced people's perception of public bike sharing. Also, that biking can be promoted by increasing awareness about the positive or negative effects of biking on the environment, in case, if there occurs no biking activity. In short, South Asian countries are pacing up to include biking in transportation planning and policies.

In general, the methodologies adopted to study biking and its determinants in the neighboring of Pakistan is through self-reported questionnaires and the results are interpreted through descriptive and statistical analysis. Most of the studies on cycling are published in social sciences literature. With the changing world and its dynamics, data collection and analysis methods are changing too. Recent studies on biking shows a variety of data collection and analysis methods. For example; (Rana et al., 2017) collected data through physical and user opinion surveys to evaluate of bicycling environment for urban mobility and analyzed data by implying situational analysis. Other than this, Castro (Castro et al., 2019) collected data through online surveys on seven different European countries to draw a difference between conventional cyclist and non-cyclist with electric bikers. In another study a descriptive analysis based study in which online surveys were used to collect data from 20 different countries including Latin America, North America and Europe (Useche et al., 2019). Kirkpatrick (Kirkpatrick, 2018) used a mixed methods approach in which in-depth telephonic interviews were conducted and ground theory was applied to conceptualize the overall research design and data analysis. The interviewers were employed through snowball and chain sampling techniques. It is a common practice to use either or both primary and secondary survey data to do detailed studies related to biking e.g. identify the demand of biking in the city. Similarly, Nawaz used secondary data and focus group through judgmental sampling technique to find motivation behind cycling in the city of Sylhet, Bangladesh, and found that health, safety, convenience and weather are the deterrent factors in biking (Nawaz, 2015).

Other than surveys and interviews, Nickkar (Nickkar et al., 2018) used GIS-based equity analysis to develop a population-density-normalized bike equity index to quantitatively assess the spatial distribution of city's bicycle infrastructure supply and how it serves the transit dependent communities. Tan (Tan et al., 2019) conducted empirical study on big data in which data was obtained from mobile phone application programming interface. The extracted data was then analyzed by using principal component analysis method to develop a neighborhood social disadvantage index with 5 sub-indices including income, housing, occupation, education, and population. Yin (Yin et al., 2018) used consumers' data to find out what can improve and facilitate promotion of bike-sharing and it was found that in addition to cultural and psychological motivations of consumers, practicing social norms is also important. Liu (Liu et al., 2016) used advance biking load prediction and optimizer algorithms to create a balance between biking demand and biking infrastructure supply (i.e. pick and drop) on the docks. In last but not least, with the varying biking conditions, policies, preferences,

perceptions, demands and determinants new methods are evolved and implied quite often. The next section explains the methodology used in this study.

## 3. Methodology

The methodology of the present study was designed to answer the following questions: (1) what motivates people to cycle in large cities of Pakistan and how are they defined? (2) what are the main correlates of perceived barriers of cycling in Large cities of Pakistan? And (3) what are the predictors of bike trip generation in large cities of Pakistan?

This paper presents the findings of an empirical analysis based on a data collection in Lahore, Pakistan. With 11.13 million inhabitants (2017), Lahore was taken as a representative of Pakistani large cities and also several large cities in the region. The survey was undertaken in spring 2018 by direct questioning method in several districts of the city.

After validation and data cleaning, 379 subjects remained in the sample. The interviews were conducted in three socioeconomic stratas including lower, medium, and higher, the basis of which was on accessing to different socioeconomic levels of shopping areas such as older bazaars, uptown bazaars, and pedestrian malls. The survey instrument was short so that it facilitates fast interviews with people on the streets. It contained nineteen questions, according to which seventeen categorical or binary variables and two continuous variables were developed. There were also two open-ended questions in the questionnaire that have not been involved in the present paper. In general, the individual and socioeconomic attributes as well as the preferences of people were targeted by the questions. Thus, most of the questions led to the generation of categorical or dummy variables. Even for making it more comfortable for the respondents, the question targeting their monthly income were asked in a categorical fashion. These categorical/dummy variables were location, gender, age, income, preferred mode of choice irrespective of time, knowing how to ride bicycle, commuting by bike, frequency of bike trips, barriers of biking, motives of biking, education, preferred distance to travel using cycle, preferred time to travel using cycle, preferred trip purpose to travel using cycle, purpose of majority trips, preferred mode in general, and using cycle in addition or split of other modes. The categories of the categorical variables can be observed in Fig.1. The continuous variables were household bike ownership and the number of bicycle users in household. The full details of the results of the survey have already been published in another peer-reviewed journal paper (Aslam et al., 2018).

To answer the first research question of this study about the perceived motives of biking, the variable of perceived motives of biking was taken as dependent variable, the data of which was based on the question "which of the following do you think is the leading motive to drive you to travel by bicycle every day?" and three options of affordability, reliability, and accessibility were given to the interviewees. The interviewers had already given extra oral explanation about the meaning of these options to the respondents. The affordability refers to the bearable buying and maintenance cost of the bike, reliability refers to the dependence (and trustworthiness) on bike as a mode of travel and accessibility refers to ease in approaching various land uses whilst biking. Since being informed about the importance of accessibility as a motivation for bicycling is essential for urban planning and policy making, this variable was taken as reference so that the odds of selection of the other two choices are compared to it.

For modeling this variable, Multinomial Logistic (MNL) regression modeling was employed and the first model was run using 17 variables, then the procedure was repeated by eliminating the insignificant variables one by one to reach the best model including the most significant variables. MNL was applied because of the categorical nature of the dependent variable. The modeling was undertaken 12 times and the following variables were omitted from the model: preferred mode choice, irrespective of time, biking in addition to using other modes, gender, education, age, location, number of cycle users in the household, income, preferred time to travel by cycle, preferred distance to bike, and knowing how to bike. The final model included 6

variables. In order to test the validity of the model Likelihood Ratio Test was conducted, where P-values of less than 0.05 were regarded as a significant model. The Goodness-of-Fit test results of Pearson and Deviance with P-values more than the significance level of 0.05 indicated a good fit of data and model. Finally, Nagelkerke Pseudo $R^2$ values were calculated to show the power of the model to predict the variance of the motives of biking.

In order to answer the second research question about the perceived barriers of biking, the outcomes of the question "what do you think are the hindrances not letting you cycle?" with six choices including health and fitness, weather and environmental conditions, culture, gender, family (travel dependent family member(s)), and non-availability of facilities (e.g. bicycle lanes, etc.) were targeted. The choice related to the family was eliminated from the model because it included few subjects. Two types of models were developed to analyze different types of barriers, firstly a model was developed for non-availability of biking infrastructures against all other choices, and the second model was allocated to issues related to culture and gender against all other options. For both models, Binary Logistic (BL) modeling was used, while the barriers in investigation (non-availability of infrastructures and culture/gender problems) were taken as reference. BL modeling was employed because of the dummy nature of the dependent variables, which was resulted after transformation of the options.

The modeling was done 13 times for the absence of biking infrastructure and the last model, including four variables produced the highest number of significant variables. The eliminated variables were respectively motives of biking, preferred biking time, preferred biking distance, income, preferred mode choice, preferred mode choice irrespective of time, bike trip generation (frequency), using cycle in addition to other modes, knowing how to bike, age, biking use for commuting, and gender. For testing the validity of the model, Omnibus Test and Hosmer and Lemeshow Test were applied, where P-values of less than the significance level of 0.05 indicated a valid model for Omnibus test and the P-values of more than this level indicated validity in Hosmer and Lemeshow Test. Like MNL model, high Nagelkerke Pseudo $R^2$ of the BL model showed the power of the model to predict the variance of the dependent variable.

The same procedure was applied for developing a BL model for culture and gender. Before starting to model, the two categories of perceived barriers related to culture and gender were merged into one group and other choices were transformed to one variable, so a dummy dependent variable was generated. The model reached its best performance after eliminating only four variables of the motives of biking, preferred biking trip purpose, preferred biking time, and preferred biking distance. The model validity tests applied for this model were the same as the infrastructure model.

For investigation of the bicycle trip generation or in other words frequency of bike travels, sought by the third question of this paper, the respondents were asked "what is the frequency of your cycling routine?" and they were given options: daily, weekly, monthly, occasionally, and need-based. The ordered nature of the dependent variable, ranging from daily (coded 1) to need-based (coded 5) facilitated the generation of an Ordinal Probit (OP) model (which was taken because of the ordered nature of the dependent variable). It was assumed that biking on need-based manner is scarcer than using bike occasionally. After eliminating insignificant variables, the twelfth model produced the best results. The eleven eliminated variables were respectively age, the purpose of the majority of the trips, gender, income, using cycle in addition to other modes, education, preferred distance for biking, preferred mobility mode, knowing how to bike, preferred purpose for biking trips, and the number of cycle users in the household. Omnibus Test was run to check the validity of the model, whereas P-values of less than 0.05 indicated a significantly valid model. The proportion of deviance value to degrees of freedom was calculated to test the goodness of fit, whereas ratio values of less than one indicated a good fit of data and model.

## 4. Analysis and results

Most of the variables of this study were categorical or dummy so the descriptive statistics of the findings related to them are illustrated in the form of frequencies and percentages in Fig.1.

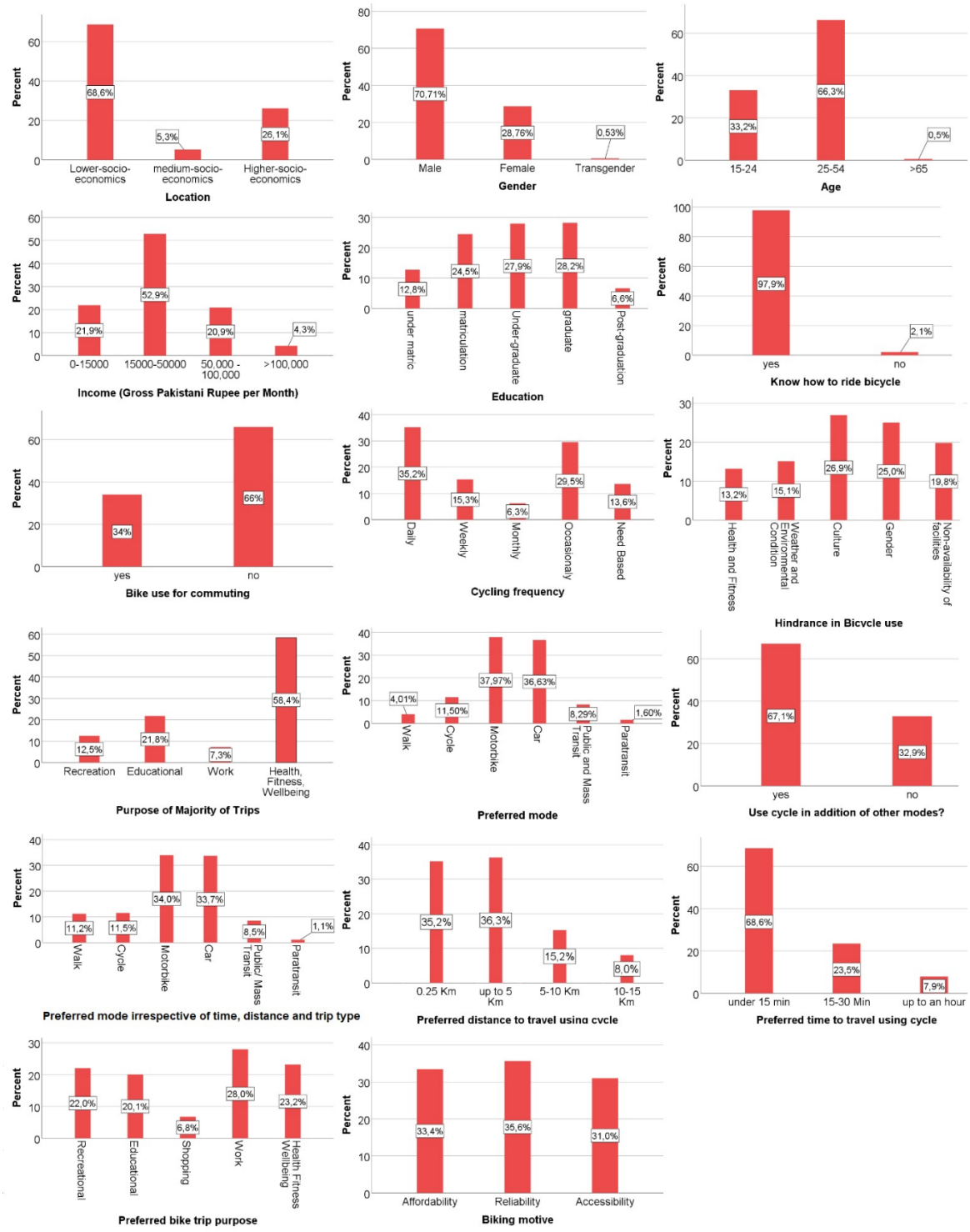



**Fig.1 The frequencies of categorical variables such as age, location, gender, income, cycling frequency and preferred distance, mode and time of travel**

In this study, as one of the variables under investigation was the perceived motives of biking that have been chosen by respondents almost uniformly, while accessibility has reported to be important of interviewees slightly less than affordability and reliability.

The highest frequencies of perceived barriers (hindrances) of biking are cultural issues with about 27% and gender problems with 25%, followed by non-availability of biking infrastructures with less than 20%. This is interesting that people in a city with considerably less active transportation infrastructure mention lack of such facilities as a main barrier of biking. This refers to their awareness about the necessity of facilities for improving the safety, security, and practicality of cycling. The third studied variable is bike trip generation. More than 35% of the respondents use bike in a daily manner, while less than 30% of them use it occasionally. Less than 14% of them bike irregularly and in a need-based fashion.

The respondents were mostly male (71%) and living in areas with lower socioeconomic statuses (69%). More than 66% of the respondents aged between 25 and 54 years and 53% had a gross monthly income of 15,000 to 50,000 Rupees (107€ to 356€, as of 1st of May, 2018). The most frequent education levels were related to graduates (28%), undergraduate studies (28%), and matriculation (25%).

It seems knowing how to bike is not a decisive issue in the sample as 98% of the respondents knew how to do it, indicating that the presence of the elderly or maybe some women who were less likely to not know biking is not considerable.

An interesting point shown by the descriptive findings is that two-thirds of the respondents do not bike for commuting, which shows that the bicycle has not become a serious mobility mode in Lahore. This is confirmed by the question regarding the purpose of bike trips: 58% of the bike trips are done for fitness, health, sport, or wellbeing and 13% bike for recreational purposes. The overall mode choice shares are also in line with the above: bicycle was the main choice of 12% of people, while motorbike and car were the main mode of 38% and 37% of the respondents respectively. However, the interesting point is that two-thirds of the respondents use bike in addition to other modes. The preferred mobility mode irrespective of trip time was also asked from interviewees, whereas motorbike and car were yet chosen by most of the respondents. Most of the respondents preferred to use bicycle for distances upto 5 km (36%) followed by 0.25 km (35%). Two-thirds of the respondents preferred short bike travel times of under 15 minutes. Finally, 28% of the respondents preferred to use a bike for commuting, while other non-work purposes like fitness, health, and wellbeing (23%) and recreational activities (22%) were the other important biking purposes.

## 4.1 Multinomial Logistic model for biking motives

While the descriptive statistics indicate slightly less importance of accessibility compared to reliability and affordability as motives of cycling in Lahore, the results of the MNL model show there are some limited numbers of significant or marginally significant correlations between choosing or not choosing a bike as a mobility mode based on priority of motives.

Choosing accessibility as the reference of the model, lets us compare the probability of biking because of priority of affordability or reliability over accessibility. The model, outlined in Table 2, shows that respondents who have chosen biking as their usual mode are considerably less likely to bike because of affordability relative to accessibility compared to those respondents who have chosen paratransit as their dominant mobility mode. Although paratransit has been taken as the reference mobility mode, it is possible to see that frequent bikers are 17% more probable to bike compared to car users motivated by the affordability of biking relative to accessibility (β=6,8E-17/4,1E-16=0.166). In other words, in comparing the biking motive of bikers with that of car users, affordability has more importance than accessibility. There are also some significant correlations in the relations between bike trip purposes. For those respondents who bike for recreational activities, it is 2% more probable to do it because of affordability rather than accessibility, compared to those who bike for fitness, health, and well-being (P=0.017).

This refers to the nature of biking for recreation and leisure, where people do not intend to reach a destination as fast and rapid as possible. The above two findings about the priority of affordability over accessibility is more understandable when we know 69% of the respondents live in districts with lower socioeconomic statuses. Finally, people whose main trip purposes are recreational are 10.6 times more likely to bike because

of reliability rather than accessibility compared to those whose main purposes are fitness, health, and well-being. This finding is marginally significant (P=0.06). Although, the model has not yielded so many significant coefficients, but it has a good Nagelkerke value of 51% (Tab.3). The model fitting criteria (P<0.001) and goodness-of-fit test results (P for deviance=0.366) show a valid model with good fit of the data. Lack of the number of significant correlations can be explained by the small difference between the number of respondents who have chosen the three biking motivations (affordability: 33%, reliability: 36%, and accessibility: 31%). In samples with more differences in the frequencies of groups, better results may be yielded.

| Variables/Category | Biking Motive | B | Wald | P | β | Biking Motive | B | Wald | P | β |
|---|---|---|---|---|---|---|---|---|---|---|
| Household bike ownership | | 0.575 | 1.8 | 0.180 | 1.778 | | 0.435 | 1.045 | 0.307 | 1.544 |
| Bike use for commuting=yes | | 38.059 | 430.3 | <0.001 | 3.E+16 | | -0.460 | <0.001 | 1.000 | 0.631 |
| Bike use for commuting=no | | 36.007 | 450.1 | <0.001 | 4.3E+15 | | -1.997 | <0.001 | 1.000 | 0.136 |
| Cycling frequency=daily | | 0.321 | 0.095 | 0.758 | 1.379 | | -1.487 | 1.808 | 0.179 | 0.226 |
| Cycling frequency=weekly | | 0.725 | 0.498 | 0.480 | 2.065 | | -0.430 | 0.163 | 0.686 | 0.651 |
| Cycling frequency=monthly | | -17.924 | <0.001 | 0.995 | 1.6E-08 | | -1.281 | 1.017 | 0.313 | 0.278 |
| Cycling frequency=occasionally | | -0.021 | 0.001 | 0.982 | 0.979 | | 0.072 | 0.005 | 0.942 | 1.075 |
| Cycling frequency=need based | | Reference | | | | | Reference | | | |
| Purpose of majority trips=recreation | | 0.837 | 0.412 | 0.521 | 2.310 | | 2.360 | 3.534 | 0.060 | 10.586 |
| Purpose of majority trips=educational | | -0.092 | 0.013 | 0.909 | 0.912 | | 0.734 | 0.69 | 0.406 | 2.083 |
| Purpose of majority trips=work | | -1.573 | 1.671 | 0.196 | 0.208 | | 2.838 | 2.992 | 0.084 | 17.075 |
| Purpose of majority of trips=health. Fitness. And wellbeing | Affordability | Reference | | | | Reliability | Reference | | | |
| Preferred mode choice=walk | | -35.909 | 785.1 | <0.001 | 2.5E-16 | | -18.66 | <0.001 | 0.999 | 7.9E-09 |
| Preferred mode choice=cycle | | -37.231 | 815.4 | <0.001 | 6.8E-17 | | -0.432 | <0.001 | 1.000 | 0.649 |
| Preferred mode choice=motorbike | | -37.531 | 1090 | <0.001 | 5.0E-17 | | 0.658 | <0.001 | 1.000 | 1.930 |
| Preferred mode choice=car | | -35.442 | 913.2 | <0.001 | 4.1E-16 | | 2.128 | <0.001 | 1.000 | 8.397 |
| Preferred mode choice=public and mass transit | | -35.324 | | 1 | 4.6E-16 | | <0.01 | <0.001 | 0.999 | 1.4E-08 |
| Preferred mode choice=paratransit | | Reference | | | | | Reference | | | |
| Preferred bike trip purpose=recreational | | -3.993 | 5.669 | 0.017 | 0.018 | | -1.757 | 1.116 | 0.291 | 0.173 |
| Preferred bike trip purpose=educational | | -0.920 | 0.56 | 0.454 | 0.399 | | 0.050 | 0.001 | 0.969 | 1.051 |
| Preferred bike trip purpose=shopping | | -1.939 | 1.672 | 0.196 | 0.144 | | -3.492 | 2.516 | 0.113 | 0.030 |
| Preferred bike trip purpose=work | | -0.750 | 0.406 | 0.524 | 0.472 | | -0.141 | 0.013 | 0.909 | 0.868 |
| Preferred bike trip purpose=health. Fitness. and wellbeing | | Reference | | | | | Reference | | | |

**Tab.1: Results of Multinomial Logistic model for biking motives (Reference: accessibility)**

| Likelihood Ratio Tests | | | | |
|---|---|---|---|---|
| **Effect** | **Model Fitting Criteria** | **Likelihood Ratio Tests** | | |
| | **-2 Log Likelihood of Reduced Model** | **X²** | **df** | **P** |
| Household bike ownership | 167.12 | 2.18 | 2 | 0.336 |
| Bike use for commuting | 172.06 | 7.13 | 2 | 0.028 |
| Cycling frequency | 178.96 | 14.02 | 8 | 0.081 |
| Purpose of majority trips | 177.19 | 12.25 | 6 | 0.057 |
| Preferred mode choice | 205.21 | 40.27 | 10 | <0.001 |
| Preferred bike trip purpose | 178.65 | 13.7 | 8 | 0.090 |
| **Model fitting information** | | | | |
| **Model** | **Model Fitting Criteria** | | | |
| Null | 242.19 | | | |
| Final | 164.94 | 77.25 | 38 | <0.001 |
| **Goodness-of-Fit** | | | | |
| **Measure** | **Chi-Square** | **df** | **P** | |
| Pearson | 152.29 | 134 | 0.133 | |
| Deviance | 139.02 | 134 | 0.366 | |
| **Pseudo R-Square** | | | | |
| Nagelkerke | 0.513 | | | |

**Tab.2 Specifications of Multinomial Logistic model for commute mode choice**

## 4.2 Binary Logistic models for perceived biking barriers

For analyzing the perceived barriers of biking, two models were generated as explained in the methodology section: once non-availability of bicycling infrastructures were taken as the reference and in the second model, cultural and gender issues were taken as reference group. In the first model, as seen in Table 4, a BL model was developed, in which people who live in districts with medium socioeconomic statuses (people who access uptown bazaars) are 13% less probable to perceive issues other than biking infrastructures as barriers of cycling. In other words, they are 13% more likely to not bike because of lack of biking infrastructures and facilities. This finding is marginally significant (P=0.076). Education including all of its groups is generally a highly significant predictor of biking barriers (P=0.002). Two of the education classes are significantly coordinated with perceived biking barriers. Having an undergraduate university education is a highly significant predictor (P=0.004). If a respondent has undergraduate education, it is 15% more likely that he/she do not bike because of unavailability of biking facilities. This means for this group of people, biking infrastructure is a more important obstacle than others. If the education is more advanced (graduate), it will be 20% more probable to not to bike because of unavailable infrastructures compared to the other reasons. This refers to the importance and effectiveness of providing biking facilities like bike tracks, routes, sharing systems, bike pools, etc. in encouraging educated people to biking. The number of cycle users in the household is also a highly significant predictor (P=0.005). One cycle user more in a household will increase the likeliness of not biking because of unavailability of facilities by 34%. A family with three cycle users is 68% more probable not to bike because of no facilities compared to a family with one biker. Finally, household bike ownership is significantly, strongly correlated with perceiving unavailable infrastructures compared to other reasons. When there is one more bike in a family, the odds of not biking because of unavailable infrastructures relative to other reasons increases 2.38 times (238%). The validity test results of this model are also seen in Table 4. The results of the Omnibus Test (P<0.001) and Hosmer and Lemeshow Test (P=0.833) both confirm the validity of the model. The model predicts about 61% of the variance of the dependent variable (Nagelkerke Pseudo $R^2$=0.607). By changing the reference from non-availability of biking infrastructures to a combination of cultural and gender issues, new results emerge. As seen in Table 5, location is still a decisive variable group (P=0.042), but surprisingly when people live in districts with lower socioeconomic status like areas located near to traditional bazaars accommodating poorer residents, it is less likely that people do not cycle because

of cultural and gender issues (P=0.021). This is perhaps because other barriers are even more powerful in their case. However, as expected, being male reduces the odds of not biking because of cultural and gender problems compared to other reasons (P=0.013). These problems also affect younger people aged between 15 and 24 years. When people get older and fall in the next age class, it will be 7 times more probable that they do not cycle affected by the mentioned problems. As expected, income is a significant variable group (P=0.034), three out of four variable classes of which are highly significant. The households having the first three income groups (0-15,000 Rupees, 15,000-50,000 Rupees, and 50,000 – 100,000 Rupees) are highly significantly probable to not bike because of these problems. However, there is no relation between the perceived biking barriers of families earning a gross amount of more than 100,000 Rupees per month (712.22€ as of 1st of May, 2018) and cultural and gender problems compared to other reasons. People with lower education (under matric and also those having matriculation) as well as people with undergraduate university education are significantly less probable to not bike because of these issues. Those who say they know how to bike as well as people who commute by bicycle are more likely to perceive such issues as a barrier. The respondents who bike daily, monthly, and occasionally are more likely to perceive these issues as biking obstacles. When the number of bikers per household increases, the odds of perceiving culture and gender as obstacles highly significantly decrease (P=0.007). The reason lies in the sub-culture of the families. Those who recognize biking as a legitimate and useful way of mobility, do not see culture and gender barriers of cycling. Likewise, families who possess a higher number of bikes are less likely to not bike because of these problems. This finding has marginal significance (P=0.063). The connection of education with perceptions of biking barriers is also seen in the trip purposes: the respondents whose main purpose of majority of trips is education are more probable to not bike because of culture and gender. This shows the sensitivity of university students and pupils against such obstacles. Some of the preferred mobility modes for daily trips are also connected to the perceived biking barriers. People whose preferred modes are walking, biking, motorbike, and personal car are less likely to not bike because of cultural and gender obstacles compared to other reasons. However, such a relationship does not exist between the perceptions of public transportation and paratransit users. If time element is controlled in the analysis, public transit and paratransit users will also have a negative significant correlation with not biking because of culture and gender, but instead the relation of the mode of bikers with perceiving these issues as barriers becomes insignificant. The results of the Omnibus Test (P<0.001) and Hosmer and

Lemeshow Test show that the model is valid and performs well. More than 90% of the variance of the dependent variable can be predicted by the model (Nagelkerke Pseudo $R^2$=0.902).

| **Variables** | **B** | **S.E.** | **Wald** | **df** | **P** | **β** |
|---|---|---|---|---|---|---|
| Location | | | 3.220 | 2 | 0.200 | |
| Location= lower-socio-economics | -0.154 | 0.514 | 0.089 | 1 | 0.765 | 0.857 |
| Location= medium-socio-economics | -2.025 | 1.140 | 3.156 | 1 | 0.076 | 0.132 |
| Education | | | 16.904 | 4 | 0.002 | |
| Education=under matric | -0.272 | 0.711 | 0.146 | 1 | 0.702 | 0.762 |
| Education=matriculation | 0.091 | 0.678 | 0.018 | 1 | 0.893 | 1.095 |
| Education=undergraduate | -1.884 | 0.654 | 8.305 | 1 | 0.004 | 0.152 |
| Education=graduate | -1.625 | 0.640 | 6.443 | 1 | 0.011 | 0.197 |
| No. Of cycle users in household | -1.069 | 0.384 | 7.752 | 1 | 0.005 | 0.343 |
| Household bike ownership | 0.869 | 0.417 | 4.345 | 1 | 0.037 | 2.384 |

| **Omnibus Tests of Model Coefficients** | | | | **Hosmer and Lemeshow Test** | | |
|---|---|---|---|---|---|---|
| **Measure** | **Chi-square** | **df** | **P** | **Chi-square** | **df** | **P** |
| Step | 92.283 | 9 | <0.001 | 3.705 | 8 | 0.883 |

| | | | |
|---|---|---|---|
| Block | 92.283 | 9 | <0.001 |
| Model | 92.283 | 9 | <0.001 |

| Model Summary | |
|---|---|
| **-2 Log likelihood** | **Nagelkerke R Square** |
| **118.434** | 0.607 |

**Tab.3 Test results of Binary Logistic regression model for perceived barriers of biking (Reference: non-availability of biking infrastructures)**

| **Variables** | **B** | **S.E.** | **Wald** | **df** | **P** |
|---|---|---|---|---|---|
| Location | | | 6.321 | 2 | 0.042 |
| Lower-socio-economics | 12.6 | 5.46 | 5.319 | 1 | 0.021 |
| Medium-socio-economics | -9.73 | 8.93 | 1.19 | 1 | 0.275 |
| Gender=male | -44.8 | 18.08 | 6.137 | 1 | 0.013 |
| Age=15-24 | 7.04 | 2.99 | 5.547 | 1 | 0.019 |
| Income | | | 8.65 | 3 | 0.034 |
| 0-15,000 | -52.2 | 19.6 | 7.061 | 1 | 0.008 |
| 15,000-50,000 | -74.4 | 25.44 | 8.548 | 1 | 0.003 |
| 50,000 – 10,0000 | -78.59 | 28.1 | 7.822 | 1 | 0.005 |
| Education | | | 6.108 | 4 | 0.191 |
| Under matric | 58.78 | 24.47 | 5.769 | 1 | 0.016 |
| Matriculation | 59.95 | 25.46 | 5.546 | 1 | 0.019 |
| Undergraduate | 63.79 | 26.785 | 5.673 | 1 | 0.017 |
| Graduate | 2.22 | 7.88 | 0.079 | 1 | 0.778 |
| Know how to ride bicycle=yes | -69.16 | 29.56 | 5.475 | 1 | 0.019 |
| Bike use for commuting=yes | -92.33 | 37.58 | 6.035 | 1 | 0.014 |
| Cycling frequency | | | 9.313 | 4 | 0.054 |
| Daily | 16.41 | 8.97 | 3.347 | 1 | 0.067 |
| Weekly | -93.58 | 3276 | 0.001 | 1 | 0.977 |
| Monthly | 31.49 | 12.32 | 6.525 | 1 | 0.011 |
| Cycling frequency=Occasionally | 52.45 | 19.096 | 7.545 | 1 | 0.006 |
| No. of cycle users in house | 7.29 | 2.723 | 7.165 | 1 | 0.007 |
| Household bike ownership | 11.22 | 6.047 | 3.445 | 1 | 0.063 |
| Purpose of Majority Trips | | | 4.742 | 3 | 0.192 |
| Purpose of Majority Trips=Recreation | 9.5 | 6.117 | 2.413 | 1 | 0.12 |
| Purpose of Majority Trips=Educational | -11.09 | 5.431 | 4.169 | 1 | 0.041 |
| Purpose of Majority Trips=Work | 2.54 | 9.892 | 0.066 | 1 | 0.797 |
| Preferred mode choice | | | 8.713 | 5 | 0.121 |
| Walk | 102.2 | 42.015 | 5.917 | 1 | 0.015 |
| Cycle | 104 | 42.045 | 6.113 | 1 | 0.013 |
| Motorbike | 87.99 | 38.784 | 5.146 | 1 | 0.023 |
| Car | 92.2 | 38.329 | 5.787 | 1 | 0.016 |
| Public and Mass Transit | 222.6 | 3277.71 | 0.005 | 1 | 0.946 |
| Use cycle in addition or split of other modes=Yes | -6.53 | 4.337 | 2.271 | 1 | 0.132 |
| Preferred mode choice irrespective of time | | | 8.341 | 5 | 0.138 |
| Walk | 55.38 | 21.52 | 6.622 | 1 | 0.01 |
| Cycle | 19.04 | 11.567 | 2.709 | 1 | 0.1 |
| Motorbike | 30.57 | 14.425 | 4.49 | 1 | 0.034 |
| Car | 43.78 | 17.114 | 6.544 | 1 | 0.011 |
| Public/ Mass Transit | 39.37 | 15.991 | 6.061 | 1 | 0.014 |

| **Omnibus Tests of Model Coefficients** | | **Hosmer and Lemeshow Test** | | **Model Summary** | | | | |
|---|---|---|---|---|---|---|---|---|
| **Measure** | **X²** | **Df** | **P** | **df** | **X²** | **P** | **-2 Log likelihood** | **Nagelkerke R²** |
| Step | 132.074 | 33 | <0.001 | 8 | 0.522 | 1 | 30.12 | 0.902 |
| Block | 132.074 | 33 | <0.001 | | | | | |
| Model | 132.074 | 33 | <0.001 | | | | | |

**Tab.4 Results of Binary Logistic regression model for perceived barriers of biking (Reference: cultural and gender problems)**

## 4.3 Ordinal Probit model for bike trip generation

For understanding the determinants of the number of bicycle trips generated by people in Lahore, an OP regression model was developed. The final model includes seven variable groups, including location of residence based on socioeconomic status, bike use for commuting, perceived barriers of bicycle use, preferred mode choice irrespective of time, preferred time to travel using cycle, motives of biking, and household bike ownership. Six out of seven variables kept in the final model are highly significant (P at 0.01 level), significant (P between 0.01 and 0.05), or marginally significant (P between 0.05 and 0.1). Nevertheless, not all of the categories under the significant variable groups are significant. The summary of the model indicates that people living in medium socioeconomic statuses are significantly 2.5 times more probable to generate the higher number of bike trips compared to people living in higher socioeconomic statuses (people living in wealthier areas). This finding is not only in relation to money issues, because income has not been a significant variable in the model. However, a wider range of socio-cultural and societal phenomena must be involved in this correlation. A highly significant variable in the model is biking for the purpose of commuting (P=0.005). People who use bicycle as a commuting mode are 47% less probable to generate more bike trips compared to those who do not commute by bike. This shows that biking in Lahore is highly under the influence of non-work purposes rather than commuting. Respondents who perceive gender as a biking barrier are significantly 2.16 times probable to have more bike travels compared to those who say unavailability of infrastructures cause them refrain from biking. This indicates that the effect of non-availability of biking facilities can be stronger than gender issues when we consider only bike trip frequencies. Fig.2A illustrates the descriptive relations between biking frequencies, perceived barriers of biking, and education, whereas it is observable that non-availability of facilities is more important for educated people and may cause their bike travel decrease more than other education groups. Fig.2B shows the descriptive relations between biking frequencies, biking barriers, and bike ownership. Although bike ownership is not a significant variable of the model, the diagram can give us a good image of the relation between the three variables, particularly bike trip generation and perceived barriers. As seen there, there is a consistent and continuous positive relation between biking frequencies from need-based and occasional to daily with bike ownership for people who perceive their gender as a biking barrier. This relation exists with a much steeper slope for people who perceive non-availability of biking facilities as a barrier only for the monthly to daily frequencies.

| Parameter | Category | B | S.E. | Hypothesis Test | | | β |
|---|---|---|---|---|---|---|---|
| | | | | Wald $X^2$ | df | P | |
| **Threshold** | Cycling frequency=Daily | -0.709 | 1.199 | 0.349 | 1 | 0.554 | 0.492 |
| | Cycling frequency=Weekly | -0.123 | 1.197 | 0.011 | 1 | 0.918 | 0.884 |
| | Cycling frequency=Monthly | 0.160 | 1.197 | 0.018 | 1 | 0.894 | 1.173 |
| | Cycling frequency=Occasionally | 1.367 | 1.202 | 1.294 | 1 | 0.255 | 3.925 |
| Location =lower-socio-economics | | 0.169 | 0.282 | 0.359 | 1 | 0.549 | 1.184 |
| Location =medium-socio-economics | | 0.916 | 0.395 | 5.376 | 1 | 0.02 | 2.499 |
| Location =higher-socio-economics | | | | Reference | | | |
| Bike use for commuting=yes | | -0.752 | 0.27 | 7.709 | 1 | 0.005 | 0.471 |
| Bike use for commuting=no | | | | Reference | | | |
| Perceived biking barrier=health and fitness | | -0.118 | 0.348 | 0.115 | 1 | 0.735 | 0.889 |
| Perceived biking barrier=weather and environmental condition | | -0.317 | 0.321 | 0.973 | 1 | 0.324 | 0.728 |
| Perceived biking barrier=culture | | 0.326 | 0.333 | 0.957 | 1 | 0.328 | 1.385 |
| Perceived biking barrier=gender | | 0.771 | 0.380 | 4.115 | 1 | 0.042 | 2.162 |
| Perceived biking barrier=non-availability of facilities | | | | Reference | | | |
| Preferred mode choice irrespective of time=walk | | 0.431 | 1.16 | 0.138 | 1 | 0.710 | 1.538 |
| Preferred mode choice irrespective of time=cycle | | -1.089 | 1.159 | 0.882 | 1 | 0.348 | 0.337 |
| Preferred mode choice irrespective of time=motorbike | | -0.021 | 1.126 | <0.001 | 1 | 0.985 | 0.979 |

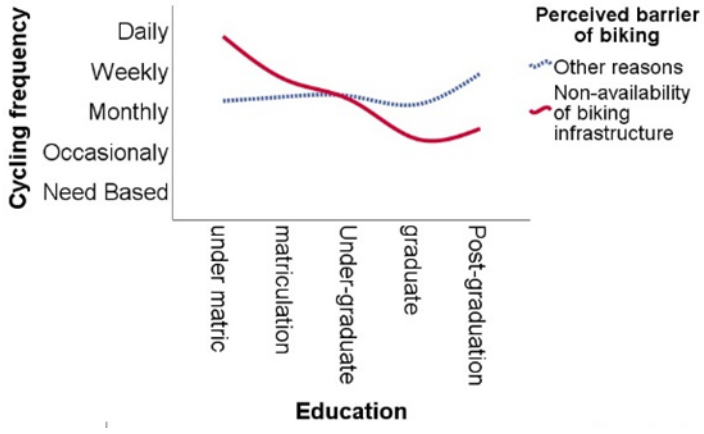
| | | | | | | |
|---|---|---|---|---|---|---|
| Preferred mode choice irrespective of time=car | -0.154 | 1.13 | 0.019 | 1 | 0.891 | 0.857 |
| Preferred mode choice irrespective of time=public/mass transit | -0.014 | 1.167 | <0.001 | 1 | 0.991 | 0.986 |
| Preferred mode choice irrespective of time=paratransit | Reference | | | | | |
| Preferred time to travel using cycle=under 15 min | 0.834 | 0.415 | 4.027 | 1 | 0.045 | 2.301 |
| Preferred time to travel using cycle=15-30 min | 0.461 | 0.409 | 1.270 | 1 | 0.26 | 1.586 |
| Preferred time to travel using cycle=up to an hour | Reference | | | | | |
| Biking motivation=affordability | -0.227 | 0.277 | 0.674 | 1 | 0.412 | 0.797 |
| Biking motivation=reliability | 0.434 | 0.272 | 2.529 | 1 | 0.112 | 1.543 |
| Biking motivation=accessibility | Reference | | | | | |
| Household bike ownership | -0.193 | 0.147 | 1.720 | 1 | 0.19 | 0.825 |

| **Test of Model Effects** | | | | **Goodness of Fit** | | | |
|---|---|---|---|---|---|---|---|
| **Source** | **Type III** | | | | | | |
| | **Wald $X^2$** | **df** | **P** | **Measure** | **Value** | **df** | **Value/df** |
| Location | 5.527 | 2 | 0.063 | | | | |
| Bike use for commuting | 7.709 | 1 | 0.005 | Deviance | 296.1 | 419 | 0.707 |
| Hindrance in bicycle use | 11.822 | 4 | 0.019 | Pearson Chi-Square | 434.6 | 419 | 1.037 |
| Preferred mode choice irrespective of time | 14.507 | 5 | 0.013 | Log Likelihood | -155.3 | | |
| Preferred time to travel using cycle | 4.908 | 2 | 0.086 | **Omnibus Test** | | | |
| Aspect driving using cycle | 5.828 | 2 | 0.054 | **Likelihood Ratio $X^2$** | **df** | **P** | |
| Household bike ownership | 1.720 | 1 | 0.190 | 61.531 | 17 | <0.001 | |

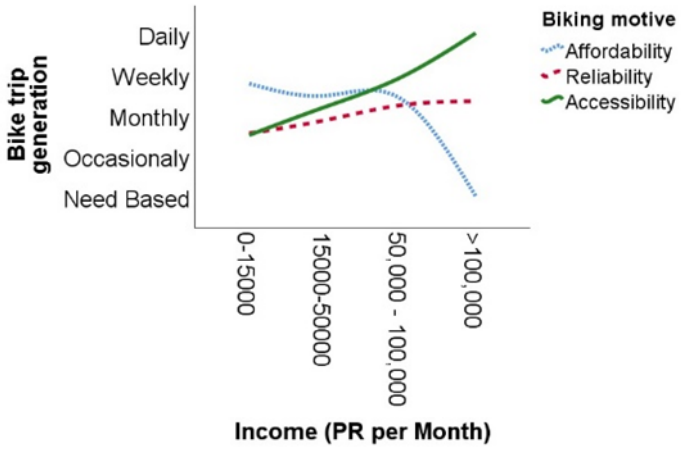
**Tab.5 Results of Ordinal Probit Regression model for bike trip generation**

According to the generated model, preferred biking time is also important in defining bike trip generation: people who prefer to bike in short times for each trip (under 15 minutes) are significantly 2.3 times more likely to have more bike trips compared to those who find bicycling trip times of up to an hour (P=0.045). The subjects of the sample of this study prefer to have more trips in short trip times like non-work trips around their homes rather than in long-time travels such as commuting travels. The goodness-of-fit test has yielded a deviance value divided by degrees of freedom proportion of 0.707 which indicated a valid model because it is less than 1. The results of the Omnibus Test are also in the same line (P<0.001).

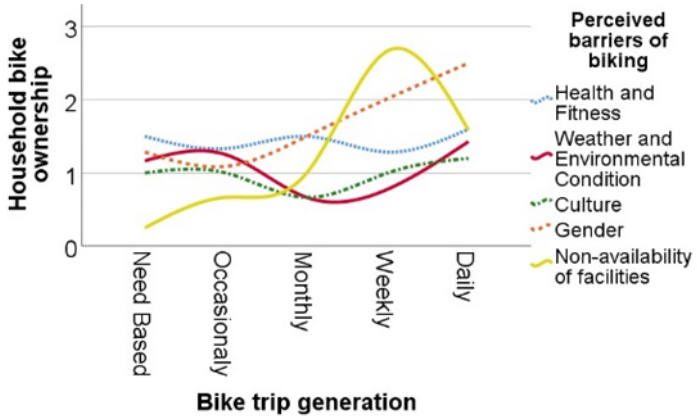
To complete the findings of the model, and to complete the findings of the statistical modeling, it can be mentioned that using accessibility for increasing the motivation of passengers to use bicycle can be used more efficiently for people with average or higher income. This can be seen in Fig.2C, where a steady positive relation can be found between bike trip generation and income for people who declare accessibility is important for their biking activity. Such behavior cannot be observed in people who are motivated by affordability and reliability.




(a)




(b)




(c)

**Fig.2 (a) The relation between cycling frequency, perceived biking barriers, and education; (b) The relation between biking frequency, bike ownership, and perceived biking barriers; (c) The relation between biking frequency, income, and biking motives**

## 5. Discussion

In terms of frequency, respondents of the study chose the motives of the biking almost uniformly and not a single motive stands out as the leading one. Reliability ranked the top most stated motive (35.6%) while the accessibility stood the least mentioned (31.0%) motive. The stats do not reflect a significant variation among the motives; nonetheless, it gives some clue regarding the reliability character of the available public mass transportation system in Lahore, which is neither efficient nor integrated (Aslam et al., 2018; Aziz et al., 2018; Imran, 2009; H. Masoumi et al.,2020). Thus, it cannot be regarded as a reliable system, which might encourage people to perceive biking as a more reliable mode of travelling for shorter distances. Our results show that people even prefer biking over paratransit modes mainly due to accessibility concerns. It is in line with the literature findings emerging from the developing countries that accessibility to neighborhood amenities (Houshmand Ebrahimpour Masoumi, 2013) and transit stations (Houshmand E. Masoumi & Mirmoghtadaee, 2016) can increase the active traveling mode trips including the biking trips. The purpose of the majority of the biking trips has been found as work (28.0%) followed by health, fitness, wellbeing (23.2%) and recreation (22.0%). Our findings draw less similarities and more differences with the findings of the studies conducted in the high-income countries. Apart from contextual variations, the other reason for having more differences with literature findings could be that this study included all types of cyclists, whereas many of the international studies have been conducted to explore the travel behaviour of a particular type of cyclists such as commuters, non-commuters, leisure based, competition/event based, females, migrants etc. However, health and fitness either remains the leading motive or one of the main motives for almost all types of cyclists in the developed countries such as in Denmark (Hansen & Nielsen, 2014), Australia (Brown et al., 2009;

Faulks et al., 2008; Zander et al., 2013), Canada (Stuckless, 2010), Germany (GIM, 2008), USA (Herman, 2015). Similar finding has also been reported by some other studies conducted in the context of developing countries such as Ho (Ho et al., 2015) investigated the motives of leisure and recreational cycling and found the physical challenge (fitness) as the main motive among various other motivations in Taiwan. However, in an earlier study, (H. Masoumi et al., 2020) found work and education as the main motives for biking trips in Lahore, Pakistan. This shows the difference in the leading motive of cycling in high income countries as the people in developed countries use cycling as a mode of active transportation for fitness and physical exercise, while in the context of developing countries, the main motives rest with work and education as compared to health concerns. Other leading motives of cycling in high income countries have been found as reduced costs (Hansen & Nielsen, 2014; Jones & Ogilvie, 2012), and economy (Barajas, 2016; De Souza et al., 2014; Sahlqvist & Heesch, 2012). All of these mentioned motives can be grouped in the category of affordability. After affordability, the other important motive reported for cycling in high income countries is accessibility or convenience (Broache, 2012a; Heesch & Sahlqvist, 2013; Izadpanahi et al., 2017; Jones & Ogilvie, 2012). Lesser studies have reported reliability (Barajas, 2016; Jones & Ogilvie, 2012) as the main motives of biking in the developed world. This shows a difference with our finding where people regard reliability more as compared to other motives of biking in Pakistan. This also provides an insight to the public mass transport system in the developed world which people generally perceive as reliable in comparison to other parts of the world. This contextual difference may make up the people in the developed world less considered with the motive of reliability for biking.

This study reports cultural issues as the leading barrier (26.9%) towards cycling in Pakistan followed by gender issues (25.0%) and non-availability of biking related facilities, mainly the infrastructure (19.8%). This finding is in conformity with some other studies conducted in the developing world, such as Masoumi (2019) also found sociocultural issues and absence or lack of biking infrastructure as the main barriers of biking in the cities of Tehran, Istanbul and Cairo. However, this finding is in contrast with the results coming from high income countries. As we have seen that the motives of affordability and reliability are more stated as compared to the motive of accessibility and the purpose of majority of biking trips is work based commuting, cycling, is generally regarded as a travelling mode for poor in Pakistani society. With that general societal mind-set, cultural issues pose a serious hindrance towards cycling practice by middle and upper income classes, however, lower socioeconomic groups perceive cultural issues less as a barrier as it is depicted by our results. Bauman (A. E. Bauman et al., 2008) also reported cultural and social factors as the barrier to cycling in Australian context but with a different interpretation. They referred to the works of Estabrooks (Estabrooks et al., 2003), Popkin (Popkin et al., 2005) and Kavanagh (Kavanagh et al., 2007) to describe it as the reduced access of lower socioeconomic areas to biking supported environment. A similar finding has also been emerged in the context of England, where Christie, (Christie et al., 2011) found environmental and social factors as barriers to cycling for children living in disadvantaged areas. However, our results show that these are the medium socioeconomic areas who perceive non-availability of the supporting infrastructure more as a barrier compared to lower socioeconomic areas. This could because of the reason that biking infrastructure in Pakistani cities is almost non-existent and situation is alike in almost all urban places. Thus, people belonging to better socioeconomic areas and having better educational levels perceive non-availability of biking infrastructure more as a barrier. Nasrudin (Nasrudin, 2014) also reported unsatisfactory cycling tracks as one of the barriers in Shah Alam city of Malaysia. Similarly, the second most stated barrier came out as gender issues, which shows female dependency on the male companions for travelling in Pakistani society thus restricting half of the population not to cycle independently. Though a good portion of female car drivers can be seen on urban roads (Masood, 2018), it is difficult to spot female cyclists due to that reason. These leading barriers are context specific and in contrast with the findings of the studies conducted in the developed world. The third most stated barrier of non-availability of the infrastructure and services is one which finds similarity with the findings of studies conducted in the high income countries such as (Bauman et al., 2008; Biernat et al., 2018;

De Souza et al., 2014; Iwińska et al., 2018; Mackie, 2009; Manaugh et l., 2017; Rijsman et al., 2019) that found infrastructure related concerns as the main barrier/one of the main barriers towards cycling. Some studies also reported weather such as (Broache, 2012b; Fowler et al., 2017; Iwińska et al., 2018; Swiers, Pritchard, & Gee, 2017) as the main barrier towards cycling, which has also been emerged in our study, though its frequency has been found lesser as compared to other reported barriers.

Our results show that the majority of the biking trips are generated on a regular basis (56.8%) while the remaining biking trips are irregularly generated. The leading majority of the trips are generated daily (35.2%). Medium socioeconomic areas are 2.5 times more probable to generate the biking trips as compared to high income areas. People living in high income areas generally possess a high education level as compared to lower socioeconomic areas and our finding from binary logistic model reveals that as the education level rises, people perceive non availability of infrastructure as the main barrier towards biking. Also, our ordinal probit model reveals that people who perceive gender issues as the main barrier to cycling are 2.16 times more probable to bike as compared to people who reported no biking infrastructure as the main barrier. As there is not much difference in the available biking infrastructure across various socioeconomic areas in Pakistani urban places, the difference in education levels across different socioeconomic areas can explain the higher trip generation from medium socioeconomic areas. Another important finding is that the non-commuters are more probable to generate biking trips. More than two thirds of all cycling trips are non-work based. This finding is in similarity with the figures reported in Germany. GIM (GIM, 2008) reported that for all the work based trips, only 16% commuting to work trips are made by bicycles in Germany even though about half of all Germans (49%) use a cycle in their everyday life. Overall, the biking trip frequency is also decreasing in some parts of the developed world as in the UK, cycling trips accounted for only 1% of all trips in 2002, which accounted for 37% of all trips made in 1949 (Horton, 2016). However, there are differences in literature findings as well for other high income countries. Australian Bureau of Statistics (Statistics, 2007) reported the strongest growth of work based biking trips in the Australian capital cities during a period 2001-06, which experienced an increase of 28.9% work based biking trips during the period. It has also been depicted that travel time of 15 minutes by using cycle is significantly positively associated with the generation of biking trips. It means longer travel time (and distance) will be a barrier towards cycling trip generation. This is in accordance with the German case, where GIM (2018) reported top most barriers towards cycling as very long travel distance (44%) and very long travel time (43%). Damant and other researchers (Damant-Sirois & El-Geneidy, 2015; Estabrooks et al., 2003) reported safety, cost, convenience, and flexibility as the main predictors of cycling frequency in Montreal, Canada whereas our model displays location, travel attitude, gender and travel time as the main predictors of the biking trip generation which shows the differences based on contextual variations.

A few very important insights have been emerged in our study. For example, this study, being quantitative in nature, didn't offer much room to investigate about safety aspect in detail. More qualitative studies in future can be done to dig up deeper this aspect of urban travel behavior. Also, the results of this study are specific to a mega city of Pakistan (population more than 11 million) which might not be the same for intermediate and smaller cities of Pakistan. The results, though important for the urban and transportation planners, and policy makers alike, are not generalizable for other urban parts of the country.

## 6. Conclusion

The previous research on biking enlightened that there is no definite answer to date to understand how people can be encouraged to bike as it varies from regions, cultures, personal characteristics. Therefore, this research focused on the motives and barriers behind biking as the preferred mode in low-income countries, while studying Pakistani context using Logit and Probit models. This research based on primary data collected through direct questioning method and were conducted in three socioeconomic status. The outcome of research identified barriers of biking as cultural issue, gender problem and non-availability of biking

infrastructure and respondents weighted these almost uniformly. When, non availability of biking infrastructure was taken as reference in Binary Logistic model over cultural and gender issues, then it showed that there will be more biking trips with the provision of biking infrastructure (i.e. 13%). Whereas motives of biking labeled as reliability, affordability and accessibility while modeling the data these motives did not show any much variation in frequency and reliability ranked highest (35.6%) and accessibility lowest (31.0%). Nevertheless, further analysis showed that people even prefer biking over paratransit modes mainly due to accessibility concerns and the purpose of majority of biking trips has been found to work followed by health, fitness, wellbeing and recreation. The barriers of biking varied from education level to socioeconomic group. This research has discussed the motives and barriers using models in details and it provides substantiate material to guide policy makers to promote greener modes of transport i.e. biking in low income countries.

This study has included all types of cyclist for exploring the motives and barriers of biking. There is a need to conduct studies on a particular type of cyclist i.e. commuter, non-commuters, leisure based, event based, gender etc. Further, safety factor has not surfaced much in the present study, therefore, it is suggested that future research on this subject should explore this factor in details in relation to motives or barriers of biking in developing countries. Another feature of this research is that it is conducted in a mega city with a population of around 11 million. Thus, the results cannot be firmly extrapolated for medium and smaller cities. Consequently, in future such studies also need to be carried out in medium and smaller cities with similar research settings.

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# The city as a complex system in structural crisis

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**Evergreen section**

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The book is included in the Studi Urbanistici series published by Fondazione Aldo Della Rocca and it can be consulted, in its original version, at the following address: https://www.fondazionedellarocca.it/
The authors thank the President Gian Aldo Della Rocca for having authorized the publication of the research in English. The paper in this new section of TeMA Journal, Evergreen, is the literal English translation (only some tables have been deleted from the original text). This section aims at drawing the attention of the international scientific community to papers that, despite the passing of time, still present elements of significative scientific interest – insights, anticipations and reflections – enough to deserve careful read back.

**Abstract**

The paper aims to be a contribution to the resolution of the deep crisis that has been affecting the current urban realities, facing the problem in all of its aspects, such as those of scientific and methodological approach and operating procedures.

**Keywords**

Complexity theory; Government of urban system; Multivariate statistical analysis.

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# 1. Introduction

This work aims to be a contribution to the resolution of the deep crisis that has been affecting the current urban realities, facing the problem in all of its aspects, such as those of scientific and methodological approach and operating procedures. In other terms, the awareness of the priority of the "city problem" on a national and international scale makes it necessary, not only the re-examination of the procedures by which urban phenomena have been faced until today, but also and firstly the "way of seeing" the city, and therefore the philosophy of approach to the urban issue.

The working group that carried on this research is convinced that to the increased complexity of the urban problem must correspond an adequate methodology of analysis and intervention, which makes use of appropriate techniques and tools, also through the intake of new technologies.

If attention is focused on the "government" of the city, urban planning and land use planning must be seen and considered, primarily, as organizational sciences. For this reason, it is necessary that the urban government is addressed at eliminating the negative externalities resulting from the increasing urban entropy and macroscopically visible in the current process of urban and metropolitan transformation.

Against this background, this paper is configured as an attempt of redesigning the approach to urban systems, oriented to the improvement and optimization of the planning, management, control and governance abilities of the transformations that affect metropolitan areas.

In this way, the strategies for governing the complexity of the "urban system" are individualized. The assumption of these strategies is the concept of urban system that not only includes the city and its complex becoming, but also the complexity of the system of decision-makers who define the desired states of the city and the complexity of the decision-making systems. The premises that refer to the whole work are related to the "paradigm of the complexity" that seems to offer the greatest scientific guarantees of reference and relation to frame, in a scientifical way, the metropolitan phenomenon.

The logic adopted in this study is the systemic-procedural one which allows to figure out the city both as a "physical phenomenon" (its form, its streets, its buildings) and as a "functional phenomenon" (the relationships existing between its elements and the laws regulating these relationships).

The focal point of this work is represented by the part related to the government of the city, where some tools are proposed, such as innovative techniques and procedures as essential elements to relaunch a new and effective policy of planning and governance of the territory. Eventually, it is reported a first application of the methodology described on a sample area: the Neapolitan conurbation.

In extreme synthesis, this work proposes three distinct lines of action to face and solve the current crisis of the city. The first one aims to updating, the reading techniques and cognitive tools of the urban phenomenon in the light of the possibilities that science and technology make available.

The second one must have as its target the redefinition of the "interpretative paradigms" of the urban phenomenon. Suffice it to say to the Copernican revolution that takes place looking at the city no longer as a machine but as a complex non-deterministic system.

The overriding objective of the third line of action must be the definition of new instruments and renewed techniques of city governance. And this is due, not only to the updating of reading and analysis techniques, but also to the new interpretative models of the city. As a matter of fact, if the urban system is connoted by its complexity, it will be necessary that the tools and techniques of governance of this complexity are no longer static projection tools (the current regulatory plans) or cumbersome and very slow techniques of formal and bureaucratic control but conform to the dynamism and variety of the 21st century city.

The work, conceived and developed in a unified action by the research team, for the necessary scientific attributions among the authors can be divided as follows: the second paragraph was drawn up by Carmela Gargiulo, the third paragraph by Rocco Papa, the fourth and the fifth paragraph by Romano Fistola and the sixth paragraph by Rosaria Battarra.

# 2. The city as a dynamically complex system

## 2.1 The 21st century city: the challenge of complexity

The concept of system and, particularly, of complex system has been pervading for some years all the scientific disciplines to the point of involving a "revolution of thought".

The methodological and operational approaches that each discipline has reworked on the basis of the new scientific thought have, in turn, produced re-orientations, in many cases even radical. At the bases of the new "vision" of the world and in general of the natural and social phenomena, there is a consideration that today may appear simple and natural, but which is the result of continuous revisions and readjustments in philosophical and scientific speculation.

The concept of "object" is replaced by the concept of "system", i.e., the Aristotelian model in which the object is composed of only two parts "form/substance" and the Cartesian model, in which the object is reducible and decomposable, have been overcome to reach the concept of system understood as a "complex unit".

The system is a set of elements and relations between the elements that define its organization. If, however, a system such as a set is composed of several elements, the rules of composition won't be simply additive as in the case of a set, but relational.

In this regard, a system can be conceived as the product of the interrelations/interactions among the elements that constitute it, of the internal organization, of the conditions, of the conditionings, of the constraints of the environment of which it is part.

The variables that define the complexity of a system, can be identified in the number and quality of the component elements, in the type and in the degree of the relationships among the elements, in the number of hierarchical levels of the relationship structure (the organization).

In one of them the systemic concept simultaneously expresses unity and multiplicity, totality, diversity, organization and complexity.

However, there are still other considerations, directly dependent on the concept of complexity, on which philosophy, theoretical physics, but also disciplines such as ecology, economics and sociology, invite to confront themselves.

In this respect, it should be emphasized that the difficulty and in many cases the impossibility of interpreting the phenomena of reality and predicting their evolution over time have undermined the conception according to which it is possible to predict, with certainty, the future evolution of a system through the knowledge of its initial state.

The theory we are referring to is the deterministic one developed by Laplace in 1776; it is based on the second law of dynamics: F = ma which, for a long time, was considered a recipe for predicting the future. If the F forces, acting on an assigned mass m are known, also the acceleration a will be known. Starting from here it follows that if the position and velocity of an object can be known and measured at a given instant, they can be determined under any condition.

The scientific research of the twentieth century has questioned Laplace's determinism following a surprising discovery: deterministic systems, also very simple in their organization and consisting of a few elements, can manifest an uncertain behavior. Such randomness is an intrinsic quality of the system itself and does not depend on the type or quantity of information available.

The first to intuit the existence of randomness was the mathematician French Henri Poincaré (1908), who observed that fortuitous phenomena can occur in a system; the very small variation that they cause on the system in the present has enormous repercussions in the future.

"A very small cause that escapes our attention determines a considerable effect that we cannot fail to see, and so we say that the effect is due to chance. If we knew exactly the laws of nature and the situation of the universe in its initial state, we could predict exactly the situation of the same universe at a later time. But even

if it happened that the natural laws no longer had any secret for us, even then we could know the initial situation only approximately. If this allowed us to predict the next situation with the same approximation, we would not need more and we would have to say that the phenomenon was predicted, that it is governed by laws. But this is not always the case; it may happen that small differences in the initial conditions produce very large ones in the final phenomena. A small mistake in the former produces a huge error in the latter. Prediction becomes impossible and there is a fortuitous phenomenon".

This kind of randomness was given the name of "chaos" in later times.

One of the principles on which chaos theory is based is the principle of indetermination by Heisenberg, according to which "the exactness, by which classical concepts can be judiciously applied to the description of nature, is limited by the so-called relations of indeterminacy".

This principle, which has become a fundamental principle of quantum mechanics, provides a good explanation of some random phenomena at a very small atomic scale.

On a larger scale, the reasons for unpredictability must be sought in other fields; for example, in the random motion of fluids. In reality, it is not necessary to appeal to such complicated and indeterminate systems because the random behavior also occurs in very simple systems.

In general, it can be said that chaotic systems are very sensitive to small actions at every point of their becoming. In this sense, the degree of indeterminacy that a chaotic system can achieve is extremely high. In addition, any phenomenon, even very small, can very quickly reach macroscopic proportions. In other words, in the presence of chaos any prediction is destined to reach a huge inaccuracy.

The conceptual framework of reference for the study of chaos can be traced back to the theory of dynamical systems (Gargiulo & Papa, 1993). The definition of a dynamic system is given by the essential information about the system (the characteristics) and by the laws and criteria of evolution of the state over time (the dynamics). The space of existence of evolution is called the space of states or space of phases (Fig.1); such a space is a purely conceptual abstraction whose coordinates are the components of the state.

Of course, the coordinates of the phase space change with the context; for example, for a mechanical system they could be identified in position and speed, for an ecological system in the populations of the various species.

Even if it is recognized that the behavior of chaotic dynamical systems is unpredictable, the space of states can be useful to represent such behavior in geometric form.

With regard to the representation of chaos, it can be said that fractals represent the geometry of chaos.

The spatial correspondence between chaos and fractals is not accidental; as a matter of fact, an analogy between fractal geometry and chaos consists in the fact that in both fields the most recent discoveries have occurred as a result of scientific advances that have questioned the traditional view of mathematics. Fractals represent above all a language of geometry; they are expressed not by primary forms (straight line, circle, etc.) but through algorithms, i.e., through sets of mathematical procedures (Fig.2). These algorithms are then translated into geometric shapes by means of a computer.

At the current state of knowledge, therefore, chaos theory does not allow to give a solution to the problem of predicting the evolution of systems also because there are still many unknowns about the actual role and meaning of chaos. One measure for chaos is entropy.

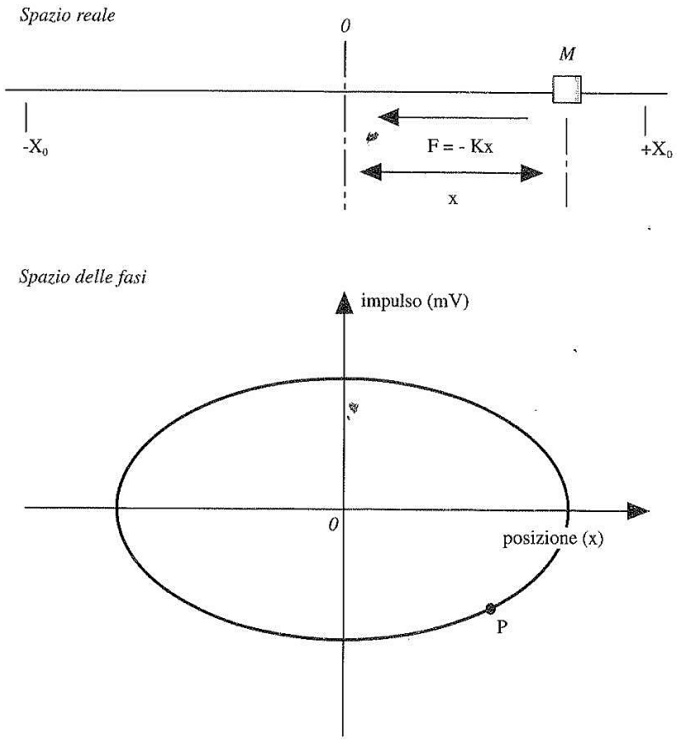



**Fig.1 The representation of real space and phase space (source: Vidal and Roux, 1981)**

*The concept of phase space can be illustrated quite simply in the case of the harmonic oscillator. The classical image of this oscillator consists of a body M of mass m moving along a straight line Ox constantly subject to a direct booster force towards an equilibrium position assumed as the origin. The intensity of this force is directly proportional to the distance OM = x. Under these conditions, the body M oscillates on one side and the other of O with a maximum elongation XO. At each instant t the state of the oscillator is completely defined by only two variables: the instantaneous x(t) position and velocity v(t) of the M body. Consequently, the corresponding phase space is a plane with the position and pulse coordinates: each state of the oscillator is associated with a point P of this plane. If the oscillator is at rest in the equilibrium position O, its state will be represented by the origin point of the coordinate system, since x = 0 and mv = 0. If the body oscillates freely from one side of O to the other, the representative point P will move in the plane generating a trajectory in the phase space. The trajectory shows that it is an ellipse with centre in the origin, as long as the oscillator is isolated and there is no friction. Thus a curve, i.e., a geometric entity, can provide a complete description of the oscillator's motion. The use of such a representation is of decisive interest when the system studied or its dynamics are relatively complex.*

The concept of entropy follows from the second law of thermodynamics; every time energy is transformed from one state into another, the available energy is reduced in favour of the unavailable energy. As Rifkin (1982) explains, the transformation of energy requires you to "pay a price". This cost is represented by a loss of energy available to perform work of a certain type in the future. The term that describes this fact is entropy. An increase in entropy, therefore means a decrease in available energy.

When energy and matter become unavailable, we come to the greatest possible disorder and therefore chaos. The second law of thermodynamics refers both to energy and to the order and above all to the organization of systems; in this respect this principle applied to a physical system is defined as a statistical principle of energy degradation, disorder of the constituent elements and therefore of disorganization.

Thus, the centrality of organization as an intrinsic quality of complex systems strongly emerges.

Organization means the form, distribution and intensity of the relationships between the components that a complex unit or system produces. Ultimately, the ability to organize is one of the fundamental properties of a system and can be expressed as the transformation of relational interactions into an organization.

The organization thus becomes the constituent property of a system.

The variety and multiplicity of existing systems makes it possible to build a hierarchy and categorization of systems.

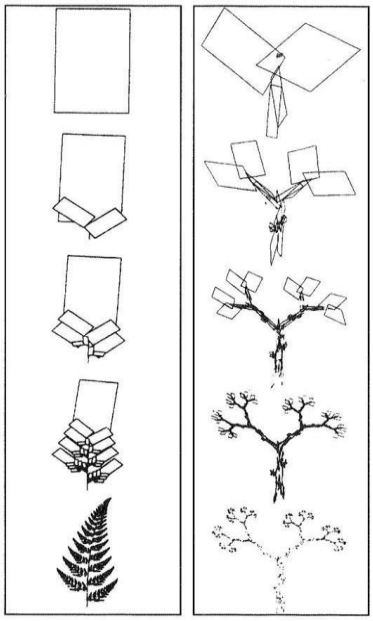


**Fig.2 The generation of fractal images (source: Jurgens, Peitgen and Saupe, 1990)**

*Simple examples of fractal images can be generated from the feedback ring of the photocopier machine; such images depend only on your copying program. The initial rectangle is transformed by a program that halves the size of an image and copies it three times until a fern fractal (left) or fractal tree (right) is obtained. A few numbers defining the copying rules are enough to specify an image that would require hundreds of thousands of numbers to be described with traditional methods.*

Five different figures of organization are thus identified:

- system;
- subsystem;
- supersystem;
- ecosystem;
- metasystem.

if system is meant as that autonomous system in relation to what is external to it; a subsystem is a system subordinate to a system of which it is a part; for supersystem, a system that controls other systems that are not included in this; by ecosystem, the systemic set of which interrelations and interactions constitute the environment of the systems that are part of it and finally for Meta system, the system that results from the interrelationships that transform and come to understand two previously independent systems (Morin, 1983). The determination of the hierarchical level of a system depends, substantially, on the choices, selections and decisions of the observer, by whom the very conceptualization of a system ultimately depends.

In other terms, in the definition of a system there are always, at the base, decisions and choices of a subject, who operates within the polysystemic selections in relation to its own purposes, the available tools and in relation to the cultural and social context.

It should be emphasized that the chaos theory produces degrees of complexity even within the scientific method of verifying a theory; until now, the method of verifying a theory has consisted in making predictions and, subsequently, comparing them with experimental data. For chaotic systems, the circumstance of the impossibility of predictions means that the verification of a theory becomes difficult and full of pitfalls, which refers to statistical and geometric properties rather than detailed and punctual predictions.

Among the infinite systems in which physical reality can be articulated there is the city, which is attributable to a dynamic system of high complexity.

As mentioned before, giving such a definition of the city means affirming, firstly, that the city is attributable to a set of components related to each other (system) and, moreover, that the future evolution of the city-

system is not linearly predictable on the basis of the knowledge of the initial conditions and that the processes of the system are not manageable and controllable through deterministic tools.
The degree of complexity reached by the city and, in particular, by the metropolitan conurbations is such that, at present, the decision-makers and administrators are unable to provide a compatible and adequate solution to the management and government problems that a system such as that urban poses as it is also subjected to the processes of maximization of entropy.
Until a few decades ago the city managed to develop while maintaining harmony and compatibility between its parts; today the occurrence, on the urban structure, of extremely variable and changing events, difficult to trace back to only one cause, but almost always the result of causes that are difficult to read and the inability to control and manage these phenomena, also due to the inadequacy of the adopted procedures and the means available, is determining unbearable conditions of hardship and congestion.
It is also worth to add the contribution of the introduction of new technologies that, involving all levels and sectors of associated life, produce effects whose peculiar characteristics are both of a cumulative type and of an effusive type (Gargiulo, 1990).
Such characteristics, encouraging the acceleration of the growth process of the sectors that they invest, generate new progress and new knowledge. Thanks to these characteristics so distinctly self-propelling, the ability to affirm and spread technological progress goes beyond the narrow limits of productive economic activities, for which, in most cases, it finds inspiration and stimulus, coming to profoundly affect the social, political and of course territorial aspects.
From the above, it can be understood how the multiplicity, the multiformity and the variety of existing relationships, in a word the complexity, within the society-city system requires adequate methods of reading and analysis and innovative control and management tools and techniques.
In this perspective, the role of the "paradigm of complexity" in the resolution of urban and metropolitan problems becomes the challenge on which to focus for 21st century city. Through this paradigm of the 21st century city will be the city where, through the right interpretation (reading and analysis) of the complex phenomena that are affecting the city, it is necessary to define procedures, techniques and adequate tools to restore well-being, livability and quality of life to the users of the 21st century city.

## 2.2 The city as a system with a strong complexity

The enormous growth of the city and its high degree of hardship, the uneasiness of its users and the degradation that is not only physical, but also and above all social, are phenomena that have undergone an increasing acceleration over the last decades.
It is interesting in this regard to recall how, already at the end of the 30s, Mumford (1938), taking up a well-known diagram by Geddes, would have prophesied the end of the metropolis if the trends towards uncontrolled urbanization had continued.
This interpretative key, actually, rather widespread, which provided for a "global urbanization" of the city and therefore its inevitable decline has been, partially, contradicted by the slowdown in the growth of the city in the last decade, so that, assuming as an interpretative key that of the "cycles of urban life", it has been affirmed by many parties that the large cities of the industrialized world are going through a phase of deurbanization or counter-urbanization that manifests itself precisely with phenomena such as the arrest if not even the loss of population (Martinotti, 1990).
Once again the image that this interpretation of urban growth gives us is that of "urban crisis" and "death of the city" even if this seems to be in clear contradiction with the phenomena of congestion, pollution, hardship but also, at the same time, with the strong, creative and innovative prospective — what has been defined as city effect (Conti & Spriano, 1989) — which seem to characterize some of the great cities of the West.

The speed of the processes of transformation that characterize the metropolis, the coexistence of apparently contradictory phenomena, the ever-increasing diffusion of the products of technology that – to recall only one of the effects induced on the "urban shape" by telematics and computer science – modify the localization logics of activities and contribute to make it increasingly difficult to read and interpret urban phenomena (Papa, 1993).

In the world of scientific research, the affirmation that the city as a "system" defined by the elements (the different activities and functions) and by the interactions and relationships between its multiple components (communications and channels) that are expressed on its territory and that produce, with different intensities and methods effects difficult to detect on all parts of the city, has been shared for a long time. (Me Loughlin, 1973).

Starting from this "position", accepted and shared by those who study and are interested in the city as a whole, various methodological and operational approaches have been developed.

There is no doubt that, at least in the initial approach, the study of urban phenomena causes many situations of discomfort caused both by the difficulty of univocally adopting one of the approaches developed, and by the complexity of the phenomena that manifest themselves in the city.

Among the scientific paradigms currently available to interpret the variety and interdependence of urban phenomena, the paradigm of complexity seems to offer the greatest guarantees of relevance and relationship.

The city can be interpreted not only as a "physical phenomenon" (its shape, its streets, its building) but also as a "functional phenomenon" (the relationships that exist between its components and the laws that regulate these relations, and therefore the life itself and the development of the city) (Papa, 1992).

In relation to this reading, the scientific approach of reference for the study of a metropolitan system is the systemic-processual one oriented to the definition of the reciprocal influences between the elements of the system and between the system and its components.

This approach can be traced back to the theory of catastrophes by Thom and to the philosophy of heterogeneity by Morin that considers the city system as a structure whose state is continuously modified by the contribution of energy (stresses) that it receives from the outside and that consumes incessantly. Its equilibrium state is only apparent since, actually, it turns out to be stationary or dynamically stable; the city, i.e., is a system characterized by an inextricable complementarity between "disordered phenomena" and "organizing phenomena", which self-regulate a subsequent state of equilibrium.

To govern such a system, it is necessary in the first instance, to know its whole structure; it is necessary to know what the parts of the system are and how they interact; in other words, to know the elements and laws that regulate its integration, without which (elements, laws and integration) one could not even think of a system.

In actual fact, the essential characteristic that allows the existence of any generic system is what Edgar Morin (1983) defines as "organizational antagonism". Every organizational interrelationship presupposes the existence and play of attractions, affinities, possibilities of connections or communications among the elements. But the preservation of differences presupposes in the same way the existence of forces of exclusion, repulsion, dissociation, without which everything would be confused and no system would be conceivable.

In other terms, every system and, above all, the urban system, produces internally both antagonism and complementarity; to govern a system it is therefore necessary to know the rules (if there are any) with which antagonisms and complementarities are organized.

Before Morin, also von Bertalanffy (1968) had stated that every totality is based on the competition between its elements and presupposes the struggle between its parts. We cannot speak, therefore, about a system without presupposing the idea of antagonism; but such an idea carries as an implicit and direct consequence the potential disorganization or disorder. As a matter of fact, the moment when the system goes into crisis,

disorder spreads. The system goes into crisis when differences turn into oppositions and complementarities into antagonisms.

In other words, it is necessary to know the elements of a metropolitan system and the laws that rule its mutual relations to identify the several dysfunctions and the various internal anomalies.

To better clarify the terms of the issue, it is appropriate to briefly recall the type of approach, we are proposing to be adopt: the systemic-functional conception of the city.

This conception leads directly to the general theory of systems, which, applied to the urban phenomenon, allows the construction of a model of investigation useful for the interpretation and decoding of urban complexity. In this respect, at the reading and analysis of the city-system it is necessary to combine the characteristics of the individual parts of a system with the characteristics of the entire system, trying to find the interrelationship that links the single parts to the whole and vice versa.

The circuit on which the passage from the parts to the whole is triggered and from this back to the parts is of a polyrelational type as the elements must be in their characters, in the relationships in which they take part, in the entire organization in which they exist and ultimately in that particular "culture medium" in which they are inserted (that particular system); vice versa the system must be defined in its distinctive features, in the relationships existing between its elements and in its relations with each of its elements. Continuing down this scientific approach and from the observation of the urban system, it can be said that the city and in particular a metropolitan area is certainly a dynamically complex system.

On the basis of the considerations expressed above and from the theory of dynamical systems it is deduced that the evolution of the city cannot be linearly predicted on the basis of current conditions (Bertuglia & La Bella, 1991). Saying, therefore, that a city is a dynamically complex system means to say that this system is defined, in addition to its own characteristics, by laws and criteria of evolution of the state that change over time.

The dynamic complexity that characterizes the city depends essentially on three main variables:

- the levels of hierarchy;
- the type and quality of the relationship;
- the number of elements.

The various levels of hierarchy allow us to read the urban structure according to various points of view. From the functional-antagonistic point of view, for example, there is a hierarchy within the city that can be traced back to the centre/periphery antagonism.

The type and quality of the possible relationship paths refer to the interconnection between the various elements of the system and depend on the ability to know the effects that each action performed even on a single part of the system can generate on one or more different parts and on the other relationships.

A function of complexity can be expressed as follows:

$$C = f(l_g, r_t, e_n)$$

where $l_g$= hierarchical levels

$r_t$= types and quality of relationships

$e_n$= number of elements.

The invariants of urban complexity that distinguishes the modern city and, above all, that of technologically advanced countries can be traced back to particular phenomena that spread with increasing intensity and that mark the difference between the organization of the current city and that of the city of the past. These phenomena refer specifically to three conditions connoting the current city:

- concentration;
- specialization;
- integration.

The first condition refers to the high physical concentration of urban and metropolitan activities. The second one refers to the increasing specialization of urban and metropolitan activities that can also be read as a direct consequence of the high concentration. The first two conditions require, consequently, the strong functional integration between activities and groups of activities.

The concentration, specialization and integration of activities produce such synergies in the urban and metropolitan system as to connoting the city as the place of complexity because complex is the system of relationships and activities and, therefore, the organization of the city.

A first response, in a methodological key, to the growing and dynamic urban complexity must be oriented mainly towards three methodological objectives:

- redefining the cognitive paradigms of urban phenomena;
- reconfiguring the techniques and methods of interpreting these phenomena;
- adapt the instruments and techniques of governance to the variety and complexity of the systems to be governed.

In an operational key, the considerations carried out push to define the levels of "treatability" of the system to be controlled and to adapt the availability and degree of sophistication of the control tools at these levels; secondly, to adapt the reading and knowledge of the urban system to the levels of operation of the instruments of government and thirdly to diversify the instruments of government at the level of the complexity of the system to be governed.

In the definition of this new and articulated methodological context of reference, a role that is certainly not marginal is played by the potential that the use of new technologies can develop, both in an instrumental key in terms of aids to knowledge, interpretation, and control of the urban system, but also in terms of rebalancing factor in defining the territorial structures and hierarchies of the next future (Beguinot, 1989).

In the perspective oriented to the "refinement" of the interpretative paradigms of the urban reality in view of the adaptation to the growing complexity, it is necessary to articulate the city in a plurality of subsystems constituting the "city-system".

Favoring the definition of the city as the maximum expression of the community to configure and organize the space, that is, considering the physical-formal characteristics of the city, the physical subsystem (the stone city) is defined; if the city is understood as the place of the maximum functional and relational concentration, that is, if urban activities and the relationships between them are taken into account, the functional subsystem (the city of relationships) will be defined; if, finally, the city is defined as a "semantic space", i.e., the way in which the inhabitants perceive and live their own habitat is preferred, the perceptive-semantic subsystem (the city of experience) will be defined.

Three subsystems that refer to three cities, therefore: a "city of stone" which constitutes the physical city, a "city of relationship" which constitutes the functional city and a "city of man" as a synthesis of the psycho-perceptive relationship between man and his own habitat. The three cities (Beguinot & Cardarelli, 1992) have always "coexisted" in the same space and at the same time. If the first constitutes the premise and the condition for the life of the second, the latter animates the first one that otherwise would be reduced to a useless succession of full and empty ili deprived of life, the third one is finally the image of the city that everyone has within himself, the result of the complex and changing relationship that is established between the individual, stone city and relationship city.

The factors affecting the development or obsolescence of each of the three cities are profoundly different; that is the reason why only in periods of great stability, the city, in its wholeness, experienced periods of prosperity and harmony; vice versa, in periods of great transformation — social, political, economic and cultural — the city experienced seasons of profound crisis, even structural, which even questioned its existence.

Assuming this key of interpretation, as it is defined in more detail in the following, the development or the current crisis of the city can be interpreted as the greater or lesser adaptability of the physical city to the

functional city, thus guaranteeing the complex system of relationships, increasingly numerous, to express itself without this intensification of exchanges translating into an increase in entropy, with effects of chaos and congestion that are difficult to control.

The current city, for its complexity and for the continuous transformation of the man-city relationship, needs the recovery of the correct use of space that is constantly altered to try to adapt to the multiplicity of functions and activities that the modern city must perform.

In other words, it could be said that in periods of great and rapid transformations, such as the current one, characterized by the growing introduction of new technologies that make possible ways and times of communication very different from the past, the stone city, which has a greater inertia to change than the city of relationships, cannot keep up with the functional city.

The different speeds of evolution of the three cities are therefore among the causes of its crisis and the discomfort of its inhabitants: in the modern city the stone city not only does not favor the life of the functional city, but even constitutes one of the major obstacles to its correct development; man is no longer able to recognize the city and above all to know himself within it.

To overcome this situation, it is necessary to relaunch a policy of transformation of our cities to adapt them to the changed needs of the community through operations of great cultural scope, before technical-operational. But to do this it is essential to develop a new and different philosophy of approach to the city, the one, proposed here, which refers to the theory of dynamical and complex systems. With the support of this it is necessary to analyze the urban and metropolitan problems in the light of the changes taking place triggered by social, economic but above all technical-scientific progress, which new technologies direct and feed.

The condition of chaos that seems to be a constant of the modern city naturally affects all "the three cities in the city".

In the city of stone, the demands for performance become more and more intense and sophisticated, as required by post-industrial society.

In the city of relationships, the number and intensity of relationships increase incessantly to the point of making it impossible the comprehension of its complexity. To try to solve this situation that, over time, becomes increasingly unsustainable, it is necessary and urgent to develop new techniques and new tools for urban and metropolitan government, management and control.

In the lived city the references and connotations of the cities of the past have been lost: the loss of historical memory, the lack of traditional references valid for the entire community, the jumble of ways of doing, living and transforming the city creates growing uncertainty and insecurity in the urban population.

In an attempt to govern the growing complexity, due to the changes taking place in the city system and the speed with which they are proposed, it is necessary to adopt techniques and tools that must refer to the correct use of new technologies, to the processes of neofunctionalization of the main urban functions, to the careful management of non-renewable resources.

## 2.3 The crisis of the city as a crisis of complexity

The multiple definitions of the city that have followed one another over time have always highlighted its central role in the processes of development of the territory. The “city as the maximum intensification of human intervention in space” (CRESME, 1991), the city as the highest concentration of functions and activities, the city as a "vital nucleus", a territorial reference pole, capable of activating flows of goods, people and information and expression of a strong creative and innovative potential (Conti & Spriano, 1990).

Nevertheless, the transformations and phenomena that characterize metropolitan areas have profoundly questioned the very principles of the city, so much so that numerous scholars of various disciplines agree in diagnosing the "crisis" of the major urban systems in the world.

In this respect, it seems appropriate drawing attention to the dual meaning that the expression "crisis of the city" is assigned by scholars and researchers of urban phenomena.
As a matter of fact, if someone means by crisis of the city the obsolescence of the urban and metropolitan settlement form (the cities as a concentration of activities) for the negative externalities that it proposes with growing rhythms, someone else will mean by urban crisis the instability of the city as an organized system that cannot find a compatible rationalization of activities and functions.
According to the writers, if there are different forms and contents of the crisis of the city of this end of the millennium, the causes will be identified univocally in the crisis of the idea of the city as an organized system that fails in giving suitable answers to the different requests of its users. If the growing complexity seems to be configured as the greatest entropic agent of the urban organization, it must be solved through techniques, tools and models of government capable of recomposing the diversification and specialization of the city.
There are numerous interpretative schemes developed trying to identify the reasons for the crisis of cities, as a way of organizing collective life, and to predict metropolitan dynamics in order to propose adequate intervention policies.
Some scholars relate the phenomena of reduction of the urban population, the increase in unemployment, the replacement of functions within the historic centers — characteristic of a phase of metropolitan decline with the deep economic crisis that affected the mature territorial systems during the 70s.
This crisis, that hit the large industry of the mature sectors (think for example of the crisis in the steel sector and its repercussions on centers such as Liverpool, Birmingham and Manchester), profoundly questions the rules of growth of the Fordist metropolis dictated by the needs of the large, mechanized factory (Camagni & Gibelli, 1992). But since the beginning of the 80s, industrial activities have been replaced by activities related to services, information, the development of information technology, the so-called tertiary sector that reached its maximum development, in terms of employees, during these years.
In this perspective, the crisis of the city can be interpreted as a "transition crisis". In the transition from the industrial society to the "information society" the city becomes more and more a space of flows; the loss of the traditional functions that had determined the growth of the city — which has as a tangible sign the presence of large "voids" in the urban fabrics has as a reflection, at first, the loss of identity of the city itself, triggering processes of degradation of large peripheral bands.
In other words, it could be said that the contradictory phenomena that characterize the great Western cities can be attributed to the simultaneous presence of two "models" of cities, the result of different economic systems that determine different criteria for the spatial location of activities. On one hand, the Fordist metropolis characterized by high building densities, functional obsolescence and infrastructure networks, the growth of the suburbs, a low environmental quality that now shows the tangible signs of its "collapse"; on the other hand, the "meta-industrial" metropolis characterized by non-polluting high-tech productions, a high offer of qualified services, a greater functional heterogeneity, a high environmental quality, which still, in most cases, has not managed to establish itself.
Another interpretation of metropolitan decline refers to the five principles of economic and spatial organization of the city: the principle of agglomeration (or synergy); the principle of accessibility (or spatial competition); the principle of interaction (or demand for mobility); the principle of hierarchy (or the order of cities); the principle of competitiveness (or export base) (Camagni, 1991).
Many of the problems that today affect cities can be related to the crisis of these principles (Bellotti & Cario, 1991). As a matter of fact, the high cost of land, on one hand, and the problems related to congestion such as traffic, degradation, pollution, do not make it more "convenient" to locate activities within the city, deeply questioning the principle of agglomeration. In this context, accessibility within cities is becoming less and less competitive, as is the location of those productive functions that qualify and specialize the role of the city. The only principle that still applies is that of the external competitiveness of cities, since despite everything they

still represent the places where they are present to a greater extent and higher quality, technical progress and innovative capabilities.

The crisis of the city as an organized structure refers to the growing hardship of the cities, to the discomfort of its users, to the degradation, which is not only physical but also and above all social — just to mention some of the macroscopic effects of this crisis — which seem to have become the structural invariants that characterize big cities.

What clearly emerges is that, beyond the interpretative models that are adopted today we are witnessing the "collapse" of the city, the jamming of the mechanism of operation, determined by the affirmation of complex phenomena that make it necessary to refine the techniques of analysis and knowledge, but above all of the tools and techniques of government of metropolitan areas.

An advance in this sense can be represented by the systemic analytical approach that starts from the affirmation of the city as a place of complexity. By adopting this interpretative model, most of the phenomena that have recently established themselves in modern metropolises can be explained, what we could define as the structural components of the crisis which are:

- congestion;
- environmental degradation;
- forced mobility;
- urban insecurity;
- ungovernability.

The reasons for these effects are not easily identifiable and the use of the systemic approach may be useful for this purpose. This, as we have seen, makes it possible to break down the city system into three subsystems: the stone city – namely the physical city –; the city of relations – that is, the functional city –; the psycho-perceptual city – i.e., the city of man.

Among the reasons that have greater relevance in determining the collapse of urban systems is the different speed of evolution of these three subsystems. Actually, while the ways of working, of using one's free time, of enjoying the different urban functions rapidly evolve, while the way of "using" and living the city changes, the physical spaces and the canals (the stone city) are transforming very slowly. The crisis of the city, in this perspective, can be interpreted as the poor adaptation of the stone city to the city of relationships.

The inertia to the change of the physical system depends on the characteristics of the urban system such as the history of the city, the physical amplitude, the demographic dynamics; but also some generalizable factors such as the scarce availability of economic resources destined for large urban transformations or the decision-making inability that slows down any attempt to adapt the physical city, as well as the lack of a guiding idea that can coagulate different forces on a strong project of rebirth and revitalization of the city.

On the other hand, the functional city, as a result of the evolution of ways of life, also induced by new technologies, is rapidly transformed. Cultural models and production processes are changing, indeed, the amount of information available is increasing and a new way of man to relate to the outside world is defining. At the same time, the city of man is no longer the "closed" urban space of the medieval city, nor the "urban field" of the city of 900, thus becoming a "metropolitan field". The expansion of the city like wildfire breaks the dialectical link between city and non-city, between center and context; the symbolic value and the semantic structure of the city are lost and man is no longer able to carve out "islands of meaning" that give him the perception of his habitat.

In other words, the city of relationships finds an obstacle to its rapid evolution in the rigidity of the physical system; man, in a society of increasing complexity, cannot recognize the city and above all to recognize himself within it.

Actually, if the different speed of evolution of the three subsystems can be identified among the main reasons for the crisis, the one that allows to explain, in a systemic perspective, the complexity of the phenomena in

progress, it will be possible to identify a series of "metacauses" resulting, most of the time, of incorrect models of development of the city.

Consider, for example, the adoption of the "additive policy" that not only favored the expansion of the city "like wildfire", but contributed to the rapid obsolescence of the existing building heritage.

By adopting this model of development, in fact, every free space within the urban centres was occupied and when this was no longer possible, the city grew in the outermost bands, giving rise to the "monstrous" suburbs, real pockets of social and urban degradation.

The incorrect distribution of functions (localized irrationality) within the city has perhaps produced even more serious consequences. The lack of control over the locations and intensity of use of the functions resulted in the strong inhomogeneity, in terms of functional potential, of the various parts that make up the city. Suffice it to recall, for example, the phenomenon of functional specialization of historic centres, which in many Italian cities have become the privileged seat of tertiary activities.

In this way it has affected the functional articulation of the cities obtaining "pieces of the city" that do not have autonomy, because contrary to the consolidated city they are characterized by monofunctionality (think for example of the urban suburbs that have become the dormitory neighborhoods for the social groups expelled from the historic centers; but also to the central districts intended for offices, used in a differentiated way at different times of the day).

In addition, the concentration, specialization of the activities and the increasing number of relationships between them, produce increasing levels of demand for displacement within urban areas. This is in particular that share of mobility that we can define as "forced", that is, not freely chosen, but rather determined by the bad organization of the "city system".

Once again, as the demand for mobility increased, it was decided to find a solution by adopting an additive logic, that is, by creating new channels and infrastructures, rather than operating upstream with interventions aimed at "governing" the demand for displacement, acting above all on the distribution of functions, which were mentioned above.

This consideration brings back to the central question, to the "knot" from which one cannot ignore if one intends to address the issue of the revitalization of metropolitan areas, that is, the poor capacity for government and control of the metropolitan system.

To the "challenge of complexity" that pose, as we have seen, urban and metropolitan systems, it is increasingly necessary to give answers in terms of timely and correct decision-making capacity on the part of the institutions.

This will result in "producing decisions" for the selection of those services and those "strategic" activities able to specialize the city by assigning them a role within the "networks of cities" that now go beyond national borders. It is known, in fact, how large cities are now in competition with each other and in this sense the efficiency of the metropolitan government is also measured in relation to the policies activated to address functional obsolescence, enhancing the culture and vocations of specific realities.

But it will also be necessary to restore value to the planning activity of the public decision-maker, identifying procedures, tools and techniques able to guide all the phases of the process of choice and implementation of interventions: from that of promotion, to design, implementation and management.

The plan, according to this philosophy of approach, is no longer conceived as the design of the expanding city, which rigidly divides the territory into homogeneous areas, but rather one or more instruments of government through which to define the urban and metropolitan functions to be developed, the permissible intensities of use, the priority interventions to be activated, the role of operators (whether public or private), etc.

## 3. City government as a government of complexity

In this section of the work, the issue of city government as the government of complex, dynamic systems in structural crisis has been faced.

In the previous pages we have tried to define the scientific and cultural context in which the research path that is intended to develop in this study moves and the reasons for the deep crisis of the city as a place of maximum concentration of human activities, the objective of the following pages is instead to develop a proposal for a method that, using the assumptions of scientific nature and exploring the reasons for the urban crisis, allows to define tools and operational techniques for the government of the city and the metropolis of the next century. In other terms, having formulated the type of approach that is intended to be followed in solving the problem - describing in consistently rigorous terms the premises and scientific references - and identified the structural reasons for the decline of the city as a privileged place for human life, in this section it is intended to apply to the city and to the metropolis the cognitive paradigm that refers to the theory of systems and consider the city and the metropolitan conurbations as complex units that therefore must be read, analyzed, planned and managed with the techniques and means of control and governance of complex systems. What are the objectives to be pursued in defining a method of governing a complex system (the city) whose active subjects (the inhabitants) must freely participate in decisions on the trajectories of the system? The city, for its complexity and for the transformation of the man-city relationship, must recover within itself the correct use of space that has been deteriorating to keep up with the countless functions that the modern city is required to perform.

Cities of stone, cities of relationships and cities as a space of sense must find a renewed balance that allows man to live in the best possible (environmental) conditions, those that his work and his intelligence allow him and that today find an unsurmountable obstacle in the ways of thinking, living and managing the contemporary city. It is necessary going back to a correct use of the city that finds its natural premise in the reuse of space after having properly recovered it. To recover and reuse the urban space it is necessary to abandon the culture of addition and make a different culture one's own: the culture of the government of transformations that aims to make optimal use of what is there and that today appears chaotic and deficient only because it is insufficiently organized.

Therefore, an objective seems to be indubitable: the city government must be oriented to the recovery and therefore to the reuse of the city, but in the course of recent urban history the recovery interventions, meant as an attempt to regain the city to man and to give it the lost values of liveability back, have generated operations that have profoundly affected the physical dimension neglecting the intervention on the functional and relational structure of the same.

It is possible, in support of this thesis, to identify in the recent history of the city a succession of rehabilitation interventions ranging from nineteenth-century gutting, dear to Hausman, to the subsequent turn-of-the-century thinning, to the restoration and urban restructuring operations, to reach the most recent recovery operations for reuse. In this evolution it is possible to observe how in the early stages the intervention was operated directly and exclusively on the physical city and how, with the passage of time, we are getting closer and closer to the idea of intervening also on a functional and relational level (recovery for reuse) that defines ways and intensity of use inside the city. Each of these interventions had as its objective the attempt to give a respond to the renewed needs and to the growing needs of the urban population.

These last few years - characterized by a growing crisis of the cities such as identity crisis, role crisis, but above all crisis of complexity and therefore of maximization of entropy - have seen, especially in the cities of our country, a widespread stagnation in the interventions on the city.

It is necessary to relaunch a policy of government of cities and metropolitan areas to adapt them to the changed needs of the community through operations of great cultural breath, before being technical-operational. To do this it is essential to develop a new and different philosophy of approach to the city that

analyses the problems in the light of the changes taking place triggered by social, economic but above all technical-scientific progress, which new technologies seem to direct and feed.
Man, therefore, transforms, uses and perceives the city depending on whether he places himself with respect to it as an actor, as a user or as an interpreter of change.
To bring the growing complexity of urban problems back to the dimension of man and his ability to solve them, we must necessarily proceed to a simplification of complexity.
The tools to pursue this goal must refer to the correct use of new technologies, to processes of re-functionalization of the main urban functions, to a careful management of non-renewable resources.
To define the policies of revitalization of the contemporary city, which must necessarily move from the intent of simplifying problems and reducing complexity, we must consider the new changes taking place in the city system and the speed through which they are proposed.
Speed could therefore be configured as the element that more than others contributes to the degradation of collective life and urban life in particular: speed of evolution of phenomena - economic and cultural - and therefore social change in a broad sense, but also physical speed of movement of people, things and information, speed of transfer of ideas and cultures, speed of learning and training of the new generations and therefore instantaneity and spatial indifference as a product of the replacement of spatial proximity with computer proximity.
Technological innovation and the new way of communicating that it allows us, and above all will allow us, can be a sure prerequisite for a different way of being and thinking and therefore of living in the city. In this way the relational city seems to expand without boundaries beyond the physical city allowing everyone to get in touch with the rest of the world without moving his body and it is to this city that the task of responding to our work needs will be entrusted.
A collective effort is needed that leads to the definition of an overall plan that combines the use of information with the correct use of space aiming at the revitalization of the city, a project that defines the ways and intensities of immaterial relationships and configures the recovery, oriented to reuse, of the spaces of the physical system.
Eventually, if the common goal is a city in which the functional space is dilated to the maximum to allow all the necessary exchanges and relationships and the physical space regains the harmony and certainty of the city of man, then everyone will be called to the maximum effort, cultural before technical, to realize the 21st century city.
To do this it is necessary to adapt not only the cultural models with which we look at the city but also the tools and techniques for its control. The city can no longer be considered as a mechanism, the city is something much more articulated, varied and diverse, in a word complex, and to manage such complexity it is necessary to radically review the ways, tools and procedures of city management.
The city, therefore, is not a machine, it is thus not a deterministic system in which, given the starting conditions, it is possible to define, with certainty and reliability, not only the future states but also the times in which these states will be realized. Instead, it presents itself as a complex non-deterministic system in which the desired states (intentions) are known but it is not possible to define with certainty possible paths to reach them keeping in mind only the starting conditions. In other words, once known the initial conditions and the laws of relationship between the individual phenomena, if in a closed system temperature pressure it is possible to define the value of the temperature of a gas as the pressure changes, in the city but also in an infinitely less articulated and complex system won't be possible to deterministically link a cause to an effect but these are linked by three distinct phenomena of relationship. In fact, a deterministic causality can be identified: every time a cause A is produced, a B effect necessarily follows; a probabilistic causality: every time a cause A is produced there is a definite probability that the effect B will occur, and finally a correlation between cause

and effect: the event (cause) A is significantly combined with the event (effect) B but it is not possible to define any reliable link between the two phenomena.

The city, therefore, as a place of complexity where the variety of the system itself (the city) are added two elements of extreme interest that however contribute decisively to expand the vastness of the problem. This refers to the complexity of the decision-making system (who decides and what they can decide on) and the complexity of the decision-making mechanisms (hierarchical decision trees, timing, responsibility, interests, etc.). The first circumstance constitutes an indispensable attribute of economic and social organizations oriented to the plurality of powers and their mutual control, - the second is closely connected to the first and grows due to the complexity of the system to be controlled and the degree of interconnection with other systems. Given the possible strategies to govern the complexity of the urban system, whether with the expression urban system we mean to define not only the city and its complex becoming, but also the complexity of the system of decision-makers who define the compatible states of the city and the tools to achieve them and the complexity of the decision-making systems that obviously refer not only to the public decision-maker but also to all those social subjects who contribute, with their choices, to define, in a decisive way, one or more future states of the city.

Upon a thorough analysis, three distinct lines of action can be identified.

The first one must be oriented to update, in the light of the possibilities that science and technology make available, the reading techniques and the cognitive tools of the urban phenomenon.

The second one must have as its objective the redefinition of the interpretative paradigms of the urban phenomenon. Just think of the Copernican revolution that takes place if we look at the city no longer as a machine but as a complex non-deterministic system.

The third line of action must have as its priority objective the definition of new instruments and renewed techniques of city governance. And this is due not only to the updating of reading and analysis techniques but also to the new interpretative models of the city. As a matter of fact, if the urban system is connoted by its complexity, it is necessary that the tools and techniques of governance of this complexity are no longer static projection tools (the regulatory plans provided for by urban planning legislation) or cumbersome and very slow formal and bureaucratic control techniques (the technique of the municipal building permit applies to all) but adapt - for quality of content, speed of procedure and control capability - to the dynamism and variety of the city. In addition, if deterministic phenomena follow the most probable trend, i.e., they develop in the direction that has the highest possibility of occurring, complex systems, as subjected to actions to achieve one or more desired states, must necessarily follow an unlikely trend.

Finally, from the entropic aspect, it should be emphasized that deterministic systems as subject to predominantly spontaneous evolutions proceed in the direction of an increase in entropy, while complex non-deterministic systems as they are subjected to non-spontaneous but voluntary evolutions necessarily produce anti-entropic phenomena.

In this direction, a decisive contribution can come from the analysis of the techniques developed in cybernetics that precisely studies the management of voluntary actions.

In a technique related to the management of voluntary actions, unlike what happens in deterministic systems in which known the causes agents can theoretically be defined the future of the system itself, it is known what you want (the state or future states) and it is a matter of forcing the system in the direction of the desired state, but to do this it is necessary to prepare the causes so that the phenomena that intervene take place in the convergent way towards the desired result.

In a procedure for the management of voluntary actions, some connoting features can be distinguished, which must therefore constitute a constant reference in the development of a new and effective model of city management. The elements of greatest interest are:

- a continuous adaptation of the causes and therefore of the conditions of the system to the current situation in relation to the objectives set;
- a continuous comparison between result and intention to govern the processes of change, preparing the causes so that they direct the system in the desired direction;
- the conveyance of massive information flows between the various elements of the system as the main anti-anthropogenic factor;
- the preparation of an adequate number of control variables which, due to their characteristics and number, can be considered compatible with the quantities to be controlled.

Beyond the necessarily schematic and therefore not immediately understandable formulation, at a second reading, the principles listed above are nothing more than the rules of behaviour that every thinking being follows when facing any vital action.

In all vital actions, in fact, from the simplest to the most complex, it is possible to recognize a continuous comparison of the result with the intentions according to a cyclic scheme in which the partial result achieved is continuously reported (information flows) to the intention, compared (through control variables) with it and based on the measured deviations a subsequent action strategy is defined.

This feedback procedure (return of the response) constitutes an essential requirement of cybernetic logic, just as the fluid that circulates in the return cycle is the information, whether it consists of orders given by the centre (government actions) or data returned from the exit to make the comparison of the result with the intention. Information is precisely the anti-anthropogenic agent that distinguishes cybernetic phenomena from deterministic phenomena, in fact it allows you to choose an action rather than another not on the basis of its greater probability but on the basis of the preferential function that the intention has attributed to it.

From the comparison between the current instrumentation and the necessary models of city government as a system (subjected to voluntary actions), some of the nodes that reduce, in the current phase, the management of the city to a substantial immobility that accelerates the crisis and is among the causes of urban decline are highlighted. In fact, the profound inadequacy of the current instrumentation for the cybernetic control of a complex system (which is precisely the city) emerges, and this due to the absolute prevalence of the static action of forecasting (urban plans) of the future compared to the dynamic activity of government (step by step) of the constantly evolving system.

Therefore, the city must be read, analysed, managed and governed as a dynamically complex system using the techniques and tools that scientific research and new technologies make available to actors and especially to urban decision-makers. The city system, however, can be articulated in a plurality of subsystems because there are several sub-cities that, sharing spatially and temporally the same experience, contribute to forming the city. In the previous paragraphs it was proposed an articulation of the city in three subsystems, for each of them it is necessary to develop a method of analysis, an instrument of intervention and a model of government. They may be traced back to:

- a stone city that represents the physical subsystem, a sort of urban hardware consisting of everything that is matter, from houses to parks, from sewers to streets;
- a city of relationships that represents the relational subsystem, the software of the city, everything that is immaterial and that makes a set of houses and things a living and vital city;
- a city of experience that, one for each user of the city, represents how each inhabitant sees, lives and feels the city.

For each one of these cities, referring to a cybernetic approach of control and regulation of voluntary actions, all the cycles of actions aimed at governing urban transformations have been defined - exhaustively. With reference to the physical city, according to the scheme shown below, morphological reading actions have been identified for the knowledge phase, meaning by morphological reading the study of the shape of the stone city and its numerical and cartographic formalization organized in geographic information systems (GIS). For

the functional city, a relational reading is necessary, whose essential elements are constituted by the current and potential uses of individual urban spaces, the intensity of use of areas and spaces, their geographical distribution, the degree of relationship and synergy that each activity establishes with all other urban activities.
For the city of experience, reading must be of a psycho-perceptive type in which, through sample surveys, it can emerge which image the city returns to its inhabitants according to various indicators such as the degree of education, the level of income, the professional condition, etc..

| System | Reading actions | Intervention Tools | Governance Models |
|---|---|---|---|
| Physicist | Morphological | Project | Control |
| Functional | Relational | Programs | Regulation |
| Psycho perceptual | Perceptual | Strategies | Recommendation |

**Tab.1 Systems, reading actions, intervention tools and governance models**

In the same way, for the physical city, that is, for houses and things, it is necessary governing through projects, i.e., defining some physical hypotheses of transformation of the city that refer to real design ideas in which the decision-maker can evaluate the quality of the transformed shape and its level of visual impact on the pre-existing reality.
For the functional city, the intervention tool must be a program of transformations of the intended uses and intensities of use within the city and the metropolitan area. A flexible tool, divided into temporally and spatially defined actions, to be updated - step by step and in a cyclical process - to take into account the transformations that each action produces on existing activities and on their degree of interrelationship with present and future activities.
For the perceptual city, the intervention tool must be configured in the definition of a strategy for transforming the city/citizen relationship oriented to the preservation of positive and shared aspects and to the elimination of the negative externalities that a transformation without evaluations under the psycho-perceptual aspect can procure.
These intervention tools must correspond, for each sub-system, as many (technical) models of governance that, enhancing the potential of the intervention instrumentation, guarantee quality of results and certainty of objectives. The model of government of the physical city must consist of a continuous and direct action that directs, regulates and verifies all the activities of physical transformation of the city. In other words, a rigorous and continuous control activity must be carried out, such as to guarantee maximum compliance with the hypotheses of programmed physical transformation.
The model of government of the functional city must be an action aimed at keeping within established limits the values of certain quantities (intended use, intensity of use and degree of interrelationship) in line with the pre-established and constantly updated programs; ultimately, an action of regulation of functional transformations must be carried out which, without opposing the complexity and minimize the entropy of the entire urban system.
Finally, the psycho-perceptual city needs address actions that, safeguarding the existing perceptual heritage, can guide the transformations, physical and functional, to guarantee continuity in change and quality in transformation.
Ultimately, the 21st century city and metropolis must be governed with techniques and models that, referring to the management tools of complex systems, are varied, flexible and diversified.

## 4. Innovative processes for metropolitan government

The vastness of the issues linked to the planning and management of metropolitan conurbations has triggered, for some years, the development of renewal processes, both in the scientific and technical-regulatory fields. As regards the regulatory aspects, a sure innovative orientation in the processes of managing the metropolitan object can be found in the approval of the italian law n.142/90 on the "Regulation of Local Autonomies". This legislation, including the new institution of the metropolitan city, seemed to provide a definitive answer, also in operational terms, to the declared inability of the municipal and provincial administrations (traditionally organized according to widely outdated models) to address and govern effectively and organically the development of the territory. The law proposes an innovative approach to the problems of the territory based on considerations such as the strong polarizations of population flows, the sudden expansion of many smaller urban centers, the proliferation and concentration of functions, the uncontrolled development of the phenomenon of the conurbation, etc. and feels the need for a new territorial and administrative way that interprets the changed dimension of the phenomena. The law perceives and answers to this need by providing for the establishment of a new territorial institution that follows, from a constitutional point of view, the provincial institution. The metropolitan area, as defined by the law n.142/90, is made up of a main city (the urban pole) and several municipalities that have economic and cultural relationships and interactions with it, concerning activities and essential services of associated life, as well as territorial affinities.

Following this assumption, the areas including the municipalities of Turin, Milan, Venice, Genoa, Bologna, Florence, Rome, Bari and Naples, and neighboring municipalities have been indicated as metropolitan areas, leaving the special statute regions of Sicily and Sardinia the task of identifying the boundaries of the respective new metropolitan areas. There have been many studies, debates and proposals (developed in particular from the middle of the seventies up to now), on the criteria for identifying the boundaries of national and international metropolitan areas; the fact is that although the law indicates precise methods and regulations for the identification and territorial delimitation almost none of the administrations of the municipalities mentioned has moved in this way. The reasons for such inaction can be sought on one hand, in the unavailability of operational tools suitable for the purpose for the local governments and on the other hand in a *laissez faire* attitude of the central government culminating in the enactment of law n. 436/93 which converts into "possibility" the obligation of delimitation of the metropolitan area (Fistola, 1988) as mentioned in art. 17 of law n.142/90.

Furthermore, in the fourth paragraph of the same article it is possible to find one of the principles of greatest interest, for the purposes of this study. This article establishes that in the metropolitan area the territory of a province with the name of metropolitan city is identified. On this identification between the new metropolitan city and the province and on the re-aggregation of the territories cut out in the delimitation of the new areas, it is of particular interest to mention some points of the law which states: "*… each provincial precincts must correspond to the area that includes most of the social, economic and cultural relations of the resident population; each provincial territory must have the minimum requirements of size, demographic entity and productive activities that can favor a serious planning of balanced development; the entire territory of each municipality must be part of a single province (concretely, in the creation of the metropolitan area, the peripheral municipalities must be fully aggregated or completely separated); as a rule, the minimum limit of 200.000 inhabitants per province must be respected; the establishment of provincial offices of the state administrations and other public bodies in the new provinces is not necessarily required; the pre-existing provinces must guarantee the new ones adequate operational tools and financial resources".* In addition, as regards the actions of territorial modification, merger and establishment of municipalities, the following is states:

"*… It is first of all necessary listening to the opinion of the populations concerned, in the forms provided for by the regional law; new municipalities with a population of less than 10.000 inhabitants or whose constitution*

*entails, as a consequence, that the population of other municipalities falls below this threshold can't be established; regional law for the establishment of new municipalities by merging contiguous municipalities ensures adequate ways of participation and decentralization of services to the communities; special state contributions are expected in the event that municipalities with a population of less than 5.000 inhabitants participate in the merger ".*

Many of the innovative contents of the law, which finally seems to support a new model of approach to the socio-economic-territorial problems of local autonomies, concern the functions attributed to the metropolitan city and the ways of providing services to the local community.

It is possible to state that the metropolitan city is established, according to the mentioned law, as a sort of hybrid entity deriving from the union between the single municipality-city and the authority in charge for managing a larger territory similar to the province.

In this way, the metropolitan city is assigned both functions of previous provincial competence, and functions normally entrusted to individual municipalities, if they have a predominantly supra-municipal character and must therefore be carried out in a coordinated and/or joint form within the area.

In particular, as regards the provincial dimension, shall we say, to the metropolitan city are assigned the functions relating to the following issues:

a. protection of the territory, wardship and enhancement of the environment and disaster prevention (sector in which, in certain cases, any state intervention must still be envisaged);
b. protection and enhancement of water and energy resources;
c. enhancement of cultural heritage;
d. traffic and transport;
e. protection of flora and fauna, parks and natural areas;
f. hunting and fishing in inland areas;
f. hunting and fishing in inland waters;
g. waste disposal at the provincial level, detection, regulation and control of wastewater discharges and atmospheric and noise emissions;
h. public health and hygiene services and prophylaxis;
i. secondary education and vocational training, school buildings within the limits assigned by state or regional laws;
l. data collection and processing;
m. technical-administrative assistance for local authorities.

With more details to the urban planning it will be said that it is a task of the metropolitan city to adopt a Territorial Coordination Plan which, while taking in account the different competences of the municipalities, points out the general guidelines of the territorial structure and in particular foresee: the different destinations of the metropolitan territory according to the prevailing vocation of its parts, the general location of the main infrastructures, the structure and development of the main communication lines, the intervention for soil consolidation and water management as well as areas in which it is appropriate to establish parks or nature reserves.

It will be seen below how this approach is very close to that which, in the context of the tuning of metropolitan government techniques, defines the specific tasks of the metropolitan decision-maker called to provide the macro-functional guidelines of the territorial system, based on the planning formulations. As far as the municipal dimension is concerned, it is possible to state that the metropolitan city must be attributed all those functions, of previous municipal competence, which highlight a specific peculiarity of supra-municipal interest and it is therefore appropriate, for reasons of territorial economy, extend to the entire metropolitan area.

They are:

a. territorial planning of the metropolitan area;
b. mobility, traffic management and transport;
c. protection and enhancement of cultural heritage and the environment and of natural areas;
d. soil defence, hydrogeological protection, protection of water resources, waste disposal;
e. collection and distribution of water and energy sources;
f. services for economic development and large commercial distribution;
g. wide-area services in the health, education and vocational training sectors and other urban services.

From the above, it would seem that there is an overlap of competences, for the two dimensions mentioned, in almost all the subjects listed. This eventuality of confluence of the exercise of the same functions by two different bodies, acquires particular interest as regards the areas of territorial planning and traffic. In this regard, the law seems to define two scales of intervention: a territorial dimension, which identifies the location, in specific municipal areas, of infrastructures and equipment of interest and supra-municipal users and falling within a planning strategy of the entire metropolitan area (the provision of the large inter-municipal road network is of specific relevance to this scale), and a local scale (of municipal competence) to which the metropolitan city is called upon to control building activity and to prepare the implementation tools envisaged in the general regulatory plan, the competence of which would seem to remain on the line between the two dimensions. Another topic to take in account is related to the relationship between the activities of metropolitan cities and the central administration. This connection was sanctioned with the institution of the Minister (without finance) for problems in urban areas at the same time as the creation of the Department for Urban Areas, which is assigned the task of fulfilling the requirements regarding the cognitive and planning phase for legislative, administrative and financial related to the upgrading and construction of infrastructures and services in urban and metropolitan areas.

As regards the activities of the Department, of specific interest in this study, these include:

- the check and control over the legislation concerning the layout and management of urban areas;
- the coordination of administrative action for the implementation of related initiatives;
- the study and implementation, by the central state administration, of programs for the solution of specific problems in the aforementioned areas, as well as the obligations relating to state activities related to the management of urban and metropolitan areas and the connection between local authorities, administrations and public institutions, including economic ones, operating in the aforementioned areas.

To carry out these activities, the following are envisaged:

- the introduction of information technology and the establishment of a study and planning office (which should carry out studies on high-voltage housing areas, research and programming);
- the setting up of an office for the coordination of interventions, for their verification and for the formulation of programs and program agreements;
- the establishment of an office for the technical implementation and supervision of these agreements.

From this list there is finally a change of reference models in the administrative and regulatory planning activities. It is to be hoped that the administrations of the new metropolitan cities inspire their interventions to planned choices with the same rigor that should inspire the organs of the Department and it is desirable that between this and the metropolitan administrations a climate of mutual cooperation is created, both in the planning stage and the implementation of the intervention programs to the needs of which the creation of the new type of local authority is due. As will be more understandable later on, some of the generating principles of the normative instrument described have been functionally interpreted and transposed into the proposed governance process and techniques. This analogy will allow a more rapid development and a more concrete possibility of implementation of the tools developed in the functional planning stage.

## 5. Innovative tools for metropolitan management

The crisis of the current urban and metropolitan systems, with reference to what has been stated on the different evolutionary speed between physical and functional systems, can be traced back to two strictly interrelated phenomena that have characterized the national urban history of the last sixty years: physical diffusion and functional proliferation.

By physical diffusion we mean that process started in the period between the two wars (where the Italian economy was still essentially agricultural), progressively invested in the urban agglomerations of our country, causing an uncontrolled expansion. The ultimate expression of this process, which had its maximum acceleration in the fifties and sixties, are the metropolitan conurbations, extensive swathes of territory pervaded by building volumes without solution of continuity, in which the original settlements, all free space disappeared giving rise to high settlement densities. The cause of this diffusion must historically be sought in the urban location of some highly polarizing functions, in particular the productive ones, the mercantile ones and the administrative-managerial ones which attracted, from the rural areas, massive quantities of population, for which it was necessary to prepare suitable living spaces. The concentration of the population in specific areas, where these functions were located, soon led to the emergence of collective needs which were answered by creating new urban service functions. This mechanism, which iterated more and more rapidly, especially in the transition period from industrial to post-industrial society, can be referred to as functional proliferation. It is possible to represent the development of the phenomenon of urban growth (Fig. 3), relative to the processes described by placing, in a Cartesian diagram, the physical expansion and the functional proliferation on the two reference axes and tracing the curve that, during the social evolution has linked the two processes. It will be possible to see how, in the current post-industrial phase, the curve undergoes a sharp surge towards the top, thus highlighting the current trend towards functional complexification of metropolitan contexts.

This phenomenon has led to the formation of the current metropolitan systems characterized, as mentioned, by a high relational complexity.

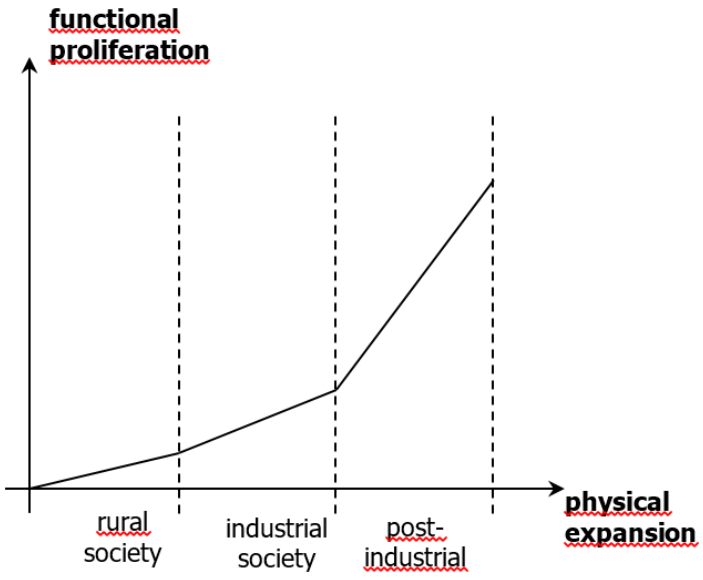



**Fig.3 The phenomenon of urban growth. The figure shows the diagram of the hypothesized relationship between functional proliferation and physical expansion in the different phases of corporate evolution**

Above described, which finds a further representation in the triangular scheme (Fig.4) (in which the events placed at the vertices are concatenated cyclically), can be useful to understand the transition from the urban to the metropolitan dimension, in particular from a functional point of view.

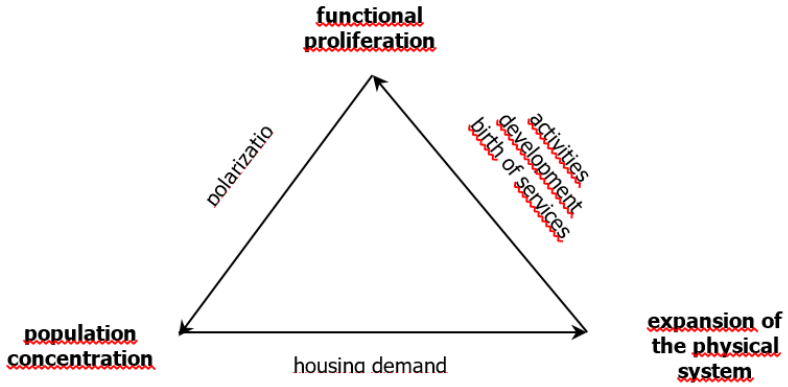



**Fig.4 The triangle of urban growth. The diagram illustrates the physical/functional evolution of the city by describing this process with the circuitry along the sides and vertices of the triangle, representative of specific generative phenomena**

It is possible to say that each complete circuit on the triangle has added a further stage in the process of physical/functional evolution of the city. Currently some of the Italian metropolitan areas are probably going through the last phase of possible development of the two phenomena mentioned at the beginning.

As far as the physical system is concerned, there is no one who does not see the conditions of degradation and marginality in which many of the metropolitan fabrics of our country currently find themselves. Considering the urban phenomenon, in its spatial three-dimensionality, it is possible to note that the physical expansion, having now consumed any free surface (in the xy plane), has begun to search for new possibilities of expansion according to the z dimension, thus generating new urban districts whose containers grow enormously in height, abruptly standing out (moreover with enormous visual impact) from the pre-existing fabric.

From the functional point of view, the proliferation of urban functions and their overlap in the metropolitan system have led to the current ungovernability and structural crisis of almost all large metropolitan areas.

The basic problem lies in the fact that attempts have always been made to control the (spatial and functional) development of the city, intervening almost exclusively on the physical system. In particular, it was considered of being able to govern urban evolution only through physical planning, but the current "crisis of the plan" highlights the erroneousness of this assumption. As has been shown, however, the urban phenomenon, partly limited in physical expansion by the unavailability of free areas, increasingly entrusts its evolution to the functional component. With the conquest by the city of the metropolitan dimension, the urban plan, unsuitable for correctly managing the functional transformation, has progressively lost any type of potential control of the urban phenomenon and has limited itself, in many cases, to sanctioning the expansion of building areas, beyond any real possibility of address and real control. It should also be noted the inadequacy of the regulatory instruments (prior to those provided for by law n.142/90 on the reorganization of local autonomies) adopted in the physical planning, unsuitable for the governance of complex territorial phenomena and moreover often ignored both by individuals and, as unfortunately happened in particular in the south of Italy, by entire regional communities. If the urban generation process is depicted, previously represented according to the triangular scheme, as a succession of linearly concatenated events (Fig.5), we will observe how urban planning intervenes only on the last phase of the generative process, thus failing in operating any control over the functional process. Therefore, the need for tools capable of interpreting complexity, of using it for the analysis of phenomena and consequently being able to appropriately orient functional proliferation, is becoming more and more acute.

As has been shown, the problem must be faced by elevating complexity to a science, approaching the urban phenomenon in an innovative way by considering the city as a dynamic system. It is necessary to develop tools that, relating to the metropolitan phenomenon in its entirety and adopting the systemic logic, allow it to be controlled, regulated and directed, essentially: the government.

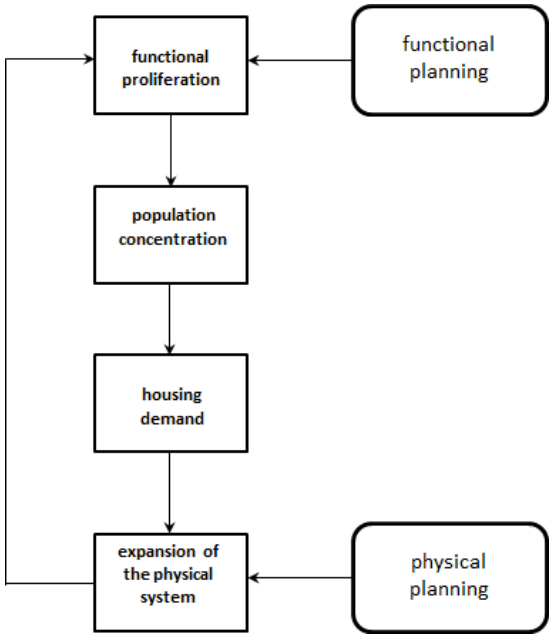



**Fig.5 The urban generation process. The figure describes the intervention of functional planning on the first stage of the urban generation process**

## 5.1. The strategic planning

Considering that currently the transformation of the city occurs by single steps (i.e. through the modification of individual built areas) it is necessary that this set of physical transformations take place in a functional planning framework that organizes and rationalizes the various actions and contains appropriate procedures for regulating the metropolitan system.

In this way, it is possible to state that the government must be implemented through a policy action, a management plan, rather than a regulatory one, which could be defined as a "plan-process"; in essence, a tool completely different from traditional plans, oriented to the forecasting of the structure of specific territorial realities, which takes the form of a definition of strategies. In this perspective, it is possible to suppose that the governance of metropolitan phenomena takes place, so to speak, at two different levels: a general level, in which all the actions of functional direction and management of the metropolitan system as a whole are defined and a level which could be defined as local, and limited in scope, to which all the operational modification actions of the space component are implemented, capable of helping to direct the system towards the strategic objective identified at the first level.

It will therefore be possible to distinguish a strategic or first-level planning which identifies the effective instrument of governance in the plan-process, and a physical planning that limits its scope of intervention to portions of anthropized territory of the metropolitan area and directly and constantly controls it the modifications following the functional directives developed at the level of strategic planning.

In order to build a conceptual scheme of the process (Fig. 6) it is possible to state that three different levels are identified:

- the level of the decision;
- the level of strategic planning (regulation);
- the level of physical planning (control).

The decision level is the one at which the Metropolitan Decision Maker (MDM) belongs, he is a manager (technical / political) of the city who defines the guidelines and policies to be implemented in the metropolitan area.

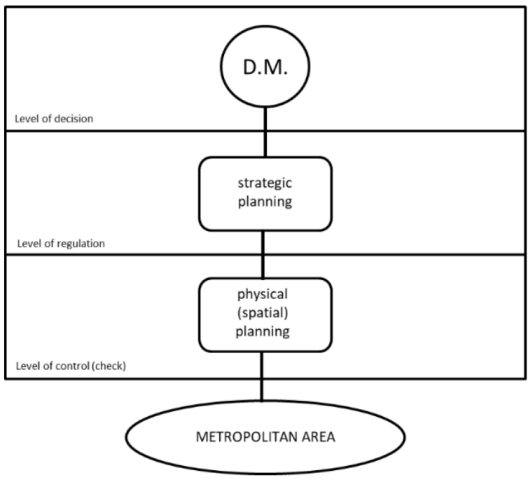



**Fig. 6 The levels of metropolitan government. In the figure, the governance actions are located at different levels populated by regulatory control procedures**

Strategic planning is located at the immediately lower level, fundamental for the political decision-maker, who receives the indispensable support for his decision-making activity from the activity of this level. At the third level there is the physical planning that governs the specific interventions and governs the evolution of the physical system through the control of the modification activity in the different areas in which the metropolitan territory is divided. It is then noted (Fig.7) how each element at the different levels receives an input and emits an output for the element of the next level.

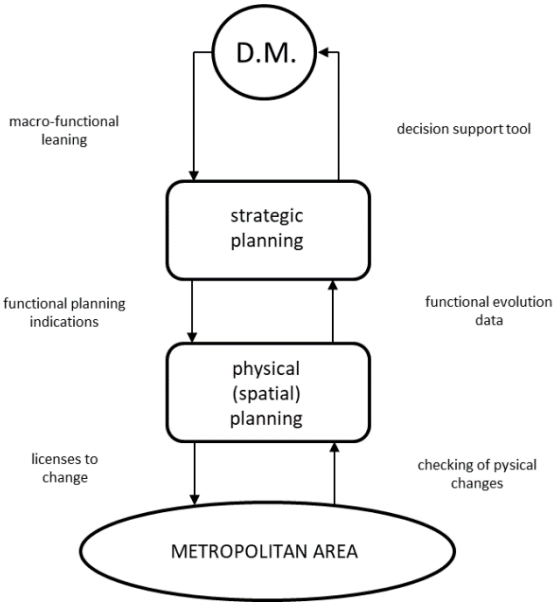



**Fig.7 The management of the metropolitan area: flows. The figure highlights the input/output flows that connect the different levels and allow the definition of the government actions of the metropolitan area**

As a matter of fact, the metropolitan decision maker receives support to the decision from strategic planning (input) and expresses a functional address decision (output) for the system. Strategic planning receives, from the physical planning level, the characteristics of the evolution trend of the metropolitan system (input) and defines functional strategies (output); finally, local level planning checks the metropolitan system, controlling its physical modifications (inputs), and defines the functional (evolutionary) patterns that it transmits to the higher level. At the same time, it authorizes (output) the transformations of the physical environments and of the single spatial elements only whether conceived and implemented in the direction of the functional choices defined by strategic planning. The whole procedure is therefore configured as a cyclical process of monitoring

and continuous direction of the metropolitan system; every new functional proliferation, which can give rise to phenomena of concentration and congestion, is promptly detected, properly managed and made compatible with the system as a whole, before it can generate functional complexification phenomena.

By examining in detail, the functions of each level, it will be said that the task of the metropolitan decision-maker is to predict, on the basis of the functional guidelines defined in the strategic planning and also referring to the community economic policies and international metropolitan management, indicating the major metropolitan infrastructural development lines, the structure of the communications network, the distribution of activities on the territory and their intensity.

The tasks of strategic planning can be summarized as follow:

- definition of the boundaries of the metropolitan area;
- delimitation of the sub-metropolitan areas or spheres of intervention;
- formulation of functional strategies for the macro-scale;
- verification of functional compatibility.

The process of defining the boundaries of the metropolitan area is probably the most complex operation for the strategic planner who, in this activity, will have to make use of the most recent qualitative/quantitative analysis techniques capable of synchronously analyzing the various phenomena active in the territory and of the most recent computational and IT tools that technological innovation makes available today to scholars and operators. It could be hypothesized (in the perfect development of the process) a sort of delimitation dynamic, flexible, temporally changeable, which could include (or exclude) in following moments, areas of territory previously excluded from the perimeter. This dynamic possibility could also constitute a thrust and solicitation element for the activation of self-centered development processes of the individual municipalities.

The tracing of the boundary of the sub-metropolitan areas will also be implemented through techniques capable of detecting the spatial and functional unity of a given metropolitan area (district / municipality), which can be configured, also from a social and administrative point of view, as a defined unit.

The step of formulating functional strategies is divided into two actions:

- the analysis of the system (reading);
- the development of the intervention strategy.

Referring to the operational descriptions relating to the second action, it will be said that the reading phase concerns the activities within the metropolitan system.

The steps to be carried out in this phase are:

- identification of land use;
- analysis of the distribution of urban activities;
- measurement of the intensity of land use;
- check of the degree or relationship (and or interaction).

The first two points are performed through operations of localization analysis and recognition with the aid of pure cartographic supports and/or computer representation tools (digital maps, computerized aerial photogrammetry, remote sensing, etc.).

For detecting the intensity of a certain activity in a place, reference will be made to measurement parameters of the intensity of use of the individual containers. This intensity can be measured through parameters such as the volume of the container, the covered area, the maximum height, the land area, etc. and compound indices such as land density. Through these parameters it is possible to build appropriate indicators that can describe the intensity of an activity on a site. Finally, the degree of relationship and interrelation between activities must be detected differently depending on the activity under study. Some significant parameters could be the number of users / hour of a given service or the number of outgoing and / or incoming telephone calls, etc.. To the physical planning, that performs its activity in a local area, it is assigned a triple task:

- governing and guiding the individual interventions of physical modification in the various metropolitan districts of competence;
- monitoring the functional transformations and evolutions;
- verifying the compatibility between content and container.

The first one is carried out, as already mentioned, through the authorization for the transformation of a space and upon a submission of a project which is not in opposition with the general functional approach; the second and third are developed through the direct survey of the district structure, both through alphanumeric data and indicators, and through info-telematic cognitive tools. All data concerning the functional system must however be collected (as will be seen in detail below) by specific departments and sent to the strategic planning level. In order to better define these tasks, it seems useful describing the operational structure and mentioning the operating modes of the system, which will be further explored in the presentation of the case-study.

## 5.2. The action phases

The strategic planning will have to be based on cybernetic control processes of the metropolitan system, using the other statistical techniques of multivariate analysis. Summarizing the different phases, it is possible to say that having detected the functional structure of the territory (not yet as metropolitan), the best development trajectories are identified in order to individuate "guiding factors", to be considered as indicators of metropolitan capacity and useful to describe the functional state of the system.

For the definition of these factors, please refer to the next section; however, it is possible to say that these criteria are used by means of specific variables, detected on the territory, able to describe the values (distribution, intensity) of the activities, to which it was mentioned above. The definition of the main factors allows to start the functional management process of the metropolitan system of which the physical limits are identified. Subsequently, the strategic planning, processing the information coming from the lower physical level, defines the system strategies that inform the support tool for the metropolitan decision-maker who simultaneously provides the macro-functionalities. These are encapsulated in the plan-process that stipulates the directives for the possible physical modification of the individual metropolitan districts. At this point the process enters a steady state phase and starts its cyclical path of: monitoring the effects induced by the functional guidelines, controlling the trend of the reference variables and possible recalibration of the functional development trajectories.

We will now try to describe the operational actions that allow the process to work properly and in particular the techniques for setting up the Decision Support Tool (DST).

The process is articulated in five steps (Fig.8):

- detection;
- collection and archiving;
- processing and updating;
- checking and amending the trajectories;
- definition of development.

It has already been highlighted that one of the tasks of physical planning, placed at the third level of the metropolitan management process, consists in monitoring the physical/functional transformations of the metropolitan system and we have mentioned the variables that allow the setting of the main factors. These variables are constantly monitored throughout the metropolitan area, through what could be imagined as a network of sensors represented by specific detection units such as the planning offices of the individual districts, the administrations of entities and service companies and trade union organizations, research centers, etc.. A database is set up at each of these sensors in which all the data concerning the variables in question are collected and appropriately filed. In this sense, it would be appropriate encouraging the creation of shared

databases (which can be accessed by multiple organizations), as the current trend seems to show, which will greatly facilitate the transfer of data. The detection and collection network finds its confluence point in the strategic planning office, where a Metropolitan Database (MDB) is located to which the data of the peripheral offices are transferred. The MDB provides for the storage and continuous updating of the values of the reference variables. The updated variables are then processed, with the methods of factor analysis, mentioned above, through a sort of expert system that will be defined as the Metropolitan Management System (MMS). The MMS verifies whether the functional trajectories follow the expected trends and provides for any redirections by inserting new functional strategies in the SSD.

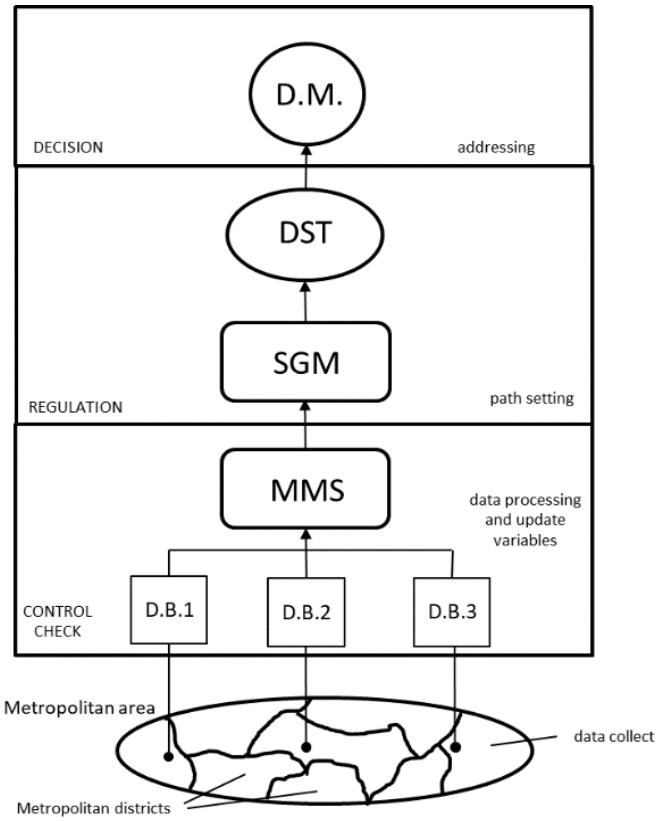



**Fig.8 The decision support. Scheme of the operational process for defining the decision support tool according to the levels of government**

In conclusion, it seems possible to formulate some considerations.

From the description of the process and of the operational moments it is clear that the functional control of the system is almost total and, in this sense, the link between strategic (or functional) planning and physical planning is positively understood; the latter recovers, in this structure, a role of real control of the modifications of the space system. Functional proliferation is suitably oriented to favor the socio-economic development of the metropolitan system, and governed to prevent its entropic complexification. In this way, the metropolitan decision-maker will finally be able to base his decisions on a support tool that cyclically checks the effect on the system and inhibits, through regulation, its negative effects. Eventually, it should be noted how, in this organization, the processes and products of technological innovation will provide a decisive aid for the definition of metropolitan governance tools. Also in this case, the smart adoption of the innovation and the definition of new tools and techniques for managing the metropolitan phenomenon, can lead to new ways of living the city and to the recovery of values of livability which seem irremediably lost in the current megalopolitan post-industrial dimension (Gottmann, 1961).

# 6. An experimental application: the government of the metropolitan area of Naples

This last section describes the application of the methodological hypotheses illustrated in the previous paragraphs aiming at defining new and more effective tools and techniques for governing cities and metropolitan areas.

The aim is to develop a decision-support tool for the governance of Italian metropolitan areas, taking into account current legislation and in particular Law 142/90 on local autonomies which established the 'metropolitan city' (AA.VV., 1991a; AA.VV., 1991b; Beguinot, 1993; Bertuglia & Occelli, 1991; Cesec, 1991; Marchese, 1989). This part does not present procedures that have already been tested and are certainly applicable, but it is a first attempt to formalize the methodology developed. The operational procedure developed is aimed at achieving three results: delimiting the metropolitan area of Naples; defining the functional planning areas; elaborating the strategic projects of the area. The procedure is divided into three steps: i) identification and collection of the variables (state indicators) to analyze the study area; ii) processing of the variables with multivariate statistical analysis techniques (principal component method, factor analysis, cluster analysis, etc.); iii) interpretation of the outputs and their formalization into decision support tools.

## 6.1 The database definition

The definition of the database, which constituted the first phase of the research, concerns an area comprising 136 municipalities in Campania. For each of these municipalities, 60 quantitative indicators (state variables) were defined. The data were obtained by consulting official statistics or from the main bodies that supply goods and services to the Campania territorial system.

Among the data needed to carry out an experimental research on an urban area, intense correlations between variables are frequently possible to find; for this reason an in-depth analysis was carried out. In this way, all the indicators that, characterized by strong correlations with other variables, would not have provided significant information were eliminated. With this objective, the correlation matrix relative to the 60 original variables was calculated; this matrix (60 x 60), as expected, presented, in 32 cases, values of correlation coefficients close to unity.

Having identified the subsets of variables that were strongly correlated with each other, we moved on to the definition of the variables with a strong information content with respect to the research objectives. Finally, the 32 indicators which, being strongly correlated with others, did not bring significant increases in information to the data system were eliminated. The data matrix, in this last phase, took on the final size of 136 x 28, namely:

- 136 rows, relating to the municipalities of the area comprising the whole province of Naples and part of that of Caserta and Salerno, in a hypothesis of a 'wide' metropolitan area (AA.VV., 1991a);
- 28 columns, relating to the number of variables describing the regional urban system.

The variables examined were divided into ten groups (Tab.2) and particularly:

- structure and characteristics of the population;
- communication input-output;
- mobility;
- energy consumption;
- household consumption and income;
- economic operators;
- gross domestic product;
- bank branches;
- employees in industry;

- distance from Naples.

The first group collects variables such as: population and population variation in the period 71/81 and 81/89 as well as the natural balance and the social balance.

The source for the retrieval of these data is ISTAT. For the second group of variables, which provide information on communications (telephone calls and television subscribers), SEAT-SARIN[1] data for the year 1987 were used.

The same source was used for the data on mobility, number of economic operators and bank branches. The seven variables of the group "energy consumption" are distinguished in relation to power. These data have been provided by ENEL[2] and refer to 1987. All the variables related to the group "household consumption and income" have been taken from the 1987 SOMEA Atlas (SOMEA, 1987).

| **Group** | **Variables** | **File name** |
|---|---|---|
| Population structure and characteristics | Resident inhabitants 1987 | POPOLAZ87 |
| | Population variant 71/81 | VAR1AZ71/81 |
| | Population variant 81/89 | VARJAZ81/89 |
| | Rate of natural increase | SALDO NAT |
| | Rate of social increase | SALDO SOC |
| Communication input-output | Phone calls for business customers | SCATTI AFF |
| | Phone calls for private customers | SCATTI PRI |
| | TV subscribers | ABB TEL |
| Mobility | Vehicles on circulation | AUTO CIRC |
| Energy consumption | Private lighting total billed power | EL D TOT |
| | Public lighting total billed power | EL IL TOT |
| | Private lighting billed power over 3kw | EL IND m3KW |
| | Lighting on premises other than dwellings up to 30 kw per rated power | EL IND 30K |
| | Lighting on premises other than dwellings from 30 to 500 kw per rated power | EL IND 500 |
| | Lighting on premises other than dwellings over 500 kw per rated power | EL IND m500 |
| | Details of total agricultural use by billed power | ELAGRI TOT |
| Household consumption and income | Per capita consumption | CONS PC |
| | Level 1 per capita consumption | CONS LIVI |
| | Level 4 per capita consumption | CONS LIV4 |
| | Per capita income | RED DISP |
| | Income Total | RED TOT |
| | Level 1 consumption | AUTOCONS L1 |
| | Level 4 consumption | AUTOCONS L4 |
| Economic operators | Economic operators | OPER ECON |
| Gross Domestic Product | Gross Domestic Product | PIL |
| Bank branches | Bank branches | SPORT BAN |
| Employees in industry | Employees in industry | IND TER IN |
| Distance from Naples | Distance from Naples | DIST NAPOL |

**Tab.2 The 28 selected variables**

1 SEAT-SARIN was a company that managed the "yellow pages", a list of companies classified by product category, which contained the address and telephone numbers for each of them.

2 ENEL is the National Body for Electricity, a public body that until 1999, the year of the liberalization of the market, was the only company for the production, transformation, transmission and distribution of electricity in Italy.

## 6.2 The calculation procedure

The principal components method provides three main types of output:

- the principal components, i.e. the factorial axes intersecting the cloud of objects (the municipalities) along the principal axes of inertia;
- the coordinates of the characters (the variables) and the coordinates of the objects (the municipalities) on the set of axes defined by the principal components.

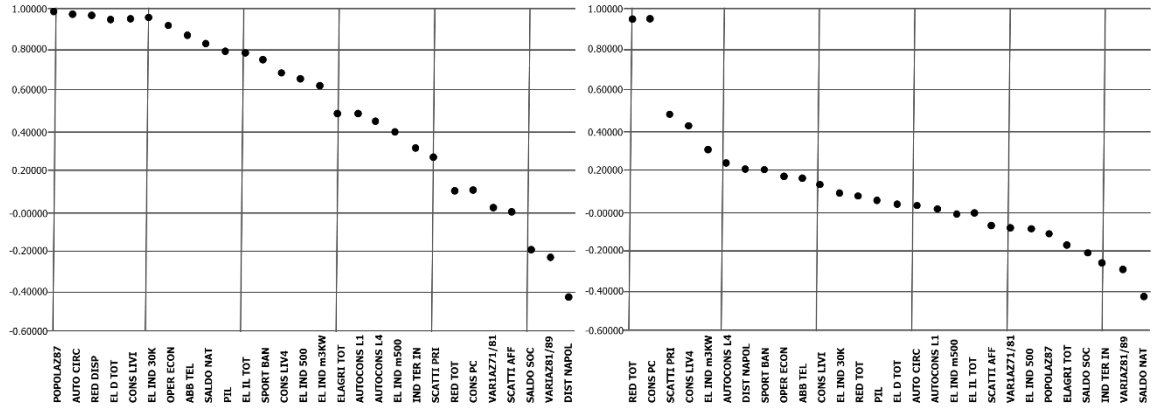
The vector of eigenvalues divided by the number of objects (the municipalities) gives the shares of variance explained by each component of the system (Luongo, 1981).

In this paper, the system under consideration has proved to be quite structured, not only because the first three components explain a high percentage (82%) of the entire variance of the system, but also because the first component alone explains almost 61% of the total variance.

In the light of these initial results, the first five main components have been taken into account for the subsequent phase of analysis. In fact, the first component explains 60.6% of the total variance, the second one 13.3%, the third one 8.3%, the fourth one 4.9% and the fifth one 3.9%, for an overall total of 90.6%.

In this type of procedure, a value of explained variance of just over 90% can be considered as an optimal threshold. The first component, which explains about 61% of the variance, can be defined as the "metropolitanism index". It is a component that prevails over the others. In particular, by analysing the correlation ratios, it can be deduced that most of the variables (25) are positively correlated with the first component; the remaining ones (3) show an inverse correlation. The first component is significantly influenced by the number of inhabitants, by the number of cars on the road and by the total disposable income; immediately following are the consumption of electricity for private use, the per capita consumption for retail trade, the economic operators and the number of television subscribers. The social balance, the variation in population from 1981 to 1989 and the distance from Naples are negatively correlated with this component (Fig.9a).

The second component, which explains about 13% of the total variance, can be synthetically defined as the "index of economic well-being". This component depends primarily on the values of per capita income and per capita consumption, and is inversely correlated with the consumption of electricity for agricultural purposes and with the social balance (Fig.9b).



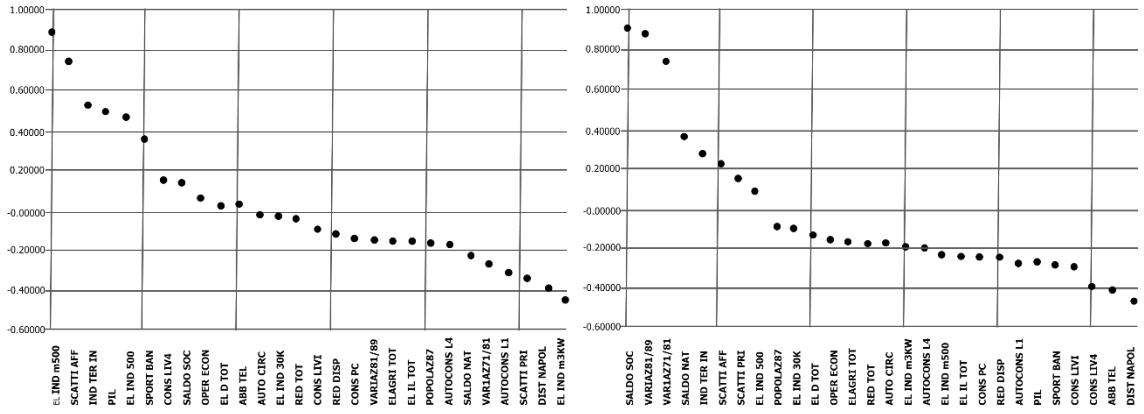

(a) (b)

**Fig.9 Sorting of the first (a) and second (b) component**

The diagrams show what part of the area is highly characterised by income and consumption variables.

The third component, which explains about 8% of the total variance, is called "industrial production index". In fact, the most relevant variables are electricity consumption for industrial use, i.e. telephone calls for business

customers and industrial employees. The variables measuring positive elements (industrial productivity, high number of employees, gross domestic product) are placed at the opposite side of the scale (Fig. 10a).
The fourth component, which explains about 5% of the total variance, is called the 'internal migration index'. This component is mainly influenced by the social balance, the variation of the population between 1981 and 1989 and the natural balance. The social balance and the natural balance positively influence the component, along with the variation of the population (Fig. 10b).
The fifth component which explains 3.5% of the total variance is called the "index of (rich) self-sufficiency on a tourist basis". The variables that have the greatest weight on this component are level 4 self-consumption (luxury goods), distance from Naples and level 1 self-consumption (Fig. 11). This shows that, although with a low incidence, the municipalities included in the study area have tourism as one of their main characteristics.




(a) (b)

**Fig.10 Sorting of the third (a) and fourth (b) component**

## 5.3 Interpretation of results

An element of great importance provided by the principal components method is the value of the coordinates that each municipality assumes on the axial system of factors.

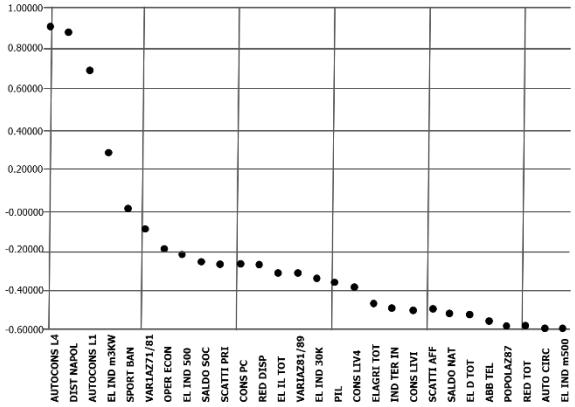
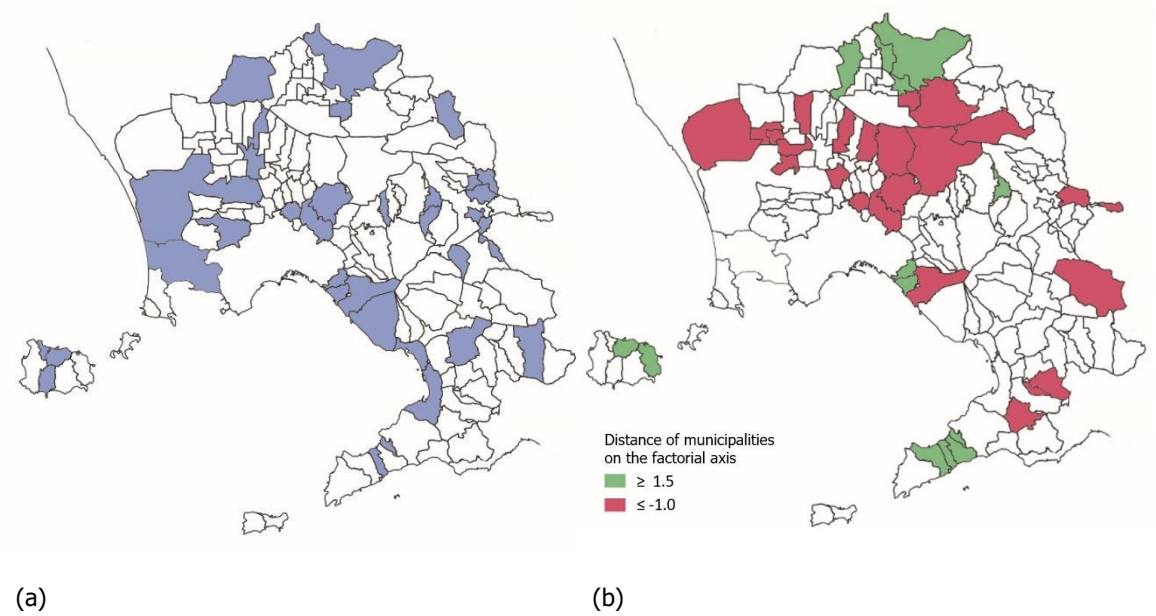



**Fig.11 Sorting of the fifth component**

By analysing the order in which the objects (the municipalities) are arranged on the first component (metropolitan index), it can be seen that the municipality of Torre del Greco is in first place; then come, in order of increasing distance, Portici, Pozzuoli, Caserta, Casoria, Castellammare di Stabia, San Giorgio a Cremano and Ercolano, up to the municipalities that close the series: Lacco Ameno, Liveri, Riardo, San Marco Evangelista and San Vitaliano (Fig. 12a). The values of the coordinates of the objects are included in a reduced

interval, and this demonstrates a flattening of the metropolitan index of the municipalities included in the study area. The municipalities of the Province of Naples that have values of the factor greater than 1 are distributed in a crown around the regional capital. These municipalities have very high values of the resident population and few qualifying functions that are, instead, located exclusively in Naples. In fact, these municipalities have been used as areas for residential developments to meet the inexhaustible demand for new housing determined by the great concentration of tertiary and industrial activities in Naples.

As regards the values that the coordinates of the objects (the municipalities) take on the second component (well-being index), it emerges that among the municipalities examined, the richest are those of Caserta, San Sebastiano al Vesuvio, Portici, Sorrento and Piano di Sorrento. From this point of view, the group of municipalities that most gravitate around Naples are those at the bottom of the ranking and in the worst position as regards the second component linked to income and consumption (Fig. 12b).




(a) (b)

**Fig.12 (a) Metropolitan index and (b) Economic well-being index**

*The figure shows that for the metropolitan index, the municipalities that present factor values >1 are those that are distributed around Naples, which are those that present factor values <1 for the economic well-being index, further confirming the conditions of socioeconomic hardship that characterise them.*

The analysis of the coordinates of the municipalities on the third component (industrial production index) confirms the results of the analysis of the trend of the first component. First of all, it can be noticed that in the distribution of the municipalities on this axis, the first places are located: Pomigliano d'Arco, Caserta, San Marco Evangelista, Marcianise, Caivano and Casoria.

These municipalities, located along the Naples-Caserta axis, represent the strong points of productive-industrial activity in the entire region. On the other hand, Afragola, Marano di Napoli, San Giorgio a Cremano, Torre del Greco and Portici are at the bottom of the list (Fig.13a).

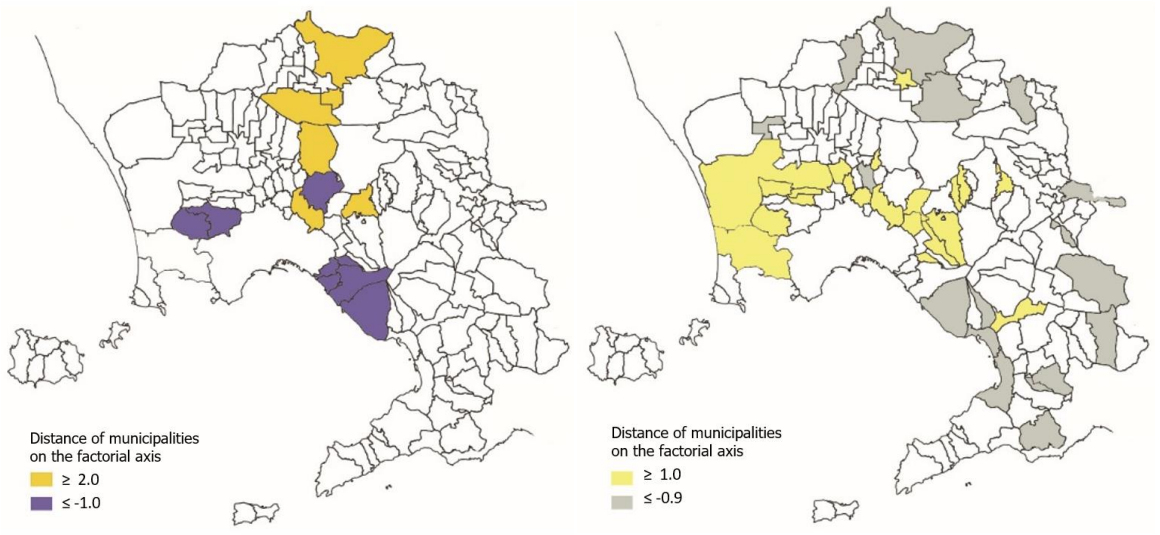
For the fourth component (internal migration index), the municipalities of Quarto, Giugliano in Campania, Villaricca, Volla, Qualiano, Casalnuovo di Napoli, San Nicola La Strada, etc. are at the top of the list. These municipalities constitute the "residential reservoirs" to respond to a demand for new housing that Naples cannot satisfy (Fig.13b).

In the ranking of the fifth component (index of tourist self-sufficiency) the first places are occupied by municipalities that are the strong points of the regional tourist system: Ischia, Forio, Sorrento, Serrara Fontana, San Cipriano, Pozzuoli, etc. (Fig.14).

Confirming this indication, the indicator with the greatest weight is represented by consumption within the municipality for luxury goods, i.e. everything that encourages tourism.

The outputs of the proposed method are an initial attempt to define operational decision-support tools for defining new instruments and techniques for governing metropolitan conurbations.

The articulation of the territory in relation to the 5 indices – metropolitan index, economic well-being, industrialisation, immigration and self-sufficiency on a tourist basis - constitute an indispensable tool, not only for the delimitation of the boundaries of the metropolitan area, but also for the identification of functional strategic planning areas.




(a) (b)

**Fig.13 (a) Industrial production index and (b) Internal migration index**

*The figure shows that for the Index of Industrial Production, the municipalities located along the Naples-Caserta axis represent the strong points of the industrial system in the Naples metropolitan area, while for the Index of Tourist Self-sufficiency, the municipalities with factor values > 1 are those that constitute the "reservoirs" for a demand for new accommodation.*

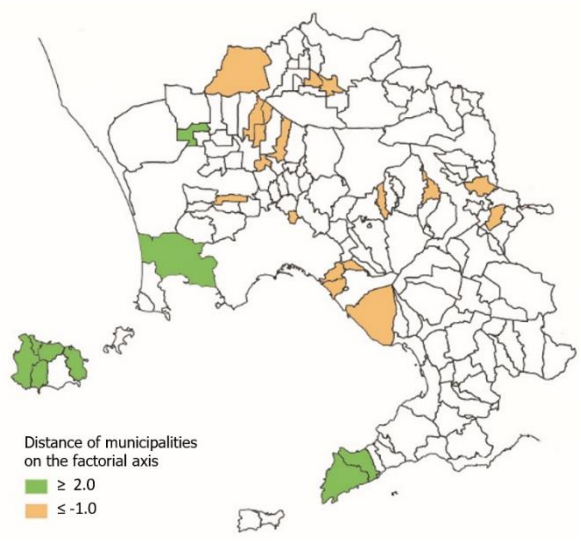



**Fig.14 Self-sufficiency on a tourist basis Index**

*The figure shows that the municipalities in which the value of the factor is equal to 2 are Forio, Ischia, Sorrento, etc. which represent the strengths of the regional tourism system.*

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**REVIEW NOTES – Urban planning literature review**

# Ecological transition: innovation in cities

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**Abstract**
Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always remaining in the groove of rigorous scientific in-depth analysis. This section of the Journal, Review Notes, is the expression of a continuous updating of emerging topics concerning relationships between urban planning, mobility and environment, through a collection of short scientific papers written by young researchers. The Review Notes are made of four parts. Each section examines a specific aspect of the broader information storage within the main interests of TeMA Journal.
In particular, the Urban planning literature review section aims at presenting recent books and journals, within global scientific panorama, on selected topics and issues.
This contribution focuses on one of the most significant features of ecological transition which concerns digitalisation and innovation. In particular, for the third issue of TeMA Journal 2021, this section of Review Note proposes a literature overview of how the vocation for innovation and Industry 4.0 can change the structure of neighbourhoods and entire cities. The contribution shows some significant best practices and interesting books and journals which delved into the topic.

**Keywords**
Ecological transition; Urban planning; Innovation.

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# 1. Introduction

The world is facing increasing environmental pressures, including rising air and water pollution, climate change, biodiversity loss and waste generation. Numerous policies and initiatives have emerged, at the international and local levels, to respond to these challenges, but more must be done to ensure a rapid ecological transition and a cleaner global environment. As highlighted in previous issues, the health crisis caused by the spread of the novel coronavirus and the resulting financial crisis have undermined the already precarious economic structures of many countries around the world. At the same time, the breaking of financial and economic dogmas (Guida & Natale, 2021) has allowed the construction of tools and the distribution of substantial resources to trigger the desired changes and promote economic, social and urban models that are not only more sustainable, but also more competitive and efficient. These changes will need to happen in a context of other major structural transformations, including economic convergence between developed and developing countries, rising urbanisation, and the diffusion of automation and digitalization (Aldegheishem, 2019).

The ecological transition depends on the development and diffusion of new technological, economic, social, behavioral, and business model innovations. Innovation – the creation and diffusion of new ideas – is at the core of the transition to a cleaner global environment. This includes not only technological innovation, but also innovation in economic and social systems and in lifestyles. Innovation is the main source of modern economic growth, which implies that the ecological transition is not only compatible with long-term economic growth. It also opens a wide range of economic opportunities for businesses, which include electricity production, distribution, and storage; agriculture and forestry; natural resource exploitation; buildings; transportation; water supply and treatment; and waste management. Many of the necessary innovations in each of these sectors already exist and now need to be diffused and scaled up. This process can be eased thanks to the development of enabling innovations such as artificial intelligence, the internet of things and blockchain technologies. At least in the technological domain, the pace of innovation for the ecological transition has accelerated markedly since the mid-2000s. However, it is still insufficient to address the environmental challenges facing the planet today, and there is evidence to suggest that the pace of green innovation has slowed again in recent years. This suggests that major barriers remain and need to be lifted in order to accelerate the ecological transition.

It is worth bearing in mind that public administrations cannot act on their own, without focusing on public-private partnerships: this extended relationship must permeate all levels and will also be central to the implementation of projects for the use of funds from Next Generation EU, or Italian PNRR (Piano Nazionale di Ripresa e Resilienza - National Recovery and Resilience Plan).

In such context, cities play a key role since they have always been associated with transformative ideas and novel social initiatives. Some argue that the innovative activities are the products of cities or regions, and that cities and urban regions are not just mere containers for innovative activities but are actively involved in the generation of new ideas, new organizational forms and new enterprise (Florida et al., 2017).

Most of the challenges our societies face today are exacerbated within urban areas. This is both one of the underlying reasons for greater innovation in cities, and one which can eventually be overcome by harnessing this same, vital innovation. The high level of provision of education, services and leisure activities, combined with a high population density and the very high frequency of interactions notably found in cities, favor technological and social innovation, entrepreneurship and creativity.

However, some cities are able to harness most of their potential and do more with their tangible and intangible resources than others. Cities that succeed in innovating are those where "people are fewer mechanical units of production and more the creators of wealth. Cities shift from having a density of resources to a density of networks and circuits where proximity to resources was substituted by proximity to knowledge" (Landry, 2012).

Besides hosting technological progress, cities are also enabling various other types of innovation. This variety of innovations is associated with products, processes, marketing and organizational contexts, all of which are

significant in urban and metropolitan areas. Some concrete ways in which cities are encouraging innovation are:

- entrepreneurial innovation oriented to support small businesses in the creation of new jobs;
- social innovation highly focused on meeting social needs by enhancing social interactions and integrating ideas, knowledge and vision of civil society with urban development;
- innovation in work systems: including teleworking, high mobility of entrepreneurs, co-working spaces, open office areas and other alternative ways to generate income;
- culture-led innovation, typically stemming from the creative knowledge of the arts and cultural domains and inspiring many city-relevant sectors and areas, including cultural tourism, consumer electronics and urban regeneration.

Some cities have oriented the physical and functional transformations of their territory towards the promotion of a competitive and fertile environment for the production of technological and social innovations. As will be described below, some cities have developed in response to this vocation, others have transformed degraded areas into innovative hubs. Still others are seeking to transform their land-use in order to be more resilient and sustainable. A significant example is the city of Venice.

The pandemic has stopped time in a city where the clocks seem to run slower than elsewhere. There is an unreal air in the alleyways, emptied of the flood of large ships. The water in the lagoon turned clear and even dolphins have been spotted. But the emptied city offers no work: many houses have long since lost their residents to become lucrative rentals on web platforms. The population now stands at around 50,000 and is falling by a thousand a year, two thousand in 2020. Venice has a sustainability problem of two kinds: environmental and social. The environmental one is linked to high water: Venice owes everything to the sea, but, at the same time, must defend itself from the sea. The second problem is of social nature and concerns the increasing depopulation.

The idea of transforming Venice into an Innovation Hub was born to address such issues. Its key, in short, is to replace mass tourism with a constant presence of medium- to long-term residents, making the maintenance of a breathtaking beauty-city sustainable. In the 1950s, 170,000 people lived in Venice, while surveys, today, show that that figure is reached every day by the sum of the flow of day trippers and the fifty thousand residents. Hence, the innovation hub would replace tourists with the so-called "futurists", people who live in the city, even if only for a few years.

In order to achieve such goal, it will be necessary to transform Venice and its vulnerabilities into opportunities for economic development and resilience. Urban planning plays a vital role in supporting this new territorial vocation, as do productive partnerships between the public and private sectors. There is no shortage of experiences, which have become best practices, analyzed below: Turin (Italy), Sophia-Antipolis (Nice, France) and Silicon Valley (San Francisco, California, US).

These are very different experiences, arising from divergent contexts and therefore developing their own peculiarities in becoming outstanding centres of science and innovation. The descriptions of the three case studies are followed by reviews of three interesting books. The first one is "The Innovation Complex: Cities, Tech, and the New Economy" by Sharon Zukin. Then, there is "Innovation Capacity and the City. The Enabling Role of Design" by Grazia Concilio and Ilaria Tosoni. Finally, "Uneven Innovation. The Work of Smart Cities" by Jennifer Clark.

## Turin - Italy

Torino City Lab (TCL) is an initiative-platform aimed at creating simplified conditions for companies interested in conducting testing in real conditions of innovative solutions for urban living. The project began in 2016 with the first "Torino Living Lab", based in Campidoglio district. The neighborhood has become the first urban space in Turin dedicated to innovation and smart city, thanks to the activation of 29 projects on different areas such

as environment, mobility and tourism. Torino Living Lab is an initiative of the City of Turin created to promote, develop and test new innovative solutions in a real context.
Citizens, companies and public administration explore and experiment together innovative products, technologies and services in a specific area of the city in order to test its functionality and utility for end users and assess the impacts on quality of life.
Torino City Lab involves a vast local partnership of subjects from public and private sectors interested in supporting and growing the local innovation ecosystem. Currently Torino City lab promotes specifically co-development and testing in the following areas:

- autonomous mobility services with a focus on autonomous vehicles and drones for the transportation of people and freights;
- innovative urban services enabled by 5G technologies: city applications of artificial intelligence and collaborative robotics, Internet of Things, augmented and virtual reality.

Torino City Lab is an open and widespread "laboratory of innovation" throughout the city area. It provides for innovators and star-uppers simplified access to public spaces and assets, including intangible assets (processes, services and data). TCL expands and strengthens relationships within the local innovation ecosystem, through an articulated partner system. Moreover, the lab allows to "scale the solutions", promoting them within networks and projects on a local, national and international scale. TCL aims to involve end users and citizens, promoting local challenges and supporting the active participation of interested communities.
The first underlying purpose of such project is positioning Torino at European and international level as a place where innovation is easier and is a shared challenge for the territory. Secondly, to attract companies from Europe and the world to engage new trajectories of economic development in sectors with high added value and to serve the citizens of tomorrow (Zanini, 2019).

## Sophia Antipolis, Nice - France

The second case study presents a more consolidated and structured experience over time: the Sophia Antipolis Technopark in the core of the French Riviera. It was designed in 1969 as a science and knowledge center by French Senator Pierre Laffitte.
On a vast, arid plateau the technology park was built: 90% of the land was planted with vegetation and it is now home to 2,500 companies, valued today at more than 5.6 billion euros and employing more than 38,000 people.
In terms of urban planning, from its beginnings, the Sophia-Antipolis Joint Association (SYMISA) has supported economic growth by creating office and residential areas, while maintaining a very significant proportion of planted areas. The first 1,500 hectares of green space were quickly transformed into departmental parks open to the public, while the hilltops were protected by a building ban. The innovation chain which began with the set-up of international Research&Development centers, continues today with the arrival of company creation and support players including incubators, competitiveness hubs, research laboratories and higher education stakeholders (Partenay et al., 2015).
Nowadays, Sophia Antipolis is the Europe's leading technopole since it has turned into a center for global technological innovation. Each year more than 1,000 new jobs are created in the technopole in key fields such as artificial intelligence, biotechnology and autonomous and connected vehicles. The technopole was built on a unique urban planning model formalised in the 1977 Charter and characterised by the special emphasis placed on the natural environment and on the will for buildings to blend into the landscape. Buildings cannot be taller than the ridge line of the park's hills.
Sophia Antipolis was designed from the beginning start as a "fertile" centre of advanced technology focusing on conviviality, diversity and multi-disciplines to pool energies creatively and thus create the major innovations of tomorrow. A state of mind which is being reinforced. Concerning its attractiveness, Sophia Antipolis has

established itself as a place of work benefitting from services and a high quality of life, including opportunities for sport and proximity with nature, to contribute to well-being at work and to facilitate scientific and technological creation and innovation. Talents, researchers and entrepreneurs from over 80 different countries have set up in the technopole. They were attracted by this innovative, dynamic culture open to change and difference and brimming with enthusiasm. This community is responsible for major innovations which are shaping the world of tomorrow.
Among the main research and innovation topics towards ecological transition, iìthe key sectors in Sophia Antipolis technopark are health and biotech, intelligent vehicles, and mobility, bluetech, sportech and cybersecurity.

## Silicon Valley, San Francisco – Californa, US

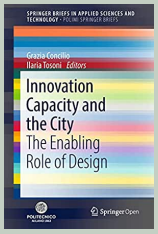
While the other two case studies refer to single urban environment or neighbourhood designed to promote research and innovation, the American Silicon Valley is an extraordinary and unique case study since it gathers more than one city, created on purpose with a vocation for research and development of innovative technologies, and more. California's Santa Clara Valley wasn't always known for high tech. The area had once been an agricultural paradise, teeming with fruit orchards and canneries. Its sunny weather, attractive suburbs, proximity to Stanford University, and casual but fiercely entrepreneurial business culture attracted talented people and new businesses to the region. A booming electronics industry emerged in the 1960s and inspired the nickname "Silicon Valley," after the main element in integrated circuits. In the 1970s and '80s, this cluster of cities south of San Francisco nurtured the invention of the personal computer.
Nowadays, the Silicon Valley is a rich ecosystem where everyone with an idea eventually shows up, raise some money, and get started. Numerous accelerators, such as Y Combinator make it easy to get a start, and the cost of starting a company has come down significantly due to cloud-based infrastructure and software development tools and frameworks.
However, Silicon Valley has become a self-parody, with all the downsides of its own success: race, age, and gender discrimination, drug and alcohol abuse, suicide and depression. Its "win at all costs mentality" has spawned excesses of every variety, also in the field of urban quality of life.
California's Silicon Valley is notoriously jobs-rich and housing-poor. There has been a particularly severe shortage of affordable housing, forcing workers employed in communities such as Mountain View, Los Altos, Sunnyvale and Santa Clara to live far from their workplaces, driving long distances through severe traffic congestion just to do their jobs. A detailed 2007 report developed by The Institute for Metropolitan Studies at San Jose State University found that Silicon Valley would need 90,000 new units of affordable housing over the next 20 years to meet growing demand.
This has been a drain on the region's economy, and a source of significant environmental damage. Because an insufficient number of homes have been built within existing Valley communities, the region's housing supply has taken the form of low-density suburban sprawl in far outlying areas, eating up the California landscape while mandating lengthy car trips that increase emissions of carbon dioxide and other air pollutants. The dilemma among land-use consumption by creating new residences for workers and traffic congestion for those living far away from their workplaces has driven the urban planning processes of Silicon Valley in the last decades (Gargiulo & Russo, 2017).
Ken Layne, an American writer, states that if Silicon Valley wants to remain the world's high-tech capital, it needs to reform itself into an urban wonderland instead of a Simi Valley suburb with lots of wealthy people. The writer proposes high quality residential areas, with services and activities and a complex system of light railway lines. The idea is to combine technological innovation and urban planning strategies in order to increase local competitiveness and turn cities into fertile grounds for attracting innovators, their ideas and their applications to the real world.

**The Innovation Complex: Cities, Tech, and the New Economy**


Author/Editor: Sharon Zukin
Publisher: Oxford University Press
Publication year: 2020
ISBN code: 978-0-19-008383-0

It is commonly said that "innovation and entrepreneurship" and how "good jobs" in tech will save our cities. Yet these common tropes hide a stunning reality: local lives and fortunes are tied to global capital. You see this clearly in metropolises such as San Francisco and New York that have emerged as "superstar cities." In these cities, startups bloom, jobs of the future multiply, and a meritocracy trained in digital technology, backed by investors who control deep pools of capital, forms a new class: the tech-financial elite. In The Innovation Complex, the eminent urbanist Sharon Zukin shows the way these forces shape the new urban economy through a rich and illuminating account of the rise of the tech sector in New York City.
The book introduced significant and interesting insights about how New York has become a supercity of the tech economy. Moreover, it presents a critical first look at urban economic transformation in the digital age and shows how the startup economy, tech ecosystem, and politics of innovation really work. Furthermore, it connects actions of government, business, and universities to expose the powerful underside of the new urban economy. The author combines original interviews with venture capitalists, startup founders, and economic development managers to explore the world of hackathons, meetups, accelerators, and innovation districts
Drawing from original interviews with venture capitalists, tech evangelists, and economic development officials, she shows how the ecosystem forms and reshapes the city from the ground up. Zukin explores the people and plans that have literally rooted digital technology in the city. That in turn has shaped a workforce, molded a mindset, and generated an archipelago of tech spaces, which in combination have produced a now-hegemonic "innovation" culture and geography. She begins with the subculture of hackathons and meetups, introduces startup founders and venture capitalists, and explores the transformation of the Brooklyn waterfront from industrial wasteland to "innovation coastline." She shows how, far beyond Silicon Valley, cities like New York are shaped by an influential "triple helix" of business, government, and university leaders-an alliance that joins C. Wright Mills's "power elite," real estate developers, and ambitious avatars of "academic capitalism." As a result, cities around the world are caught between the demands of the tech economy and communities' desires for growth-a massive and often-insurmountable challenge for those who hope to reap the rewards of innovation's success.

**Innovation Capacity and the City. The Enabling Role of Design**




Authors/Editors: Grazia Concilio, Ilaria Tosoni
Publisher: Springer
Publication year: 2019
ISBN code: 978-3-030-00122-3

Adopting design as a way to embed innovation within urban environments, in order to conceptualize feasible answers to complex global challenges, is the core topic of this book. In particular, our line of reasoning tries to reduce the conflict between those innovators who, despite targeting societal change and sustainability, adhere to the classical economic model and therefore look for market success and profitability and those who, otherwise and in opposition to such mindsets, do not focus on the potential for revenue from their innovations and promote alternative ideas and economies. To that end, this book explores the conditions for innovation to be disruptive of values yet, at the same time, gradual during the dynamics of change. For us, disruptiveness, with regards to values, is the best guarantee for establishing an effective path to sustainability, while the gradual aspect is crucial to reduce the risk of a dull resistance of the predominant socio-economic system.
With such an intent in mind, the book puts together three key concept domains rarely considered in a unitary fashion. They are: innovation, the only possible response to global crises, aiming at transforming behaviours and practices towards systemic changes and transition; design, a way of creatively conceiving, developing and driving forward new practices for undertaking large scale transitions; and cities, seen as the environments where problems present themselves in the most socially relevant way and at the same time as key opportunities for testing and adopting forms of innovation which target global challenges. Therefore, given the setup and aims of our reasoning, we interrogate how the interplay between design and the urban dimension can contribute to sparking or fastening the various pathways of the innovation process.

The book discusses these issues moving from some key research hypotheses. The first hypothesis concerns the application of design approaches and tools and how they can facilitate the generation of innovations in urban contexts both as an endogenous process relating to local resources and as a result of embedding innovations from other contexts with similar, or even dissimilar conditions. The second condition related to the fact that application of design approaches and tools may help propagate local innovation skills and capacities within urban contexts not having previously been exposed, to the required extent, to other innovation facilitating conditions. The third condition concerns the potential of application of design approaches and tools in facilitating the scaling, embedding and/or transferring, of innovations born from some urban contexts into other contexts having similar, or even dissimilar conditions.
Operationally, what the authors will be looking at are multiple (sub)processes, including: (i) the dynamics of innovation pathways and their interactions with the urban dimensions and resources; (ii) the skill and capacity building processes, enabled by design, leading to those relevant dynamics; (iii) the creation of the conditions for scaling innovation in a generative dialogue with the city; (iv) the creation of the conditions for distributing innovations "born elsewhere" and the generation of local "hubs" of actors dealing specifically with such innovations, and/or the transformation of those innovations into something else, more tailored to the local situation, or even dramatically different.
The last point alludes to Jacobs' belief in a powerful multiplier effect of the "two interlocking reciprocating systems" leading to "explosive city growth". As per our second caveat, we do not intend to follow such a line of thought to the point of considering a massive take up and a diffused emergence of innovations as the inevitable outcome of adding design tools, methods and instruments to a supposedly non-design-enabled process. More modestly, we will be satisfied if an "appropriate" injection of those methods and tools, combined with critical awareness for the role of urban dimensions and networks, will "increase" the creative capacity and/or encourage the relevant innovation to be judiciously adopted and put into practice in a certain community or environment.
The book chapters follow this reasoning starting from the exploration of key concepts and then introducing the main research findings.

**Uneven Innovation. The work of Smart Cities**


Authors/Editors: Jennifer Clark
Publisher: Columbia University Press
Publication year: 2020
ISBN code: 978-023-118496-0

The city of the future, we are told, is the smart city. By seamlessly integrating information and communication technologies into the provision and management of public services, such cities will enhance opportunity and bolster civic engagement. Smarter cities will bring in new revenue while saving money. They will be more of everything that a twenty-first century urban planner, citizen, and elected official want: more efficient, more sustainable, and more inclusive. Is this true?
In Uneven Innovation, Jennifer Clark considers the potential of these emerging technologies as well as their capacity to exacerbate existing inequalities and even produce new ones. She reframes the smart city concept within the trajectory of uneven development of cities and regions, as well as the long history of technocratic solutions to urban policy challenges. Clark argues that urban change driven by the technology sector is following the patterns that have previously led to imbalanced access, opportunities, and outcomes. The tech sector needs the city, yet it exploits and maintains unequal arrangements, embedding labor flexibility and precarity in the built environment. Technology development, Uneven Innovation contends, is the easy part; understanding the city and its governance, regulation, access, participation, and representation—all of which are complex and highly localized—is the real challenge. Clark's critique leads to policy prescriptions that present a path toward an alternative future in which smart cities result in more equitable communities.
Uneven Innovation problematizes the smart city project, showing us the many ways that it continues—rather than disrupts—underlying patterns of inequality, precariousness, and powerlessness. Clark's insightful critique is not only a call for action, her work draws to light the 'operational standards' that all cities should be pushed to uphold when engaging the latest urban development fad. An essential read for practitioners, activists, and scholars seeking to understand and shape the role of technology on the future of cities and the urban workforce.

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**REVIEW NOTES – Town Planning International Rules and Legislation**

# Resilience as an urban strategy: a comparison of resources and interventions in the European Recovery Plans for the green transition

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**Abstract**
Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always following a rigorous scientific in-depth analysis. This section of the Journal., Review Notes, is a continuous update about emerging topics concerning relationships among urban planning, mobility, and environment, thanks to a collection of short scientific papers written by young researchers. The Review Notes are made up of five parts. Each section examines a specific aspect of the broader information storage within the main interests of the TeMA Journal. In particular: the Town Planning International Rules and Legislation. Section aims at presenting the latest updates in the territorial and urban legislative sphere. The ecological transition is one of the most important missions within the recovery and resilience plans that aim towards an increasingly sustainable city model. The reference scientific literature highlights the importance of studying the relationships between energy policy and the physical-functional organization of urban systems. In this direction, the content of this review aims to define the framework of the interventions and resources in the resilience and recovery plans of two European states of Spain and Ireland. We review their ecological and green revolution/transition reforms in a comparative study with Italy and Germany. The aim is also to define the role and impacts of these reforms in future urban strategies.

**Keywords**
Urban sustainability; Recovery plans; Green energy transition; Covid-19.

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## 1. The economic framework in Covid-19

The pandemic still seems not to leave us and has generated a deep furrow globally (Ania & Joseph, 2021). The World Bank estimates that the Covid-19 has given rise to one of the worst economic recessions since 1870, dramatically increasing poverty levels. Countries such as Spain have suffered a decline in gross domestic product (GDP) over 10% and Italy with 8.8%. The whole employment geography has been distorted, involving unprecedented working conditions and the resulting crisis in many sectors. In the first phase of the pandemic, the economic recovery was very fragile. The International Monetary Fund attests that in the first phase of confinement, there was a suspension of 45% and more than 70% of companies, which recorded a significant reduction in their turnover compared to the previous year. Particularly affected by the current crisis are small and medium-sized enterprises, which represent the lifeblood of the economic and territorial fabric and risk being wiped out by this "storm". In the latest reports issued by the European Commission, economic forecasts seem to be giving positive signals. The EU economy recovered its level of pre-party production in the third quarter of 2021, from recovery to expansion. According to the projections, the EU economy will continue to expand, reaching 5%, 4.3%, and 2.5%, respectively, in 2021, 2022, and 2023. These prospects depend on the evolution of the pandemic and the pace at which supply adapts to the rapid reversal of demand after the reopening of the economy. According to this year's forecasts, employment in the EU will grow by 0.8% this year, by 1% in 2022 and by 0.6% in 2023. Employment is expected to exceed the pre-crisis level in the coming year and grow in 2023. In addition, unemployment in the EU fell from 7.1% this year to 6.7% and 6.5% in 2022 and 2023, respectively. The resumption of national economies is also due to the timely adoption of effective and coordinated measures that have partially limited the impact of this crisis. In particular, the enactment of the current recovery and resilience plans is an instrument both to relaunch the economy and provide opportunities for our European countries to improve the quality of life of citizens.

## 2. Transition to a green energy city model

Overall, the related reforms as envisaged in the recovery and resilience plans pursue two objectives. The first is to continue to maintain urban competitiveness within EU territories in a series of financing useful to restart urban business systems. The second is to give a boost to forms of organization of urban systems that aim towards ecological transition and sustainable mobility infrastructure. The set of reforms envisaged within the ecological transition show that it is necessary to intervene on all the components of a physical., functional and environmental urban system and to focus on how to structure the relationships between them (Gargiulo & Papa, 2021). "Ecological transition" means a set of actions aimed at the sustainability of the economy to facilitate the transition from a system based on polluting energy sources to a virtuous model based on green sources. Therefore, the ecological transition implies the ability of urban systems to "pass" towards production and consumption systems pre-existing to systems able to grow economic capital without destroying natural., social., and human capital (Bridge & Gailing, 2020). There is a need for a radical transformation of the production system towards a sustainable model that makes energy production, industrial production and, in general., people's behaviour and lifestyles less harmful to the environment. The growing importance of a geographical perspective on energy transition within countries' public policies and strategies is welcome compared to the challenges that cities face today, such as the climate crisis, reducing energy consumption and improving pedestrian and cycling accessibility to urban places and services (Zecca et al., 2020). The key points of the energy transition are: (i) renewable energy sources; (ii) sustainable agriculture and circular economy; (ii) zero-emission green mobility; (iv) environmental and biodiversity protection. Consequently, energy policy is invariably designed and applied within a real minefield of stakeholders, interests, conflicts, and alliances. It requires a long-term planning perspective and a holistic look at political., social., economic, and technological challenges and scenarios. It is generally accepted that in the sustainability global challenge, cities are the front-runners, with their strong role to be the core of the sustainable energy transition: role

recognised by the high presence of energy efficiency themes on the European Urban Agenda. The attention to the urban and territorial aspects of energy emerges, at the international level, close to the first energy crisis in the early 1970s and it considers, from the beginning, the integration of energy variables in the urban planning as a crucial theme. The systemic and critical framework draws scientific literature that highlights the importance of analysing the relations between energy policy and physical-functional organization of urban systems (Gargiulo & Russo, 2017). State of the art literature adopted illustrates the importance of including green energy strategies starting from spatial planning to increase the resilience of our territories. This theoretical awareness does not yet find an equivalent practical application in daily life's government and urban management by highlighting a gap. However, a holistic or integrated approach involving energy efficiency/savings in urban planning is not complete. The scientific community in recent years has developed a variety of strategies, approaches, and methodologies outlining a completely fragmented picture. Some studies have focused mainly on land use in relation to energy consumption (Navamuel et al., 2018; Hanif, 2018; Trepci et al., 2020). In particular, the study The Costs of Sprawl analyses the relationship between urban sprawl phenomena and related energy costs (along with other parameters such as environment, management). It analyses different models and configurations of population density to define the least burden of compact settlements. The density/energy consumption ratio has become a wide field of study. Other studies, however, have focused on the quality of the built environment through better integration between environmental conditions and the use of new technologies. Alongside this line, consideration of the economic value of energy decreases, and the energy component becomes important in the field of design (Mauree et al., 2018). In this research, a series of studies have been undertaken aimed at the energetic parameterization of urban blocks regarding solar gain (Raydan & Steemers, 2013). This approach paved the way for studies that focused only on buildings without considering other types of consumption (transport, services, production). However, it should be noted that the added value associated with energy consumption and behaviour changes, depending on the shape of the city. In this regard, it is important to highlight the studies of Oke, 1981 on the island of urban heat, showing how solar gain can produce discomfort in the city (especially in warm and temperate climates) and thus increase energy consumption. In summary, the scientific framework of reference shows that at the international level, the energy consumption of a territory depends on the settlement model and, vice versa, the energy shapes model the physical and functional organization of the settlement, the behaviour of citizens, and the process of social inclusion. Furthermore, energy-related planning is not yet integrated with spatial planning and is seen as a sectoral issue. The current trend to separate the theme of energy from spatial territorial increases the number of energy strategies, policies, and actions, making them non-integrated, with less impact on the city and less efficient results in the long run. This lack of integration reduces the ability to develop cities and societies with zero carbon emissions due to the complexity of managing bi-directional relationships. Therefore, the role of recovery and resilience plans, born in front of a pandemic scenario, can act as a hinge between the scientific community and territorial planning both at the national and local level aiming with public and private long and short-term investments able to exploit green energy efficiently. Sustainable and resilient development is needed to avoid inequalities and to allow everyone to benefit from the benefits of a cleaner and more inclusive economy. In this respect, the content of this review aims to define the framework of the interventions and resources in the resilience and recovery plans of two European states Spain -Ireland on the green revolution and ecological transition by comparing them with the other two recovery and resilience plans examined in the previous review (Gaglione & Ayiine-Etigo, 2021). In addition, the review aims to define the role and impacts of these reforms in future urban strategies and in the integration of planning tools addressing the challenges facing the city every day, such as climate change, land-use optimisation, urban regeneration, and respect for the principles of environmental sustainability.

**Plan de recuperación, transformación y resiliencia, Spain**

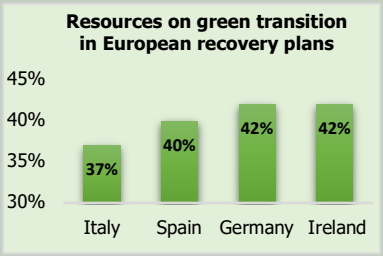
The structural reforms envisaged within the National Recovery and Resilience Plan of Spain constitute an opportunity for the Spanish economy, which for decades has led to significant imbalances that have indirectly hindered the ability to grow in a sustainable perspective over time. The strategic axes on which the Plan is based are: (i) the green transition; (ii) digital transformation; (iii) social and economic resilience. With respect to these three axes, Spain has allocated about 70% of its resources to projects which are functional to the green and digital transition. Most of the resources will be used in public investment at the same time in line with the Sustainable Development Goals of the UN Agenda 2030 and the specific recommendations of the EU institutions. The Spanish Government has expressly indicated in its text that the current uncertainty surrounding the COVID-19 pandemic and the actual recovery path of the economy has suggested that no assumptions should be made beyond 2023. It is deficient in terms of the degree of detail, particularly regarding the concrete modalities and timing of the use of funds during the period considered. At the present time, therefore, the total amount that Spain will be able to benefit from, consists exclusively of grants and is concentrated in the three-year period 2021-23, amounts to EUR 70 billion. The Government does not exclude the use of an additional 70 billion in the form of loans in the following three years, but this possibility is now to be considered hypothetical (the decision is postponed to the next years). The Plan's architecture is structured on 4 main pillars: green transition, digital transformation, social and territorial cohesion, gender equality. In turn, 10 missions and 30 implementation policies have been defined for each of the four pillars. In particular, the Plan highlights two important matrices. The first as each of the thirty implementing policies contribute to the missions in which the Plan is articulated. The second, instead, highlights the contribution of each policy compared to the thirty components of the Plan by defining three thresholds that are: equal to or above 40%; within 40 and 10%; less than 10%. The policies that affect urban systems and that can give direct and indirect benefits to the city are those concerning sustainable mobility in urban and metropolitan areas, renewable energy, and urban regeneration. As regards mobility, a plan for sustainable, safe, and connected urban and metropolitan mobility is planned. The main objective is to decarbonize urban mobility and improve air quality and city life. The project should make it possible to exploit the economic, social., and industrial opportunities associated with this type of transformation. The realization of the investment passes through a modernization of the existing infrastructures and an optimization of the urban and metropolitan transport. The improvement of infrastructure for mobility should contribute positively to both the development of territories and social cohesion. Regarding renewable energy, the National Plan of Energy and Climate (PNIEC) (2021-2030) will be implemented to provide guidelines and strategies for a green city model. In the current context it is essential to accelerate the actions provided for in the Plan. This would ensure, the production model, promotion of decarbonisation, energy efficiency, implementation and integration of renewable energy, development of energy storage, circular economy, nature-based solutions and improve the resilience of all economic sectors. This Plan provides for a significant increase in the use of renewable energy, which, in 2030, should account for 74% of the total resources available and reach 42% of end-users. Finally, provide an urban regeneration plan through recovery and redevelopment programmes of the real estate at the urban scale. Consequently, that would ensure quality and safety of living both from a social and environmental point of view also improving Within the individual neighbourhood’s pedestrian and cycling trips to reach places and urban services.

**National Recovery and Resilience Plan, Ireland**

Reforms and investment in the Plan will help Ireland to become more sustainable, resilient, and better prepared for the challenges of their territorial contexts. During the design of the Plan, the Irish authorities consulted the social partners and national and regional stakeholders, while continuing a close dialogue with the Commission prior to the formal submission of the Plan. In detail, the Plan as Spain moves on three main components, namely, the green transition where 42% of investments are expected, the digital transition 32% and finally the social and economic resilience 26%. A total of EUR 989 million will be provided in grants. In turn, the Plan consists of 16 investment measures and 9 reforms in the three components listed above. As far as the green transition is concerned, climate and environmental policies aim to achieve the climate and energy targets for 2030, which will be a major challenge despite the adopted climate action plan. Secondly, Ireland's contribution to the EU's energy efficiency target remains unambitious. Finally, Ireland needs to significantly accelerate the roll-out of renewables, especially onshore and offshore wind, to reach the target of 70% renewable electricity by 2030. Investments concerning the green transition on forms of mobility in electrification and the upgrade of Cork Suburban Rail located in the county of the province of Munster in Ireland where it aims to encourage the transition from private cars to transport railway.
In Ireland, only 2.75% of the network is electrified, which is very low compared to the rest of Europe. The Plan foresees targeted investments in the commuter railway around the city of Cork, providing significant capacity increases, including the construction of a through platform at Kent Station, the doubling of the line between Glounthaune and Midleton, and the new signal., given future electrification. Regarding renewable energy, energy efficiency reforms in residential and public buildings are planned, helping households, companies, and the public sector invest in energy efficiency and green

technological solutions to reduce carbon emissions. Finally, the rehabilitation of wetlands to change the use of soil from peat extraction to carbon sequestration. The Irish Plan also includes climate change reforms. For example, Ireland will reform the climate governance framework and enshrine climate neutrality in the law by 2050. Secondly, Ireland will also implement carbon tax legislation.

**A comparison of the European Recovery Plans**




The comparative analysis of the four plans allows one to observe the priorities introduced by the two States described in this review and those described in the previous review (Gaglione & Ayiine-Etigo, 2021). All EU plans have met the minimum expenditure parameters of 37% for the climate and 20% for digitisation. Their weights of actions and interventions are different, both in absolute value and as a percentage of the total resources available. The plans also have quite different structures, making it difficult to compare them given the different needs and territorial characteristics. Italy requested the most of 122,60 billion in loans and 68,88 billion in grants for the amount for six years, respectively. Spain applied for 69.51 billion in grants; Germany 25.61 billion, and Ireland 0.99 billion. Compared to a city's physical., environmental., and built-up urban features, the plans move over common areas and with different methods and tools. First, with Italy, an entire package of 59.47 billion foreseen for the green transition has given greater priority to renewable energy, hydrogen, network, and sustainable mobility providing for funding of 23,78 billion and the energy efficiency and upgrading of buildings with an amount of 15.36 billion compared to the circular economy and sustainable agriculture of 5.27 billion and protection of land and water resources of 15.06 billion. Within each macro-category, such as renewable energy, hydrogen, network and sustainable mobility, the priorities are addressed to a territory's physical characteristics. For example, 8,58 billion has been voted to develop a more sustainable local transport combined with the increase in the share of energy produced from renewable energy sources of 5.90 billion and followed immediately after by the upgrading and digitization network infrastructure of 4.11 billion. 13.95 billion is invested in energy efficiency, redevelopment of buildings, and seismic efficiency. Finally, on the protection of land and water resources, only 1.69 billion is provided to protect green areas and soil. Secondly, Germany's green reforms are divided into three main components. The largest resources were used in the Climate-friendly mobility component with an amount equal to 6,6 million, using half of the resources envisaged in the ecological transition equal to 22%. It is preferred to promote the purchase of alternative traction buses for rail transport and committed to replacing the fleet of heavy commercial vehicles with an amount of 2.5 million. This is followed by the relative component Decarbonisation using renewable hydrogen with a sum of 3,2 million equal to 11% aimed at creating integrated energy systems based on renewable energy sources and oriented towards climate objectives. Finally, the third component on Climate-friendly renovation and construction with an amount of 2.6 equal to 9%. In this sector, investments were made mainly in the energy efficiency of buildings with an amount of 2.5 million euros. Ireland has given the highest priority to improving mobility towards more sustainable reforms with 164 million. It has pledged to reduce carbon emissions by 108 million. While unlike other countries has made a more significant contribution to supporting research projects and innovation to develop solutions in the climate sector of 72 million followed immediately after the improvement of the energy efficiency of buildings 60 million. Finally, Spain, like other countries, has given priority to promoting an emergency plan for sustainable mobility in urban and metropolitan areas with an amount of 6.54 million and at the same time an urban regeneration plan of 6.82 million. Spain further invested an amount of 3.16 million in a National Energy and Climate Plan (PNIEC) (2021-2030). To conclude, the comparison of the different recovery plans highlighted the implementation of sectoral measures on the different components of an urban system in common areas related to sustainable mobility, renewable energy, and the energy efficiency of buildings. Only Spain has introduced measures to realize instruments with the Plans. Spain has defined the system of rules and organization of the examined territorial context like the PNIEC. The role of these reforms in the recovery plans must act as a hinge and coordination of research policies at the European, national., regional levels to address current and new urban strategies. In addition, the review argues that the recent reforms planned for transitions should aim to combine the theme of Energy in Spatial Planning at different scales, from national to local. Similarly, the recovery plans emphasize place and resources synthesis. In all scientific research will, in the ensuing years, define the wealth of knowledge and methods for the great challenges that cities are called to respond. For example, climate change, energy efficiency, soil protection as well as an update of existing planning tools, such as the national climate change adaptation plan, to increase the resilience of the territory by adapting and renewing, respecting their functions and the identity of their places.

## Author Contributions

The work, although the result of a common reflection, was divided as follows: David Ania Ayiine-Etigo, paragraphs 1 and review box of "National Recovery and Resilience Plan, Ireland"; Federica Gaglione paragraphs 2, review box of "Plan de recuperación, transformación y resiliencia, Spain" and a comparison of the European Recovery Plans.

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**REVIEW NOTES – Urban practices**

# Toward greener and pandemic-proof cities: policy responses to Covid-19 outbreak in four European cities

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**Abstract**
Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always following a rigorous scientific in-depth analysis. This section of the Journal, Review Notes, is the expression of a continuous updating of emerging topics concerning relationships among urban planning, mobility and environment, through a collection of short scientific papers. The Review Notes are made of four parts. Each section examines a specific aspect of the broader information storage within the main interests of TeMA Journal. In particular, the Urban practices section aims at presenting recent advancements on relevant topics that underlie the challenges that the cities have to face. The present note provides an overview of the policies and initiatives undertaken in four global cities in response to the Covid-19 outbreak: Madrid (ES), London (UK), Milan (IT) and Brussels (BE). A cross-city analysis is used to derive a taxonomy of urban policy measures. The contribution discusses the effectiveness of each measures in providing answers to epidemic threats in urban areas while, at the same time, improving the sustainability and resilience of urban communities.

**Keywords**
Covid-19; Urban policies; Madrid; London; Milan; Brussels.

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# 1. Introduction

In December 2019, in the Wuhan province of China, a new form of Coronavirus (Covid-19) emerged. Since then, the virus has been spreading globally and, as of 05 October 2021, more than 200 Countries around the world have reported 271 million confirmed cases and a death toll of 5.32 million deaths (Template: Covid-19 pandemic data). The Covid-19 pandemic triggered both third and first world economies, causing severe disruption to society and business, especially in urban areas (OECD, 2020a).

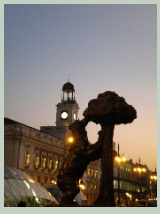
# 2. Toward greener and pandemic-proof urban areas?

Urban areas have been the ground zero of the COVID-19 pandemic, with 90 per cent of reported cases (UN, 2020). They are densely populated places where people live and gather, thus at high risk of spreading the virus due to the close proximity among residents and challenges to implement social distancing (Neiderud, 2015). These conditions have generated a large debate about the future role of cities in the post-Covid scenario. In this respect, some authors have argued that large urban areas are nearly defenseless in times of unprecedented disease outbreaks (Desai, 2020) and that dense urban settlements are not compatible with the needs of social distancing (Megahed & Ghoneim, 2020). These circumstances, coupled with increasing dematerialization of services and pandemic-pushed growing teleworking rates, have prompted some authors to questioning the ever-growing urban concentration model and envisioning a resurgence of rural areas as alternative and safer mode of urbanization in the post-Covid society (Cotella & Brovarone, 2020).

On the contrary, other authors have stressed the pivotal role played by cities in the Covid-19 response in terms of implementing nation-wide measures, but also in terms of providing laboratories for bottom-up and innovative recovery strategies (UN, 2020; OECD, 2020a; UCCN, 2020). Advocates of this second line of argument have seen in the Covid-19 crises an unpredictable opportunity to reshape our cities toward a greener and pandemic-proof urban future (OECD 2020a; Lai et al., 2020; Pierantoni et al., 2020). These optimistic claims are supported by a growing body of interdisciplinary research. Synergies, indeed, has been identified between policies aimed at providing answers to epidemic threats in urban areas and policies aimed at improving the sustainability and resilience of urban settlements (Garcia, 2020; Barbarossa, 2020; Pinheiro et al., 2020). Decentralization of public facilities, prioritization of soft over car-centric mobility, hierarchization of the transport system and public services, and redundancy of public, green and open-space functions have been identified as integrated measures able to achieve both public health and city sustainability targets (Pisano, 2020; Sharifi et al., 2020).

Within this context, the present short paper provides an overview of the policies and the initiatives undertaken in four major European Cities in response to the Covid outbreak: Madrid (ES), London (UK), Milan (IT) and Brussels (BE). This is followed, in paragraph 4, by a discussion on whether these measures are (or will) promote a sustainable urban recovery.

### 2.1 Madrid



Madrid is the capital and most populous city of Spain, with an estimated population of almost 3.4 million inhabitants. It is the second largest city in Europe and its influence in politics, education, entertainment, environment, media, fashion, science, culture, and the arts all contribute to its status as one of the world's major global cities.

Due to the pandemic crises, economic activity in Madrid suffered a strong setback of 9.6% in 2020, bringing its powerful growth of 3.6% in 2019 to a halt. The unemployment rate reached 14.03 percentage points, an increase of 3.83 points compared to the previous year. This slump in economic activity has caused income to fall in 37% of Madrid households to at least some extent.

To cushion the impacts of such an unprecedented situation, the City Council has drawn up in June 2021 the *Recovery, Transformation and Resilience Plan*. The plan seeks to make Madrid one of the best city to live and work in 2030 and has been developed, since its inception, in coordination with the 2019-2023 *Government Operational Program*, whose objective is to advance the social protection of the most vulnerable people, who have been especially impacted by the crisis caused by the pandemic, as well as to recover and stimulate the city's economic activity. The plan identifies 26

transformation challenges and includes a total of 105 investments with an estimated budget of 3.900 million euros. These measures, which are structured into 10 lines of action, constitute a catalogue of high-impact actions, in strategic areas, aligned with the 10 leveraging policies of the *National Recovery Plan*. For instance, the *City Renaturalisation* line of action is aimed at increasing the quantity and connection of urban green areas. This line of action addresses renaturalisation at three different scales: building, neighborhood and city, thus covering a wide variety of interventions ranging from the implementation of green roofs to the design of large urban green infrastructures. The most notable proposal under this line of action, due to its scope and expected impact, is a city-scale renaturation project with a wide time horizon, known as the *Metropolitan Forest* project. It will constitute a green infrastructure that will extend over 75 kilometers, and foresees the planting of up to 450.000 trees of native species. The *Sustainable Mobility* line of action promotes low-emission mobility and will involve the progressive adaptation of the city's infrastructures. Actions within this pillar include the extension of the city's network of bike lanes as well as the commitment towards the complete electrification of the city's bus fleet and the introduction of "green" hydrogen as a new sustainable energy vector. The *Urban Regeneration* line of action will carry out the urban rehabilitation of neighborhoods and degraded or aged areas, incorporating sustainability criteria, seeking to recover urban spaces and buildings. This line of action also aims at creating new centralities by following a polycentric city model to favor an urban balance and strengthen the quality of life in the neighborhoods. Service centers will be promoted in different areas of the city with special attention given to the neighborhoods hardest hit by COVID where the vast majority of interventions will be articulated. The *Resilient and Capacitated Children, Adolescents and Youth* line of intervention includes a number of actions finalized at supporting families and their most vulnerable members through education and training for employment. This line of action also addresses the reduction of the gap between men and women, while eliminating gender violence, through initiatives such as the following: i) equalizing the remuneration of men and women; ii) increase of women in managerial positions; iii) implementation of gender equality plans and iv) promotion of co-responsibility in the care of children. Finally, the plan identifies a series of different formulas for public-private collaboration, with the goal of increasing the capacity and efficiency of investments in projects due to the multiplier effect of mobilizing public resources jointly with the business and productive sector and the involvement of social agents, to achieve the challenges faced by the Spanish capital city.

**2.2 London**

With a population of 8.9 million inhabitants, London is the capital and largest city of the UK, the biggest urban economy in Europe and one of the major financial centres in the world. The pandemic has severely hit the city's economy that has witnessed a major recession in the course of 2020 with a GDP loss of 16.6% in Q2 2020 over Q1. Furthermore, the pandemic has further exacerbated pre-existing social inequalities, with low-income workers of colour, young adults, and women being the most affected social groups.

In order to address the challenges imposed by the virus outbreak, in June 2020, London's business and community groups have come together with the Mayor and leaders of London Councils to form the *London Recovery Board*, an initiative aimed at reshaping London as a fairer, more equal, greener and resilient city than it was before the crisis. The Board has identified a grand challenge that is "to restore confidence in the city, minimise the impact on communities and build back better the city's economy and society". Based on a participatory process that has involved over 63,000 Londoners, the Board has formulated 9 missions to help building the city back better. The latter has been lately included in the *London Recovery Programme,* a strategic document issued by the Greater London Authority in October 2020. The *High Streets for All* mission seeks to stich the essential uses of the city back together following decades of fragmented city planning to restore local neighbourhood functions. To this end, the mission includes a number of initiatives such as the redevelopment of vacant and underused buildings into productive use; the development of flexible and family friendly local work spaces; the restoration and the expansion of public space that will help support local small businesses, foster community ties and provide space for arts and culture. The *Green New Deal* mission is aimed at tackling the climate and ecological emergencies and improve air quality by doubling the size of London's green economy by 2030. To meet this target, a number of coordinated actions are envisioned, such as scaling-up programmes to retrofit and improve the energy efficiency of the existing building stock, and mobilising finance to support environmental programmes and provide support for the growth of London's clean tech and circular businesses. The *Helping Londoners into Good Work* mission is finalized at supporting Londoners entering into good jobs, with a focus on key sectors to London's recovery. Actions under this missions include: i) establishing sector specific London 'Academies' to support Londoners to gain relevant skills and move into good work in digital, health, social care, green economy, and creative and cultural industries; ii) coordinating skills, careers and employment and ensuring that employment and enterprise provide a secure route out of poverty and iii) attracting international investments in economic sectors that are considered key to London's recovery. The *Healthy Food Healthy Weight* mission aims to ensure that all Londoners have access to healthy food within an environment that supports them to maintain a healthy lifestyle. Actions under this pillars are thus target at: i) increasing physical accessibility to healthy food by offering incentives and encouraging the establishment of farmers' markets and ii) promoting physical activity by improving walking and cycling conditions as well as expanding urban green areas. The *Digital Access for all* mission is aimed at ensuring that every Londoner have access to good connectivity, basic digital skills and the devices or support they need to be online by 2025. To meet this target the city of London has launched a number of initiatives, such as the *DevicesDotNow* and the *Good*

*Things Foundation* network that have distributed thousands of devices to continue learning online to both year 10 pupils and adult learners. Furthermore, under this mission, the city is in the process of developing a long-term strategy for the implementation and maintenance of a modern and efficient 5G network, in collaboration with the agents of the sector, which will facilitate both the deployment of 5G infrastructures in significant municipal spaces and the development of standardized technological solutions.

**2.3 Milan**

Whit 1.4 million inhabitants, Milan is the second largest city in Italy. As the capital city of the Lombardy, one of the wealthiest EU regions, Milan is considered a leading alpha global city, with strengths in the fields of the finance, commerce, art, design, fashion, media services, research and tourism.
On February 21st 2020, the first Italian Covid-19 case was registered in Codogno, a small town about 50 kilometers south of Milan. Since then, the virus has spread over the Lombardy region, making Lombardy and its capital the focal point of the virus outbreak in Italy. The pandemic has severely hit the city's dynamic economy and social life, reversing the long-standing growth trends that have characterized its economy, with consulting services, finance, constructions and horeca being the most affected economic sectors. In order to provide a response to the social and economic challenges posed by the pandemic, on May 4th 2020, the city Council launched *Milan 2030,* the city's adaptation strategy to the Covid pandemic. The document was first released as a draft in early April 2020, open to observations and contributions through an online participatory process. Central to the adaptation strategy is the idea that the pandemic is generating long-lasting radical changes in citizens lifestyle and business operations and that these changes will require a strong reorganization of the city's physical and organizational assets. Therefore, city's reorganization should not merely provide a short-term operational response, but should also set the condition for improving city's readiness and resilience to current and future critical situations that could occur in the mid and long term. The first part of plan provides an analysis of the social and economic impacts of the virus outbreak. This part serves as the plan knowledge-base to set a future vision of the city. The vision encompass 5 main guiding principles in the fields of governance, economic development, public services, workforce and sustainability. Based on such principles, several planning and revitalization interventions are defined. One of the most important line of intervention concerns with the reallocation of the uses of roads and public spaces with the main objective to increase soft mobility supply and develop areas that allow commercial, recreational, cultural, and sporting developments, while respecting the appropriate physical distances. In this respect, the adaptation strategy envisions the development of 35 km of new bicycle lanes, the re-development of city's pedestrian paths, with new and widened pavements, and the extension of Limited Traffic Zones and pedestrian areas. On the land use side, interventions have been target at strengthening public services with attention to proximity, ensuring access within a 15-mininutes walk to essential services, balancing the differences between neighborhoods, enhancing specificities, and trying to reduce inter-district travel. Accordingly, the Municipality of Milan is cooperating with the Lombardy Region to create local services, starting from popular neighborhoods, with high population density and characterized by an older population. Other strategic lines of intervention included the adaptation of the city's Time and Hours Plan to a different schedule for public services especially for social and educational services and productive activities, in order to avoid overlaps in entry and exit times, regulate the demand for mobility and facilitate physical distancing, identifying timeslots reserved for the most vulnerable groups. A further line of intervention concerned with the simplification, expansion and acceleration of digital services available to the citizens in order to reduce the needs to travel and contain physical contacts between public servants and city users. Finally, the plan intends to support both business and household economic recovery by providing e.g. microenterprises financing services, social rental services and facilitated access to credit. A dedicated section of the strategy is also devoted to skills redevelopment, targeting individuals that have lost their jobs due to the current crises.

**2.4 Brussels**

Brussels — officially the Brussels-Capital Region — is a region of Belgium comprising 19 municipalities, including the City of Brussels and has an urban population of 1.2 million inhabitants. It grew from a small rural settlement on the river Senne to become the de facto capital of the European Union, as it hosts a number of principal EU institutions, including the European Parliament, the Commission and other administrative, legislative and executive EU institutions and agencies. As one of the top financial centers of Western Europe, it's economy is largely service-oriented and dominated by regional and world headquarters of international companies though it still does have a number of notable craft industries. Brussels have been severely hit by the Covid pandemic with consultancy, horeca and commerce being the most affected sectors. More than one in four workers have been put on temporary unemployment since March 2020, while the city GDP is expected to shrink by 8% this year. Furthermore, the effect of the pandemic has also been felt unequally in Brussels, where infection rates have been two or three times higher in poorer, cramped neighborhoods than in richer, greener ones.
In contrast with the cities of Madrid, London and Milan that have articulated organic city adaptation responses, Brussels response to the Covid-19 has been relatively fragmented and characterized by a number of sectoral policies regulating

different aspect of the urban life. These measures have been issued by the City Council between March and October 2021, targeting specific policy domains such as mobility, social welfare, land uses and public services. In particular, measures in the mobility domain have been the focus of the city administration. When confinement was imposed on 19 March, the immediate priority of Brussels authorities was indeed to encourage social distancing by giving more space to cyclists, pedestrians and shoppers. In this respect, the city started the construction of dedicated bike lanes in the capital – infrastructure that has been increasing in recent years but still lags behind cities in Flanders, the Netherlands, and Denmark and elsewhere. In particular, from May to November 2020 over 40 kilometers of new, dedicated cycle paths were developed. Even Rue de la Loi, one of Brussels' most congested streets that snakes past the Belgian parliament and the European Commission headquarters, got the bike lane treatment in May. Dedicated bike lanes and fewer cars on the road has led to an explosion in bike use – up 44% on the previous year in early September. Another important measure in the soft mobility domain concerns the extension of pedestrian areas in the historic city center. Since September 2020, the so-called "Pentagon" area has been divided into different residential areas where quality of life and safety are priorities and where the maximum speed of 20 km/h is maintained. In this way, the city created more space to respect the physical distance rules. The City of Brussels has decided to adjust this temporary measure in order to be better suited to residents and traders, but also commuters, visitors, customer. A participatory process has been also launched in September 2020 to review the impact of the adopted measure and to ensure that all city users are heard in this project.
The city has devoted increasing attention to the recovery of commercial, leisure and horeca activities and has developed in May 2020 a dedicated recovery plan. Beside financial aids and incentives, bars, restaurant and café have been allowed to expand their terraces onto sidewalks and even close roads in some areas. Finally, the city has created a special structure, the Social Action Unit COVID (CSAC), to assist the inhabitants of Brussels who were materially, financially and psychologically affected by the Covid-19 crisis.

## 3. Discussion and conclusions

As Covid-19 spreads across the world, cities have become epicenters of the pandemic, amplifying the spread and transmission of infection, with their dense population and transport networks. At the same time, cities have become catalyst of sustainable recovery. Many examples of good practices taking place in cities across the word are captured by dedicated and constantly-updated reports of international organizations such as WHO (2020), UN (2020) and OECD (2020a) and UCCN (2020). This contribution provided a focus on European cities and examined policy response to the Covid-19 epidemic in a sample of four representative urban areas. A cross-city analysis of measures implemented in the cities under investigation can be a useful exercise to derive a taxonomy of urban policy measures. This is reported below, together with some considerations on the effectiveness of such measures in providing answers to epidemic threats in urban areas while, at the same time, improving the sustainability and resilience of urban communities. Considering the social, the physical and the functional subsystems composing the city, measures could be addressed to:

### 3.1 Physical subsystem

- *Expansion of cycling infrastructures*. Cycling is promoted by many cities as a recovery strategy since it can reduce pressure on crowded (and often depotentiated) public transport while allowing citizens to respect social distancing, thus lowering the risk of virus transmission. Especially in dense urban settlements, as those exanimated in this article, where commuting distances are compatible with the use of bike, cycling represents an alternatives solution to provide citizens with essential needs, go to work when necessary, and still perform some physical activity, even in times of pandemic outbreaks (Garcia, 2020). At the same time, the promotion of cycling in urban areas represents an essential ingredient to improve cities livability and reduce the externalities of car-oriented urban development (Ison & Shaw, 2012).
- *Improvement of walking paths/ expansion of pedestrian areas*. These measures can be considered effective tools to promote sustainable mobility while, at the same time adapting the city physical environment to the new challenges imposed by the virus outbreak. On the city sustainability side, these measures can contribute to sustainable mobility targets by shifting mobility demand from private cars to active transportation modes (Li et al., 2014). On the health side, ameliorate walkability has been

demonstrated an effective tool to improve public health by promoting physical activity (Frank et al., 2006). Furthermore, extension of pedestrian areas and sidewalks can guarantee enough space for safe physical distancing while favoring business reopening by accommodating longer lines deriving for lower business accommodation capabilities (WHO, 2020).

- *Extension of green and open space functions*. Environmental benefit of public, green and open spaces are well-established: they contribute to the purification of water and air climate, to the regulation and mitigation of the urban climate, and support biodiversity conservation (Chiesura, 2004). Following the pandemic outbreak, researchers have found that the virus transmission spreads more easily indoors than outdoors (Morawskaa & Caob, 2020) and that urban green urban spaces have been crucial for exercise and mental wellbeing during the stringent lockdown (Razani et al., 2020). Extension of these areas represents thus a valuable contribution to foster city sustainability while, at the same, time providing concrete spatial planning answers to epidemic threats.

## 3.2 Functional subsystem

- *Decentralization of public facilities*. Decentralization of public facilities is considered a fundamental property to contain the spread of the virus since it allows people to be able to get the goods and facilities they need within the minimum distance from their houses, thus limiting the interaction with the other sectors of the population (Pinheiro et al., 2020). Furthermore, the decentralization of healthcare services can reduce the response time, and saving operating costs (Pisani, 2020). A balanced juxtaposition of homes and services, is thus not only a well-known urban planning strategy to reduce long-distance trips and promote active transport, but represents also an emerging tool for containing epidemic spreading.
- *Improvement of IT infrastructures and digital services*. These measures can generate positive co-benefits: the digitalization of public services can indeed reduce the need to travel while at the same time contain physical contacts between public servants and city users. Furthermore, IT technologies can also provide a fast and concrete response to citizen's needs. Investments in this domain should be thus certainly encouraged in the context of city's recovery plan.

## 3.3 Social subsystem

- *Households / small business economic support.* The pandemic crises has exacerbated the existing social inequalities while severely affecting cities economy. Measure aimed at provide households economic, social or rental support as well as measures target at provide relief to most affected economic sectors have been implemented in all cities under investigation. While undoubtedly necessary, these measure, if not integrated in a wider urban economic recovery strategy, can be considered only effective in the short term. Their impacts on cities sustainability and resilience is hard to demonstrate.
- *Human capital development*. According to OECD (2020b), the global pandemic is triggering substantial changes in the labor market. Accordingly, it is essential for governments to help workers transition to the post-Covid 19 economy. These measures are highly recommended by international organizations as they provide the ground for fostering citizens' resilience to current and future disruptive events.

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## Image Sources

All images are from wekepedia.org.

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**REVIEW NOTES – Economy, business and land use**

# Sustainable development in cities: a review of frameworks and indexes

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**Abstract**
Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always following a rigorous scientific in-depth analysis. This section of the Journal, Review Notes, is the expression of a continuous updating of emerging topics concerning relationships among urban planning, mobility and environment, through a collection of short scientific papers. The Review Notes are made of four parts. Each section examines a specific aspect of the broader information storage within the main interests of TeMA Journal. In particular, the Economy, business and land use section aims at presenting recent advancements on relevant topics that underlie socio-economic relationships between firms and territories. The present note tries to clarify the concept of sustainable city from a practical perspective rather than from a theoretical one. It does that by describing some of the most widespread framework in defining urban sustainability.

**Keywords**
Urban sustainability; sustainability indexes; sustainability framework

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# 1. Introduction

The issue of sustainability has become central in the research agenda of a great number of scientific disciplines. The concept of sustainability is deeply intertwined with the economic development. In other words, in the modern society in which we live no economic development is possible without making it sustainable. This aspect is applicable also to urban development as this review notes are extensively trying to enquire. Sustainability in cities is becoming a central issue in the policy agenda, given the rapid growth of city population and the consequent environmental and social problems related to it (Chen & Zhang, 2020; Guida & Carpentieri, 2021; Martínez-Bravo et al., 2019). For example, several cities are designing plans to decrease their dependence to fossil energy towards renewable ones, even if this transition is not free from obstacles and challenges (Mazzeo, 2019). In addition, climate change poses new risks and challenges to which cities should reply by developing adaptation plans (Ministero dell'Ambiente, 2018). Literature about public policy, indeed, agrees on the fact that, in order to embrace a sustainable transition, administrations should support "*radical transformations in technologies, markets and institutions towards sustainability goals*" (Truffer & Coenen, 2012, p. 3). The concept can be declined in the three spheres of economic, social and environmental sustainability, and it is a shared opinion that an effective sustainable development should take in consideration all of the three aspects without neglecting one of them. However, organizations - both public, private, and administrative - may set priorities related to their needs and characteristics that could skew activities towards one of the three pillars. For example, private companies working the energy sector may tend to give priority to activities oriented towards environment preservation and climate change. Similarly, urban areas may be more efficient in implementing one of the three pillars of sustainability. Previous studies have extensively described what is sustainability for cities and what are the aspects to be implemented in order to set up an effective sustainable development strategy (among others, Bianconi et al., 2018; Mori & Christodoulou, 2012; Sodiq et al., 2019; Tira, 2020). Moreover, in recent years, several organizations have tried to assess the advancements of urban areas on the sustainable development disentangling it into the three pillars, by developing sustainability indexes. They are effective tools composed of several different indicators that measure economic, environmental and social performance. In doing so, the indexes provide useful instruments that underline what are the specific topics – and the related activities – material to the sustainable development of cities. Indeed, by monitoring the advancements on indicators provided by these frameworks, urban areas can develop more effective sustainable development strategies. In this review note, I try to describe some of the most important city sustainability frameworks in order to clarify what are the most important aspects considered by the scientific and policy community when describing how sustainability can be assessed for urban areas. In particular, this short paper focuses on three guides that provide indications to develop city sustainability indexes: the *Reference Framework for Sustainable Cities*, and the report called *Indicators for Sustainable Cities* provided by the European Commission. Furthermore, this work also comments the *Sustainable Cities Index* provided by the listed company Arcadis in 2018.

# 2. Sustainability indexes and indicators

Before unveiling the indicators provided by the sustainability indexes, it is appropriate to understand what should be the priorities for the sustainable development of cities. The Reference Framework for Sustainable Cities (RFSC) provides an interesting scheme for understanding that. The RFSC is an initiative developed by the French Ministry in charge of housing and urban development, the Council of European Municipalities and Regions, and the CEREMA, a public body that supports national and local authorities towards sustainable development. It has the support of several partners included the European Commission. The RFSC provides a framework for assessing the sustainability of cities that enriches the scheme of the triple bottom line. In

addition to the economic, environmental and social pillars, indeed, the framework suggests two further dimensions on which to evaluate urban sustainability: the spatial dimension and the governance dimension. The five dimensions group a total number of 30 topics that are represented in Tab.1.

| Sustainability dimension | Topic |
|---|---|
| Spatial | Develop sustainable urban planning and land use |
| | Ensure spatial equality |
| | Encourage territorial resilience |
| | Preserve and enhance urban, architectural and cultural heritage |
| | Promote high quality and functionality of public spaces and living environment |
| | Develop alternative and sustainable mobility |
| Governance | Ensure an integrated territorial strategy |
| | Foster sustainable administration and financial city management |
| | Implement a process for assessment and on-going improvement |
| | Increase citizen participation |
| | Strengthen governance in partnership |
| | Facilitate capacity building and networking |
| Social | Ensure social inclusion |
| | Ensure social and intergenerational equity |
| | Build a supply of housing for everyone |
| | Protect and promote health and well-being |
| | Improve inclusive education and training |
| | Promote culture and leisure opportunities |
| Economical | Stimulate green growth and the circular economy |
| | Promote innovation and smart cities |
| | Ensure connectivity |
| | Develop employment and resilient local economy |
| | Encourage sustainable production and consumption |
| | Foster cooperation and innovative partnerships |
| Environmental | Mitigate climate change |
| | Protect, restore and enhance biodiversity and ecosystems |
| | Reduce pollution |
| | Adapt to climate change |
| | Manage natural materials resources sustainability and prevent waste |
| | Protect, preserve and manage water resources |

**Tab.1 The dimensions of the sustainable city (source : www.rfsc.eu)**

This framework supports local administrations to design their sustainable development plans that should be then evaluated on a number of indicators. It has been developed to summarize the several frameworks designed at European and global level creating an integrated scheme for urban development. In other words, it provides the synthesis of some of the most spread sustainable urban policies, giving precise indications about how to develop a sustainable urban environment. Based on this framework it becomes easier to understand the indexes and indicators provided by other organizations to quantitatively and qualitatively assess and monitor the progress made. The indexes also provide a tool for a benchmark among cities. There exist several urban sustainability indexes, but most of them are mainly concentrated on the level of environmental sustainability and green infrastructures, sometimes avoiding issues related to climate

change adaptation, sustainable governance or sustained economic growth. The document *Indicators for Sustainable Cities* of the European Commission provides an overview of such indexes. Out of the 14 indexes described, six are mainly referred to the environmental sphere and in particular to the issues of pollution and resource use. On the other side, is not common to find indicators related to the climate change adaptation and adjustment, the governance and sustained economic growth. In this sense, one of the most holistic indexes is the *China Urban Sustainability Index.* It is still skewed on environmental concerns, but also takes into account other social and governance factors. In Europe, the most complete tool is probably the one provided by the European Foundation for the Improvement of Living and Working Conditions. This framework indeed, identifies the following indicators: *global climate, air quality, acidification, ecosystem toxification, urban mobility, waste management, energy consumption, water consumption, nuisance, social justice, housing quality, urban safety, economic urban sustainability, green public space and heritage, citizen participation, unique sustainability*. These indicators really reflect the commitment towards sustainability from all the relevant perspectives and not just from the environmental one, as most of the other indexes do. According to the RFSC, thus, this scheme can be considered a good one to assess and monitor the sustainable development of cities.

Finally, an interesting perspective is the one provided by the private company Arcadis that has developed a composite index based the triple bottom line: social (people), environmental (planet) ad economic (profit) sustainability. The index is interesting because it provides a ranking of several cities worldwide, thus providing examples that may clarify how cities rank in sustainability indexes. The index is described in the following green box.

**Sustainable cities index - Arcadis**

Developed in 2018, the index explores the perspective of citizens. It is divided into the social, economic and environmental spheres of sustainability, and rank 100 cities at global level. The social pillar reflects social mobility and quality of opportunity and life. The environmental pillar describes management of energy use, pollution and emissions. The economic one, assesses business environment and economic performance. To each city is assigned a score for each of the three pillar, and the total performance of the three together makes the final sustainability score. The social sub-index is composed, in turn, of 10 indicators: *affordability, education, health public transport, digital, income inequality, work-life balance, crime, demographics, cultural offerings.* The environmental sub-index is composed of 11 indicators: *energy, air pollution, greenhouse gas emissions, waste management, water and sanitation, green spaces, bicycle infrastructures, electric vehicle incentives, environmental exposure, negative emission technologies, natural disaster monitoring.* Finally, the economic sub-index is composed of: *employment, economic development, ease of doing business, transportation infrastructure, tourism, connectivity, University technology research.*

It is interesting to note that for each pillar the first three cities have common characteristics. The first three cities in the social pillar are Edinburgh, London and Paris: three of the most attractive European cities for private investments. The top three in the environmental sphere is composed of Stockholm, Frankfurt and Zurich, three northern European cities smaller than the ones ranked first in the social pillar. Finally, the economic pillar sees Singapore, London and Hong Kong in the first three position. As for the social pillar, also in this case the three positions are related to three of the biggest cities in terms or investment attractions worldwide.

In the end, the index identifies four cluster of cities: the balanced innovators, the pos-industrial opportunists, the evolutionary cities, the fast-growing mega cities.

This index thus provides a useful framework and a detailed list of indexes to assess the level of sustainable development of a city and also introduces a cluster differentiation that unveil the main challenges faced by cities in each cluster, and thus the priorities that need to be set.

## 3. Discussion and conclusions

In this review note I have tried to clarify the concept of urban sustainability by describing some of the most important frameworks and indicators that provide support to sustainable development plans of cities. Most of the frameworks are skewed on the environmental sphere, which is perfectly understandable given the relevance of climate change challenges (Shirgir et al., 2019). Nevertheless, this paper argues that a holistic view is necessary to tackle sustainability from different perspective that also take into account social,

economic, governance and land use factors (de Luca et al., 2020; Li & Yi, 2020; Sáez et al., 2020). In this sense, I argue that the RFSC framework is very useful and relevant as a guide that provide a complete reference framework for cities. Given the lack of a totally shared view, however, an overview of the several existing indicators could help cities in designing clear strategies and also to identify clear indicators to assess and monitor their level of sustainable development.

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