

TeMA

This Special Issue of TeMA - Journal of Land Use, Mobility and Environment, collects twenty-seven contributes of international researchers and technicians in form of scenarios, insights, reasoning and research on the relations between the City and the impacts of Covid-19 pandemic, questioning about the development of a new vision and a general rethinking of the structure and urban organization.

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TeMA Journal offers papers with a unified approach to planning, mobility and environmental sustainability. With ANVUR resolution of April 2020, TeMA journal and the articles published from 2016 are included in the A category of scientific journals. From 2015, the articles published on TeMA are included in the Core Collection of Web of Science. It is included in Sparc Europe Seal of Open Access Journals, and the Directory of Open Access Journals.

Special Issue

Covid-19 vs City -20

scenarios, insights, reasoning and research

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Special Issue

COVID-19 vs CITY-20

SCENARIOS, INSIGHTS, REASONING AND RESEARCH

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The cover image is a photo collage of some cities during the Covid-19 pandemic quarantine (March 2020)

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Special Issue

COVID-19 vs CITY-20

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Contents

- 5** EDITORIAL PREFACE
Carmela Gargiulo

- 9** Covid-19 and simplification of urban planning tools. The residual plan
Pasqualino Boschetto

- 17** Covid-19. Some moments of the 21st century, with a look at Milan
Roberto Busi

- 31** Geographic Information and Covid-19 outbreak. Does the spatial dimension matter?
Michele Campagna

- 45** Health emergency and economic and territorial implications. First considerations
Salvatore Capasso, Giuseppe Mazzeo

- 59** About the effects of Covid-19 on solid waste management
Alessandra Cesaro, Francesco Pirozzi

- 67** The city and natural resources.
Pandemic disaster can be a driving force for new perspective
Donatella Cialdea

- 81** **Evolution of mobility sector during and beyond Covid-19. Viewpoint of industries, consultancies and public transport companies**
Pierluigi Coppola, Francesco De Fabiis
- 91** **Tourism on demand. A new form of urban and social demand of use after the pandemic event**
Fabio Corbisiero, Rosa Anna La Rocca
- 105** **Questioning urbanisation models in the face of Covid-19.**
The crisis as a window of opportunity for inner areas
Giancarlo Cotella, Elisabetta Vitale Brovarone
- 119** **The Covid-19 pandemic effects in rural areas.**
Turning challenges into opportunities for rural regeneration
Claudia De Luca, Simona Tondelli, Hanna Elisabeth Åberg
- 133** **Shaping space for ever-changing mobility. Covid-19 lesson learned from Milan and its region**
Diego Deponte, Giovanna Fossa, Andrea Gorrini
- 151** **From social distancing to virtual connections**
How the surge of remote working could remold shared spaces
Luisa Errichiello, Daniele Demarco
- 165** **The paradigms of urban planning to emergency-proof.**
Rethinking the organisation of settlements at the time of a pandemic
Isidoro Fasolino, Michele Grimaldi, Francesca Coppola
- 179** **Virucity. Rethinking the urban system**
Romano Fistola, Dino Borri
- 189** **The role of the urban settlement system in the spread of Covid-19 pandemic. The Italian case**
Carmela Gargiulo, Federica Gaglione, Carmen Guida, Rocco Papa, Floriana Zucaro, Gerardo Carpentieri
- 213** ***"Passata è la tempesta ...". A land use planning vision for the Italian Mezzogiorno in the post pandemic***
Paolo La Greca, Francesco Martinico, Fausto Carmelo Nigrelli

- 231 Covid-19 and spatial planning**
A few issues concerning public policy
Sabrina Lai, Federica Leone, Corrado Zoppi
- 247 Take advantage of the black swan to improve the urban environment**
Antonio Leone, Pasquale Balena, Raffaele Pelorosso
- 261 Imagining living spaces in extreme conditions: suggestions from a case study in Bari**
Giulia Mastrodonato, Domenico Camarda
- 269 Risk, health system and urban project**
Gerardo Matteraglia
- 283 Geographical analyses of Covid-19's spreading contagion in the challenge of global health risks**
The role of urban and regional planning for risk containment
Beniamino Murgante, Ginevra Balletto, Giuseppe Borruso, Giuseppe Las Casas, Paolo Castiglia
- 305 The resilient city and adapting to the health emergency.**
Towards sustainable university mobility
Francesca Pirlone, Ilenia Spadaro
- 315 Physical spacing and spatial planning.**
New territorial geographies and renewed urban regeneration policies
Piergiuseppe Pontrandolfi
- 327 Mega cities facing Covid-19 pandemic.**
How to use urban spaces in Tehran after the new pandemic
Elmira Shirgir
- 333 Rethinking rules and social practices. The design of urban spaces in the post-Covid-19 lockdown**
Maria Rosaria Stufano Melone, Stefano Borgo
- 343 Data analysis and mapping for monitoring health risk. What has the spread of the Covid-19 pandemic in northern Italy taught us?**
Michela Tiboni, Michèle Pezzagno, David Vetturi, Craig Alexander, Francesco Botticini
- 363 About the Sustainability of Urban Settlements.**
A first reflection on the correlation between the spread of Covid-19 and the regional average population density in Italy
Maurizio Tira

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Shaping space for ever-changing mobility. Covid-19 lesson learned from Milan and its region

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Abstract

In the Milan experience, Covid-19 emergency crucial issues were already hidden weaknesses of the city and its region: the limited capacity of transit transport, roads and public spaces, with crowding problems for both work and leisure. The challenge is to regenerate the competitive “human measure” of Milan, based on its unique relationship between public spaces and mobility, overcoming its health risk. The report raises a question on the established transit-oriented development approach, focusing on spaces “in between” and not only on nodes and networks. The traditional “invariants” welcome changes: the spatial structure of the public realm becomes a platform for ever-changing mobility and services, providing quality of life for communities, users and tourists. With this respect, streets represent by far the most strategic asset of the urban public realm. They can be reshaped in resilient infrastructure capable to respond to new forms of mobility based on a renewed Mobility-as-A-Service paradigm, as final result of different travel behaviors of the post pandemic scenario, among which an expected reduction of the overall “mobility consumption” (space) and new temporal urban rhythms (time). To this end, short-term and responsive planning becomes a crucial opportunity to enable rapidly deployed responses, through an extensive use of new analytical tools based on Open and Big data analytics and computer-based simulations.

Keywords

Mobility; Resilient infrastructure; Public space; Data analytics.

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1. A Perspective Shift: From Nodes to Textures

1.1 Milan identity at risk

Milan and its region have been deeply touched by Coronavirus, not only for the number of hospitalizations and deaths; its competing identity feature itself has been put in crisis: a world class hub for high quality meetings, providing exchanges of inspiring ideas, experiencing a vibrant social and cultural life, mixing business and leisure. The lockdown killed this priority asset. Its icon, the Milano Design Week, was cancelled. The world famous out of venue ("Fuori Salone"), regenerating historical nucleus as well as trendy peripheral neighborhoods¹, in synergy with regional manufacture districts², is waiting for better times to come, investing in maintaining its competitiveness in the wood/home/textile/fashion chains and the whole system.

In recent years, Milan became an ever more appealing city to live and work and an imposing global touristic destination, booming after the Milan Expo 2015 and looking forward to the 2026 Winter Olympics³.

A polycentric settlement structure, with dense historic cores and open landscapes, in a fine-grained multicenter urban region of great variety and biodiversity, a comprehensive functional system with human-scale dimensions (city diameter: 15 km; urban region diameter: 40 km). The success of its "human dimension" is based on its relationship between collective spaces and mobility, both at city and regional level; collective spaces deep on culture and vibrant for social life, connected by accessible public transport facilities.

This vibrant density now implies unsustainable health risks. In addition to this indisputable issue related to a lifestyle based on physical proximity, the Milan system was well performing up till now but at the limit of its capacity; transit transport, roads and public spaces show crowding problems (Fig. 1), both at city and regional scale, for work as well as for leisure/sport mobility⁴. Not only trains and subways but also urban parks (such as Parco Sempione) as well as regional outdoor destinations (e.g. the lakes) were congested and still are, despite the social distancing regulations, as one could see from the Navigli waterfronts as soon as they were re-opened. The hidden weakness of the city and its region is now crystal clear in the midst of the emergency, and of course limited capacity of mobility infrastructures are also combined with environmental issues: traffic pollution, risks of floods related to land consumption and climate change, as the Seveso river flooding of May '15 made clear, invading important roads and neighborhoods⁵.

The challenge is to regenerate this unique competitive "human dimension", the physical proximity of Milan and its region, overcoming the health risk. Milan is very "little" indeed⁶; the city is well served by subways and public transport, connecting peripheral neighborhoods with the historic center, which was already conceived as pedestrian/bikeway oriented (Area C, 30 km zones); 55% of city mobility is by subway⁷. Within the region, mobility is mostly by car but 50% of commuters are coming to the city by train⁸, after reaching the closest local train station or a major subway interchange parking by car. These two crucial percentages are now downsized to 1/3 due to restriction on transit capacity, in order to overcome health risks, by ensuring physical distance between users⁹. How can this system not crash? What could the short term and "new normal" scenarios be?

¹ Such as Lambrate and North of Loreto (NoLo), emerging urban creative districts.

² See for example "Brianza Experience" in the wood manufacture district as well as the initiatives by the Museum of Modern Art of Gallarate, in the Siplon textile district.

³ Milan welcomed almost 11 million of visitors in 2019 (source: City of Milan Statistics).

⁴ Works are in progress for subway extensions; also, a renewal of the Regional Railway Service is programmed; the "Milano 2030" City Plan foresees the transformation of the railway ring into a Circle Line to support peripheral regeneration areas.

⁵ The land consumption (urbanized land) is 14,3% of the Lombardy territory (source: Regione Lombardia, 2018).

⁶ The City of Milan is only 182 km² wide.

⁷ Source: City of Milan Statistics 2019.

⁸ Source: City of Milan Statistics 2019.

⁹ Estimate shared by media on the base of governmental restrictions for the re-open phase, May 2020.



Fig.1 People invading roads during last edition of the Design Week (via Tortona).

1.2 Scenario Inputs

The unsustainable scenario is that the 2/3 of mobility no longer supported by subway/trains will shift to private cars. Fortunately other variables could come into play to cut down the mobility demand and avoid its peaks, as indicated by scenarios under discussion right now in the political agenda at all levels: smart working¹⁰; differentiation of times and calendars for public offices, facilities and also for the private sector; e-commerce, home delivery and remote service-provision. Moreover, alternative mobility ways could be promoted, allowing individual mobility with less pollution and infrastructure space occupancy (e-bike/e-motorbike, personal or shared, e-car sharing, soft/eco last mile logistics); already urban trends, their extension to the whole urban region could be supported. New regulations could allow a hybrid ever-changing use of the infrastructure space. The tactical urbanism proposed by the resiliency plan "Milano 2020"¹¹ is going into this perspective, where flexibility in time and uses is leading the experiments. Commuters mobility will increase the percentage of individual vehicles, but smart working and individual vehicle sharing could be promoted also at regional scale; most of all, the major interchanges could be focused not only on the shift vehicle/subway but also on vehicle/soft mobility: new temporary bike lanes are "colored" on roads above the subway lines, in order to welcome alternative mobility on the same axes connecting peripheral interchange gateways with the metropolitan core center in about less than 20 minutes. Temporary solutions could prepare the transition towards a new normal settlement model.

1.3 A resiliency regeneration model

The fundamental question is which is the vision beyond these scenario inputs. The current crisis could offer the opportunity to learn from the Milano lesson and lean towards a new resiliency model integrating

¹⁰ See ULI Urban Land Institute Italy, Young Leader webinar May 21st, 2020.

¹¹ City of Milan, May 2020.

development and mobility, a new vision of the connection between settlement and infrastructures and more specifically between mobility and collective open spaces.

A question is now open on Transit Oriented Development, so far undisputed model of sustainability, which promotes concentration in transportation nodes in parallel with land saving. At the moment, concentration is perceived as a high-risk health factor: at least it requires a new smart management in real time (as suggested for example by the Singapore case). As a consequence of a deeper critical look demanded by unexpected changes, the focus has been shifted from "networks & nodes" towards "spaces in between" which came out as resiliency resource.

A broader concept of regeneration as re-interpretation of the figure-ground approach: regeneration not only of dismissed sites and yards around major nodes of infrastructure networks (the figure) but also of their background (the ground), id est the meshes of infrastructure networks, the spaces in between the infrastructure grid: a rediscovery of the complementarities between filled and empty spaces which shape the texture of the territory. The focus on the resiliency approach will no longer be on abandoned areas around railway stations, potentially high density new poles (both urban and regional) but on the textures themselves, low-medium density textures, urban and regional consolidated textures: intelligent landscapes¹².

1.4 The rediscovery of low/medium density districts

The experience of health risks related to dense, concentrated settlements is leading to a rediscovery of the low-medium density contexts: territories bypassed by High Speed railway corridors, "slow" territories, often with great historic and natural landscapes, could offer alternative healthy lifestyles, supported by broadband connections, smart working opportunities, home care and e-commerce services, enjoying outdoor private spaces and larger indoor spaces, thanks to a low-budget real estate market. Back to the "provinces", contexts with entrepreneurial culture and availability of spaces to be reused for new start-ups, hopefully encouraged by de-bureaucracy policies. Back to the countryside, sometimes already family home places, integrating proximity and care of elderly parents, otherwise a new choice of inspiring landscapes for creative people or open-air living opportunities for young couples with children. Regeneration of historic villages is on stage in the public debate just after the Covid-19 emergency, especially for Central Italy or for mountains contexts¹³. For the Milano urban region¹⁴, this shift of perspective leads to realize the resilience potential of its historic production districts (Fig. 2).

In the Northern dry plains, manufacture districts of small medium enterprises have shown resilience facing digital and globalization challenges since the 70s; today they are ready to re-convert their production process for emergency needs, almost in real time. As an example, in the Simplon manufacture district (N/W of the metropolitan core) textile industries are now producing health masks, and mechanical industries are manufacturing machineries for hospitals. Dangerous effects of delocalizing strategic production abroad are now clear; these districts are ready to promote and welcome a reshoring of essential manufacture chains. Their mixed-use feature, integrating home and factory, living and working spaces, their fine-grained flexible texture with multitask outdoor courtyards, offer a resiliency settlement model for contemporary emergency times. In the Southern wet plains, agricultural districts have shaped the territorial pattern for centuries, the rural landscapes; historical nucleus ("cascine") regeneration potential could be boosted by new smart working trends, offering a healthy lifestyle integrated with agricultural environment.

¹² References could be rooted in the Colin Rowe school (the conference *ROWE ROME 2015: The Best of Both Worlds - Regenerating the Light City*) as well as in a contemporary visionary landscape planning (Vegara, 2016)

¹³ See Stefano Boeri's call for regeneration of ancient Italian villages ("borghi"), interview on *La Repubblica*, April 21st, 2020.

¹⁴ Population density: Milano City 7.588 inhabitants/km²; Lombardy average 422; more density in the Northern urban region than in the South: e.g. Provincia di Varese 743, Como 468 but Mantova 176, Cremona 202 (source Istat 2019).



Fig. 2 The resilient hybrid texture of manufacture districts (Brianza).

The food production, with its organic and “zero-km” added value and new HT cold chain techniques and logistics, is also re-organizing these territories as food districts.

The Lombardy health chain (manufacture HT production and research hospitals) will soon launch its new Human Technopole, currently under construction in the former Expo site (Milano Innovation District MIND). It is spread across in the whole urban region and it demonstrated its vitality with the first experimentation and protocol on plasma at San Matteo hospital in Pavia, and the innovation of the saliva test for coronavirus at the Insubria University of Varese and Busto Arsizio labs. The “provincia” is evidently vibrant.

The Milano region districts are resilient because they have always been hybrid: they perform flexibility (time, space layout, change of uses), plan evolving variety (uses, typologies, morphologies) and their ecosystem has evolving biodiversity; and now they are becoming more and more “smart”, not only thanks to the HT integration with the clustering program supported by Regione Lombardia, but also by becoming the preferred location for intermediate hot-spots for smart working, in between wide-spread remote working and the company headquarters. Experiments are already ongoing, for instance by banks such as Intesasanpaolo, which located company co-working spaces in the major district poles of Lombardy, such as Gallarate or Saronno, intermediate cities of the polycentric Milano region structure.

More specifically, Milano manufacture districts, once described as land-consuming “infinite city”¹⁵, now reveal resiliency resources which could be developed also in a contemporary regeneration approach, seizing the opportunity of the new dedicated regional law (L.R. 18/2019). This law, launched last November as completion of the previous regional law on land consumption (LR 31/14)¹⁶, promoting the synergy “regeneration & land saving”, could now be re-interpreted to reboot manufacture districts, providing incentives for reuse of dismissed industries and reconversion of the existing ones, promoting their competitiveness by making treasure of the proximity to logistic hubs and developing new opportunities related to the opening of the Gothard/Ceneri tunnel (foreseen by end 2020). Regeneration & health through resiliency, a more complex and site-specific planning paradigm than just land-saving, according to new priorities in the public goals arena.

¹⁵ This term to indicate the Milan urban region was introduced by the sociologist Aldo Bonomi in his book *La città infinita*, published in 2004 by Bruno Mondadori, Milan, Italy.

¹⁶ L.R. 31/14 and 2018 Variant of the Lombardia Regional Plan.

There is also a change of perspective at city level, from the CityPlan "Milan 2030" approved last fall to the recent "Milan 2020" Resiliency Plan: strategies such as tactic urbanism or temporary uses proposed for tackling climate change and flooding risks, aging population and social inclusion, are now refocusing on the health emergency and post-Covid-19 economic restart, for quick temporary interventions during the current re-opening phase and for management of the upcoming year of coexistence with the virus (2020-2021).

1.5 Transit & roads: towards a resilient balance

The district model teaches us the resiliency of open systems, flexible and self-organizing, not only for their hybrid mix but also for their mobility model, which is individual, as in all low-medium density settlements: individual mobility has to be re-conceived as a resiliency resource and not just as an obsolete unsustainable mobility way to shift as much as possible towards the transit mode. The mobility pervasiveness of regional textures, low-medium density contexts, provide a sanitary presidium. Alternative itineraries have a safety potential. Under the perspective of the Coronavirus emergency, individual mobility is sustainable indeed. The challenge is how to design this pervasive individual mobility in eco-friendly and energy-savings terms¹⁷. It is an open research field, and a very urgent one.

A multiple scale approach is crucial, holding in a comprehensive vision the pervasivity of regional/urban textures together with mobility options for commuters and for inhabitants/users inside the urban cores. Not just from a sectorial point of view (transportation and mobility plans, all levels, including bike regional plans) but from a comprehensive master planning point of view: the overall perspective of the settlement system, integrating its morphology with the mobility model. A sight which recognizes equal dignity both to roads and railways, at all scales. An integrated vision of roads and transit systems with a goal of modal mix more than a modal shift strategy: mix vs shift for a resiliency performance of the whole settlement. It is a matter both of structure and management of the model.

Trans-European infrastructure corridors crossing at Milan, especially the Gothard one which will be upgraded by December 2020 with the opening of the new transalpine base tunnel, are calling for urgent decisions about their management and their integration into regional infrastructure networks. An orientation towards a High Capacity instead of a High Speed model will promote the hybrid use of the lines, both for passengers and goods, allowing more flexibility in management and resiliency of the system, in order to be able to face emergency and short-term commuter issues (both towards Lugano and Milano). Priority will be given to the integration of the corridor with the regional railway system (regional and suburban lines) and not to the fastest connection between metropolitan cores (Milano-Zurich) as alternative to the air lines at continental scale.

In order to promote the open structure of the system, alternative hybrid corridors (both railway and roads) should be promoted, even secondary ones, as well as missing links: feasible small scale interventions but strategic for increasing the flexibility and so the resiliency of the whole network, providing alternatives, emergency by-passages, temporary passages.

Milan transalpine infrastructures are already offering a multi-branch structure, with the Simplon axis, not only the Gothard one; a third one, a minor corridor could be promoted, the Bernina one, connecting Milan to Zurich through touristic landscapes of lakes and mountains: it was recently proposed as Sport Corridor for the Winter Olympics of Milan 2026¹⁸. All these three corridors, with their complementarities and synergies, could support the regeneration of low-medium density landscapes, resilience landscapes. Strategic will be the completion of the Pedemontana transversal axis, linking Malpensa and Orio al Serio airports and serving as a spine of the manufacture districts.

¹⁷ See for example the integration strategy of train stations and bike paths in the Franciacorta Regional Plan, 2017.

¹⁸ Fossa, G. & Guenther, F. (2020, in press). The Sport Corridor, *Urbanistica*.

The issue of resiliency corridors is internationally shared: similar infrastructure hybrid corridors, integrating a settlement system of intermediate cities, are now under discussion in competitive macro-areas abroad, such as New York-Boston¹⁹.

Therefore, under the pressure of the virus crisis, a revision of the Transit Oriented Development approach in a resiliency perspective is emerging, given that a certain level of concentration in selected locations could not be avoided for environmental reasons.

Research for innovation is already concerning not only railway and smart logistics but also driverless vehicles and electrical highways, smart roads. All these research streams will be convened towards individual eco-mobility, both regional and urban, safety commuting and last mile logistics, facing the e-commerce boom.

1.6 Infrastructure spaces as living smart landscapes

The virus teaches us that space is a resiliency resource. Resiliency requires resource spaces available on textures inside infrastructure patterns but also on the infrastructure space itself: resiliency spaces are those in between settlements, blocks, buildings: open spaces as flexible landscapes, whichever function is currently hosted there. From an urban design method, we discover materials for resiliency plans (figure-ground²⁰) (Fig. 3).

A new concept of infrastructures as space resource, resilient, open to hybrid and temporary uses, to smart flexible changes: infrastructures as living landscapes, a spatial shape which has changeable structures and sections, ready to assume different space configurations and to welcome different uses and users, from mobility to restaurants, active and passive uses: a place with a hybrid identity (Fig. 4).

Infrastructures pervade tissues; the metaphor is no longer the backbone but the respiratory and circulatory system: roads and railways are conceived as space occupancy, lanes and tracks together with their safeguard bands, rivers with flooding strips, power lines, gas pipelines, cables, are all considered as land strips; climate change risks are integrated in this space resilient to health risks.

From connections between network nodes to axes of a spatial structure which will be source of the regeneration of the living landscape. The mesh innerves the territory making it resilient, able to absorb and redistribute flow changes in typology and consistency, shading capacities, integrating services, redesigning the mobility space also as an identity place.

Innovative projects already experimented the use of safeguard land strips along infrastructures, a reserve in case of need of extra lanes/tracks, for hosting greenways in the meantime. Famous best practices redesign still active infrastructures as spines of the open space system (Madrid M30 eco-boulevard, Hudson River Park, Boston waterfront): railway and highway corridors, waterfront axes (canals, rivers, lakes, seashores). Historic references are Robert Moses (integration of green and infrastructure system) and Frederick Law Olmstead who conceived greenways and parks as a regional system integrating health goals.

Fertile is the proposal of the green river²¹ on the Milan circle line which opens up the yard regeneration to the urban/regional system of greenways and parks, linking nodes to textures.

Today's priority indeed is not only the regeneration of urban portions, abandoned areas around transit nodes (brownfields, yards, urban voids, etc.), but the regeneration of the whole mesh of public open spaces/public realm (streets, squares, parks, greenways, bike and pedestrian paths, infrastructure strips and rings), exploring specifically a new resilient role for streets for both mobility and urban space (a place to stay).

¹⁹ See Yaro, R. Reboot New England, project proposal in progress, PennDesign, Philadelphia, 2020 and RPA Regional Plan Association NY Annual Assembly May 27th, 2020.

²⁰ See Graves, 2009 and Hurtt et al., 2019.

²¹ Stefano Boeri Architects, Milano, 2017.



Fig. 3 A "figure-ground" interpretation of the Milan historic texture ("Milano 1840" by Charles P. Graves).

So far, the pedestrianization has been a must for major urban projects transforming strategic dismissed areas, as well as for city centers and historic nucleus. But now a new walkability demand is emerging, in order to integrate in a shared space a slow mobility mix: a hybrid and resilient walkability. As a quick answer to the virus pressure on mobility, this new walkability paradigm should be extended to the whole consolidated city in the metropolitan core and to the urban textures of the district cores. Today a resilient approach with temporary solutions focused on space textures is mandatory, considering the health situation, which is now leading the regeneration demand, with emergency and new-normal phasing. The traditional invariant becomes resilient: the spatial structure of the public realm becomes a platform for ever-changing mobility, services, and quality of life. A new vision integrating mobility and services and outdoor living for communities, users and tourists. A new challenge integrating place making, street design and transportation programming, towards a comprehensive resilient design approach, for intelligent living landscapes.

2. Resilient Infrastructure for Pedestrian Mobility and Walkability

The rising demand for transport services and infrastructure linked to urbanization (United Nations, 2014) requires institutional setups to effectively design and plan future cities to achieve environment-related goals at local and national levels, and ultimately to improve quality of life (Vandecasteele et al., 2019). Encouraging the shift towards sustainable mobility strategies based on public transport and active modes of travel (i.e. Sustainable Urban Mobility Plan) is one of the main challenges of European cities (Buhrmann et al., 2019), since they are increasingly facing problems of traffic congestion, road safety, energy dependency and air pollution.



Fig. 4 Bikers in Foro Bonaparte at the first day of the re-open phase.

Facing this trend, advanced urban planning activities are shifting towards a focus on walkability, with regard to the development of strategies and design elements which enhance the accessibility, comfort and safety of the urban setting for walking, considering also the needs of vulnerable road users (e.g. pedestrianization of urban areas, barrier-free streets, public spaces for outdoor activities). According to the General Theory of Walkability (Speck, 2013), the essential elements for evaluating the level of walkability of urban environments (Gorrini & Bertini, 2018) comprise the following: (i) presence of services within a walkable distance; (ii) level

of comfort and safety experienced by pedestrians; (iii) attractiveness of the urban areas in terms of architectural design and social context.

As highlighted by the 2030 Agenda for Sustainable Development Goals (SDGs) adopted by the United Nations in 2016, there are several targets directly linked with making walking a primary travel mode, beyond a first - and-last-mile solution to connect to public transport, most notably SDG 11.2-Sustainable Transport for All, SDG 3.6-Reduced road deaths and SDG 3.9-Reduced exposure to air pollution. Nevertheless, walkability has a recognized social impact considering that more accessible, inclusive and livable public spaces (including streets) attract more people in the community (e.g. elderly, people with reduced mobility, women, children), allowing them to maintain social and civic contribution to community life.

Walking is in fact recognized today as a catalyst, a fundamental driver of sustainable urban development as part of a wider planning approach which entrusts the role of leading actor to active mobility, as an intrinsic dimension to the quality of life experienced in cities. Walking is by far the oldest, most accessible, democratic, reliable and sustainable form of mobility and its pivotal role is given by definition being the mode of transport which links all other types of movements: any journey in fact begins or ends by walking.

Walking ensures direct access to any urban opportunity and accessibility constitutes, in fact, the basic principle, the qualifying and transversal element with respect to all other urban disciplines: if in the past distance represented the element capable to shape the physical structure of cities, today is time, the fourth dimension, by its intangible nature, which transforms their functional form and guarantees the correct use of urban functions beyond efficiency and speed.

And such use, which in turn ensures social participation, is possible thanks to the system of public spaces, - primarily streets, squares and parks - which represents the most strategic asset of the urban built environment, the most long standing elements of the urban fabric, that remains over time and shapes the city.

This articulated multi-functional system, that constitutes the matrix of relationships and the vital frame of urban development, may include a large array of diversified assets: ecological corridors, shared and walkable streets, pedestrian areas, green infrastructure, etc. In particular, the public space shaped by streets is the essential infrastructure of equality, creating spontaneous interaction, diversity and vibrancy.

It is this in-between space that brings people together and acts as a human catalyst by putting social interaction at the heart of urban life.

Furthermore, streets are called to deal with patterns and variables that are not all predictable to date and, in this sense, they must act as flexible and resilient infrastructural elements, capable of accommodating new forms of transport and adapt to future mobility trends.

As a result of digitalization and based on the Mobility-as-a-Service paradigm, the flexible space provided by streets is fundamental to ensure the correct use of new transport opportunities and innovative mobility solutions, to include micro-mobility devices, on-demand transit services, e-healing and ride sharing schemes and driverless technology.

For instance, new ways of managing and designing the curb space are emerging as response to a growing competition in cities for curb access due to the rise of ride services and the renewed models of city logistics as far as urban goods delivery is concerned. Once again, time can be considered the key variable to allow for a wider use of the same space, by envisaging a dynamic curb able to ensure flexibility and an effective coexistence of movements and uses.

Despite the possibility to accommodate new forms of mobility, the resilience and flexible use of the public space has become a more urgent necessity as a result of the Covid-19 pandemic, which will definitely generate a new mobility morphology due to different travel behaviors of the post pandemic scenario, among which an expected reduction of the overall "mobility consumption" (space) as well as new temporal urban rhythms (time). This crisis opens opportunities for decades to come, to reshape and redesign our cities.

The idea that safe, generous and accessible common space is fundamental to public life. We need a greater amount of public space, more capacious, more articulated, more polysemic and multifunctional; a hybrid space, made up of several components, flexible for different uses.

Experiments and concrete interventions are being launched all over the world. Actions that redefine the relationship among different mobility systems, coming to imagine new ways to distribute the space on the road and also to radically rethink the uses of urban spaces.

From the point of view of urban planning, this is a topic that is both critical and exciting at the same time: a decisive redefinition of limits and spaces is not always possible and not everywhere, although certainly this moment of rethinking represents a great opportunity to give new priorities and imagine more virtuous initiatives and new balances.

Given the critical situation due to the Covid-19 pandemic, the European Commission (2020) has recently provided guidelines for short-term urban mobility and transport planning interventions. Among the principles included in the document, the section 'Active Mobility' has a specific focus on walkability: "*Many European cities are taking steps to make active mobility (e.g. walking and cycling) a safe and more attractive mobility option during the Covid-19 outbreak. Urban areas could consider temporary enlargements of pavements and increased space on the road for active mobility options to facilitate the needs of the population to move in a safe and efficient way, while reducing speed limits of vehicles in increased active mobility areas*" (European Commission, 2020, p.15).

In this regard, the activities of urban transport planners and decision makers are projected ahead towards investigating sustainable future mobility solutions taking into account the need to effectively plan the city in order to ensure public health, but also to enhance social, environmental and economic resilience.

Taking into account the urgency of the current situation, the Open Streets plan of the Municipality of Milan²² (2020) provides an initial framework for promoting pedestrian mobility in order to reduce risk of contagion associated with high contact and crowding in mass transit facilities, but also to reduce the use of private transport modes.

This includes short-term interventions on road network and public transport infrastructures (i.e. temporary enlargement of sidewalk infrastructures, social distances and queue management in transit infrastructure), to guarantee the possibility to access public transport, services, retails and goods within a comfortable walkable distance from home.

In just a few short months nation-wide lockdown and post-lockdown phases have drastically changed citizens' behaviors and mobility patterns related to the cities, neighborhoods and streets in which they live. Moreover, it is nonetheless necessary to investigate the unprecedented changes and long-term effects of disruption on urban mobility. In this framework, Urban Informatics (Foth et al., 2011) provides innovative walkability assessment tools and metrics for supporting the activity of mobility and transport planners in an efficient and effective manner, within an evidenced-based approach. Thanks to the recent development of advanced Information and Communication Technologies (ICTs) and the increasing availability of digitally widespread data sources, Big and Open Data is becoming a valuable support to the activity of decision makers by unveiling hidden mobility patterns in the cities and specific target users' needs (Batty, 2013).

The proposed multi-disciplinary methodology is based on the integration of the different knowledge and skills ranging from computer science, urban planning, traffic engineering and environmental psychology (Fig. 5).

This is aimed at investigating innovative tools and metrics for assessing the level of walkability in urban areas (with a focus on the City of Milan as a case study), considering the impact on Covid-19 pandemic on pedestrians' safety (i.e. risk of being exposed to contagion due to social density).

²² Available at: <https://bit.ly/3bD1AAH>

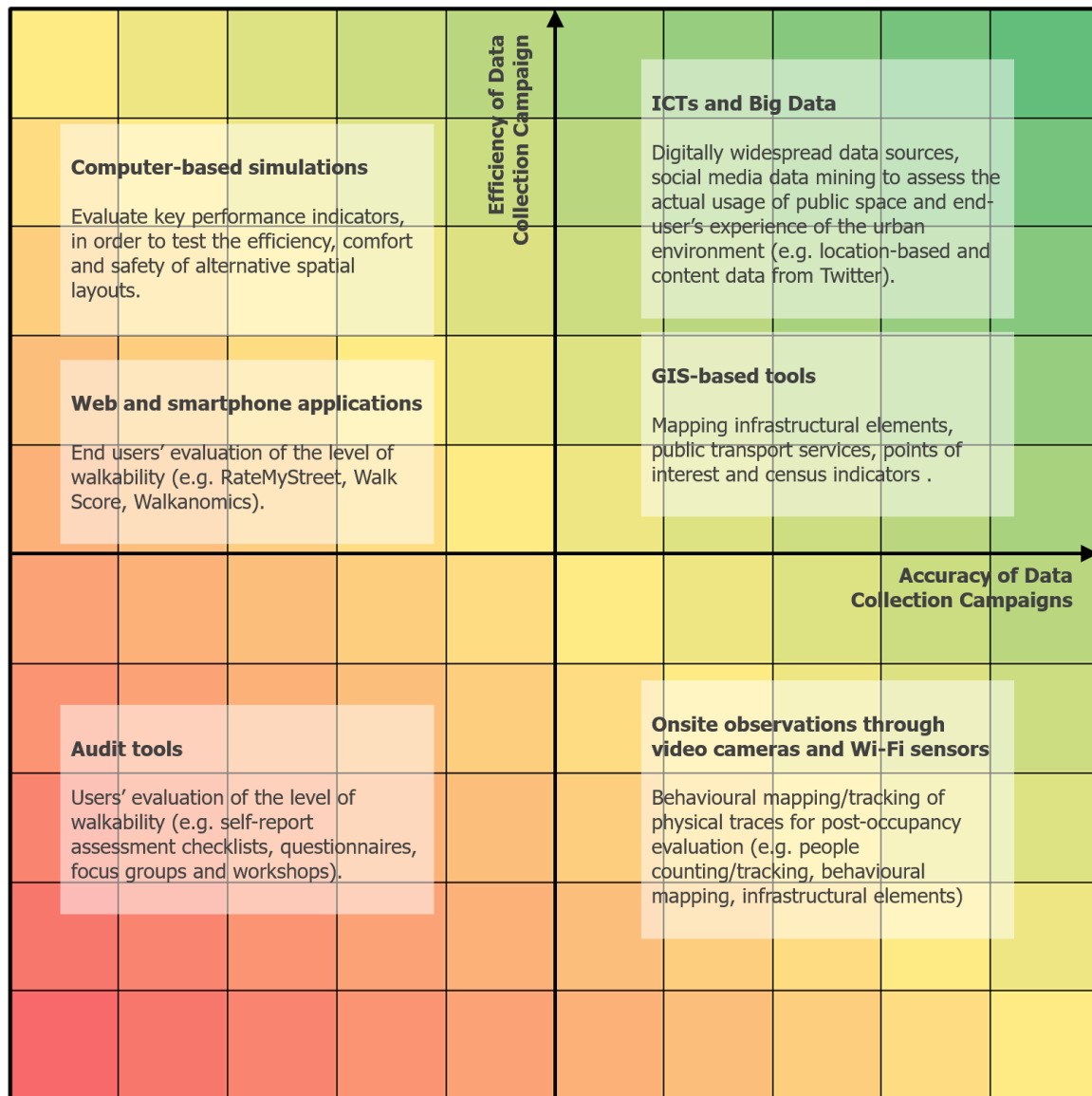


Fig. 5 The proposed multi-disciplinary approach for assessing the level of walkability in urban areas.

This is based on: (i) cartographic analysis of the Milan sidewalks network, to identify the areas which foremost need the implementation of short-term solutions to accommodate pedestrian flows in compliance with the recommended social distancing of one meter (Section 2.1); (ii) computer-based simulations of pedestrian dynamics to test the effectiveness of alternative conditions and courses of action in a predictive and explanatory scheme (Section 2.2).

2.1 GIS-based Interactive Sidewalks Map of the City of Milan

Geographic Information Systems (GIS) allow to analyze large samples of geo-referred structured datasets for assessing the level of walkability of cities, neighborhoods and streets, focusing for example on public service density, land use mix, road infrastructure connectivity, point of interests and census data about the socio-demographic characteristics of the inhabitants (Blecic et al., 2015; Oliveri et al., 2015).

The proposed work took up this challenge by applying GIS-based technology to produce an interactive cartographic analysis of the City of Milan (Fig. 6), based on geo-referenced open datasets regarding the

infrastructural characteristics of the sidewalks network²³. Starting from the recommended interpersonal distance of 1 meter for contagion containment, the analysis considered the space occupied by each person (0.6 m + 0.2 m of comfort zone) and applied 1 meter spacing assuming different sidewalk sections. In this way, it was possible to define intervals to evaluate the level of suitability of sidewalks based on their width.



Fig. 6 A screenshot from the interactive map showing sidewalks widths in Milan and highlighting the critical areas where physical distancing cannot be respected: very difficult (less than 2.4 m), highlighted in red; somehow doable (between 2.4 and 3.3m), in yellow; doable (between 3.3 and 4.2 m), in green; easy (more than 4.2 m), in blue.

The map was built starting from the polygons of the pavements available as open source on the Geoportal of the Municipality of Milan²⁴. Starting from these polygons, the center line of each single sidewalk was obtained and the distance from the edge of the roadway and the buildings was calculated. The results obtained therefore showed the width of each sidewalks, before deducing street furniture elements (e.g. streetlamps, benches, etc.). Data have then simplified and cleaned up to make them usable more comfortably by removing all segments shorter than 20 cm, considered not essential for visualization or analytical purposes. Once the new database was created, an interactive map was developed and published²⁵.

The preliminary results showed that more than 40% of Milan sidewalk area is not adequate to allow the necessary social distancing measures against Covid-19 pandemic crisis. Is therefore required, in line with the

²³ Available at: <https://issuu.com/systematica/docs/milan-sidewalks-map>

²⁴ Available at: <https://geoportale.comune.milano.it/open-data/>

²⁵ Available at: <https://research.systematica.net/prj/milan/sidewalks.html>

principles and objectives of the Open Streets plan of the Municipality of Milan²⁶ (2020), a capillary series of interventions to retrofit our sidewalks and grant adequate comfort and safety levels for pedestrians. Future works will be aimed at further analyzing this sidewalks' database alongside other information regarding road hierarchy, vehicular traffic, public transport accessibility levels, socio-demographic information. This will allow the mapping tool to be essential for cities in decision-making process as a means to facilitate the identification of intervention clusters, define priority areas and design adaptation measures most effectively.

2.2 Calibration of Computer-based Models for Pedestrian Dynamics Simulation

Computer-based systems for the simulation of pedestrian dynamics provide optimized solutions for supporting the activity of transport planners and decision makers in the design of transport infrastructures. This is based on the possibility to evaluate key performance indicators (e.g. travel time, density condition, waiting time), to test the efficiency, comfort and safety of alternative spatial layouts and traffic management conditions (i.e. *what-if scenarios*) in a predictive and explanatory scheme.

In this framework, the current work aimed at applying simulation models to investigate the effects of disruption related to Covid-19 pandemic crisis on pedestrian mobility. In particular, we applied a descriptive set of metrics and parameters for representing the impact of social distancing into the Social Force Model of the pedestrian simulation platform PTV Viswalk (Kretz et al., 2018).

We focused on calibrating the dynamic regulation of interpersonal distances among pedestrians (i.e. *social isotropic parameters related to repulsive force*), to avoid conditions of inappropriate proximity and spatial restriction due to high density situations.

The proposed calibration phase allowed to compare simulation results between the Social Force Model and the proposed Social Distancing Model (Fig. 7). This was based on the execution of a simulation campaign focused on pedestrian counter flow situation in a corridor-like scenario (3-meter width, representing the average width of sidewalks in urban areas), characterized by Level of Service B (corresponding to irregular flow in condition low-medium density).

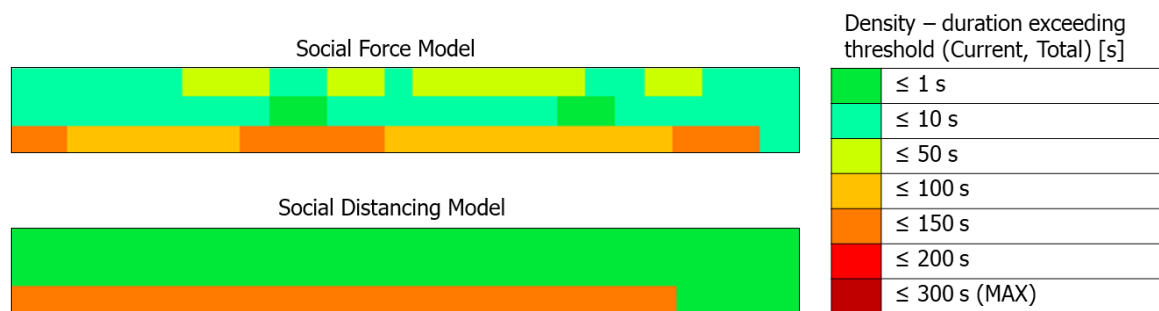


Fig. 7 Simulation results achieved through the Social Force Model and the proposed Social Distancing Model.

The proposed discretization of the simulated environment (each cell is of 1×1 meter, that is the recommended space for guaranteeing social distancing in dynamic situations) allowed to calculate the level of density in the simulated scenario, identifying those cell occupied by more than one agent for each second of the simulation (300 seconds in total). Results showed that pedestrian circulation dynamics driven by social distancing are more often characterized by continuous detouring maneuvers and speed adjustments, causing temporary/local situations of high density and queueing due to the limited capability of the infrastructure to accommodate pedestrian flows. The proposed approach represents an innovative contribution for the estimation of the impact of social distancing on pedestrian dynamics, comparing the traditional approaches devoted to the mere

²⁶ Available at: <https://bit.ly/3bD1AAH>

estimation of flow rate (Highway Capacity Manual, 2010) and Level of Service (Fruin, 1971). This is linked to the possibility to evaluate the need to provide short-term urban mobility and transport planning interventions (e.g. temporary enlargement of sidewalk infrastructures, queue management in transit infrastructure), within an evidence based approach.

Future works will be focused on: (i) variable density conditions and complex spatial layouts; (ii) introducing the notion of shared space among group members (e.g. family, friends); (iii) video-recorded observations of behavioral patterns related to social distancing; (iv) evaluating the plausibility of the model against the so called fundamental diagram (Seyfried et al., 2005), in which the relationship between the variation on the pedestrian flow with respect to the increasing of the level of density is represented.

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Author Contributions

Although this paper should be considered a result of the common work of the authors, G. Fossa took primary responsibility for the Section 1; D. Deponete and A. Gorrini for the Section 2.

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Image Sources

Fig. 1: Photo by Giovanna Fossa.

Fig. 2: TerraItaly™ - © CGR-Parma.

Fig. 3: Charles P. Graves (2009). *The Genealogy of Cities*, The Kent State University Press, Ohio.

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Fig. 5: Systematica Srl.

Fig. 6: Systematica Srl.

Fig. 7: Systematica Srl.

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