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The Times They Are a-Changin' and cities have to face challenges which may not be further postponed. The three issues of the 13th volume will collect articles concerning the challenges that cities are going to face in the immediate future, providing readings and interpretations of these phenomena and, mostly, methods, tools, technics and innovative practices (climate proof cities, zero consumption cities, car free cities) oriented to gain and keep a new equilibrium between cities and new external agents.

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Contents

EDITORIAL PREFACE: TEMA JOURNAL OF LAND USE MOBILITY AND ENVIRONMENT 2(2020)

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

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The Times They Are a-Changin' and cities have to face challenges which may not be further postponed. In particular, six of these challenges to modify and/or adapt cities physical shape, facilities distribution and their organization as complex systems: climate changes effects, population aging, reduction of fossil-fuel energy consumptions, immigration flows from disadvantaged regions, technological innovation, and optimization of land use. The three issues of the 13th volume will collect articles concerning the challenges that cities are going to face in the immediate future, providing readings and interpretations of these phenomena and, mostly, methods, tools, technics and innovative practices (defiantly defined as Climate proof cities, Zero consumption cities, Car Free cities, ..) oriented to gain and keep a new equilibrium between cities and new external agents. This new issue of TeMA journals collects seven scientific paper developed by researchers from Africa and Europe continents.

For this issue, the section "Focus" contains five contributes. The article, titled "The Berlin Mobility Lab Flaniermeile Friedrichstraße" by Stefan Lehmkühler, Alena Büttner, Claudia Kiso, Marco D. Schaefer (German Environment Agency). This article outlines the German Environment Agency vision for "Tomorrow's Cities", briefly discusses the benefits of civic engagement in the realm of transport and outlines the concept for the mobility lab as well as its formation process concluding with the authors' views on the course of action taken in Berlin.

The second article, titled "Urban accessibility: the paradox, the paradigms and the measures. A scientific review" by Carmen Guida (University of Naples Federico II), Matteo Caglioni (Université Côte d'Azur). The paper presents a systematic review of the relevant literature regarding the development of the accessibility concept within the worldwide scientific panorama. It represents a part of a wider research focused on the elderly quality of life within urban environments and aimed at designing innovative tools for both public administrations and elderly citizens. The contribution presents the results of bibliometric analyses run in R studio through a tool, developed in 2017, named bibliometrix, on a sample of almost 5,000 documents published between 1959-2019.

The next article, titled "Assessment of Land use/Land cover Changes Linked to Oil and Gas Exploration Developments" by Mugendi David, Mireri Caleb, Kibwage Jacob, Oyoo Daniel (Kenyatta University, Kenya). The paper aimed at understanding land use/land cover changes (LU/LC) linked to oil and gas exploration under changing climatic conditions in South Lokichar Basin. The authors' opinion is that this knowledge will inform policy makers on appropriate sustainable vegetation cover management strategies for the sake of pastrolism practiced in the study area. The study assessed medium resolution spatial imageries acquired for the area in both rainy and dry seasons, before (2006-2011) and after (2012-2017) the oil and gas exploration developments begun.

The fourth article, titled "An investigation of challenges in the existing pattern of intra-city traffic in Enugu metropolis" by Ifeanyi F. Echendu, Francis O. Okeke, Rosemary C. Nnaemeka-Okeke (University of Nigeria). This study was carried out in order to examine the challenges in the existing pattern of intra-city traffic in Enugu metropolis with a view to proffering solution to traffic and transportation problems experienced in the study area.

The last article of this section, titled "Back from the future. A backcasting on autonomous vehicles in the real city" by Luca Staricco, Elisabetta Vitale Brovarone, Jacopo Scudellari (Politecnico di Torino, Italy). The evolution of mobility with specific regard to the transition towards the autonomous driving is undoubtedly one of those processes that bring with them a very high level of uncertainty. The paper deal with several issues and presents a reasoning on self-driving vehicles, evaluating their effectiveness and uncertainty by using the backasting technique applied to the city of Tourin.

The papers address the section "LUME" (Land Use, Mobility and Environment) are two. The first, titled "Building strategic scenarios during Covid-19 lockdown", by Stefania Santoro, Maria Rosaria Stufano Melone, Domenico Camarda (University of Bari, Italy). The paper explores evidences concerning agents' behaviour starting from a test, carried out during the pandemic event and based on decision making process simulation to develop possible future visions of the city of Bari. Two different contexts were analyzed: simulation performed in presence (face-to-face classroom) and online simulation (online education) performed through MS Teams platform. The research question focuses on the analysis of the performance of the methodology through a comparison between two decision making process simulations, i.e., face-to-face and online conditions.

The second article, titled "Pedestrian routes and accessibility to urban services: An urban rhythmic analysis on people's behaviour before and during the Covid-19", by Cecilia Zecca, Federica Gaglione, Richard Laing, Carmela Gargiulo (Robert Gordon University, United Kingdom and University of Naples Federico II, Italy). The paper pay particular attention the pedestrian accessibility of large shops before and during Covid-19 within Aberdeen urban context; on the other hand, it proposes how to adapt the pedestrian paths and spaces to reach larger retails such as supermarkets, pharmacies in compliance with social distancing and with the aim of providing useful suggestions to decision-makers.

The new Review Notes section propose four insights on the themes of the TeMA journal.

The first research "After recovery: towards resilience" by Carmen Guida. The contribution aims at discussing the main impacts and consequences of the Covid-19 pandemic on our lives and urban systems. It is focused on how researchers and policymakers can enhance urban resilience, in sight of a potential new health crisis and considering the coexistence of the new coronavirus within urban environments.

The second research "Strategies and guidelines for urban sustainability: the Covid-19 effects on the mobility system in Italy" by Federica Gaglione. The contribution examines how Covid-19 containment measures changed people's habits in reaching urban places and services, thus influencing the mobility subsystem. In more detail, this review focuses on of Italian legislative documents, the measures to relaunch public transport and sustainable mobility after Covid-19 in Italy.

The third research "Toward greener and pandemic-proof cities: Italian cities policy responses to Covid-19 pandemic" by Gennaro Angiello. The section concludes by analyzing the level of digitalization of Italian cities, finding that Italy is more focused on e-governance practices while is still weak its commitment in attracting digital entrepreneurs. The contribution provides an overview of the policies and initiatives undertaken by major Italian cities in response to the Covid-19 pandemic. Furthermore, the article analyses whether and to what extend these policies have also contributed to set the ground for a more sustainable and resilient urban future. Results of this analysis suggest that urban policies in the four largest Italian cities has been mainly target at containing the virus outbreak and reducing the negative impacts of the pandemic. In most cases, policies have been uncoordinated and temporary, favouring a sectoral rather than a systemic approach. The city of Milan has been found the only notable exception. The last research "Entrepreneurship in the city: the digitalization" by Stefano Franco. The Economy, Business and Land Use section underlines the benefits that entrepreneurship exerts on the city, with a specific focus on the digitalization. It finds that cities can enhance digital entrepreneurship by attracting digital firms and by implementing e-governance practices.

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The Berlin Mobility Lab Flaniermeile Friedrichstraße

Exploring cooperation in developing Tomorrow's Cities

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Abstract
In Berlin, measures that promote cycling and walking have moved up the political agenda and gained momentum over the last four years. This is due partially to the strong involvement of civil society actors in designing, planning and implementing the promotional measures. This article will use one of the measures as an example that illustrates the immediate benefits and future potential of cooperative planning and civic involvement in the design and implementation of strong measures to make transport more sustainable.
Cycling and walking are vital to achieving "Tomorrow's Cities", a vision developed by the German Environment Agency. Tomorrow's City avoids unnecessary traffic. It is quiet, compact, green, climate-friendly and dominated by mixed-use developments. However, multiple, sometimes controversial measures changing the status quo are necessary to achieve this vision. Allowing for more civic participation and involvement while promoting experimental modifications of public space help gain support for sustainable mobility in general, as well as the measures needed to achieve this goal. Flaniermeile Friedrichstraße, a mobility lab planned for 2020 at the heart of Berlin, serves as an interesting case of long-term civic involvement in cooperative public experiments that translates an idea of sustainable mobility into temporary practice.

Keywords
Tomorrow's Cities; Cycling; Citizen Participation; Road Transport Safety; Changing Cities e.V.

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1. Introduction

In 2017, the German Environment Agency (Umweltbundesamt, in the following: UBA) developed a vision for Tomorrow's Cities to show how sustainable transport solutions can turn urban areas into more livable, green and compact places. Walking and cycling play a pivotal role in the vision's implementation. Meanwhile, Berlin has seen tremendous civic engagement efforts to grow the mode share of cycling over the last four years, culminating in the so-called "Volksentscheid Fahrrad", a successful petition for improved cycling infrastructure (in the following: 'cycling referendum'). Ever since, civic engagement for more sustainable transport by the referendum's initiators CC-Central e.V. has gained momentum and issues like safety in road transport, quality of life and better walking and cycling infrastructure have grown in importance. As part of these efforts, Berlin's local authorities in cooperation with CC Central e.V. have decided to conduct a mobility lab ('traffic experiment') in its central and famous Friedrichstraße (Senatskanzlei Berlin, 2020; SenUVK-Berlin, 2020a), from mid-August 2020 to January 2021. This article outlines the UBA vision for "Tomorrow's Cities", briefly discusses the benefits of civic engagement in the realm of transport, and outlines the concept for the mobility lab as well as its formation process concluding with the authors' views on the course of action taken in Berlin. Data and statements presented in this article are the sole responsibility of the authors and do not necessarily reflect the views of any of the institutions named herein.

2. Background

In order to meet the objectives of the Paris Agreement (UNFCCC, 2015), the necessity and the urgency for substantial changes in the transport sector have gained common ground. Economic growth, the rising share of the global population living in urban areas and analysis found in a large body of academic literature point to the essential role of urban transport solutions integrated with new urban development approaches.

Cities worldwide including New York, London, and Melbourne strive to improve their livability by emphasizing pedestrian and cyclist-friendly urban design in order to raise these mode shares and reduce transport-related emissions (see NYCDOT 2008, 2009; Mohamad, 2019; ITS International, 2019). A practical approach to doing so in Barcelona, Spain, is the urban planning concept of the Superblock, which is widely studied for its pedestrian and cycling-friendly characteristics (Barcelona, 2014; O'Sullivan, 2017; Bliss, 2018; Macher, 2018; Zimmermann & Zimmermann, 2020). An even more ambitious proposal applied to the city and the region of Oslo aims at limiting and eventually ending the overall growth of vehicle kilometers travelled (VKT) through "the reallocation of road, street and parking space" to walking and cycling (Tennoy, 2019, p. 15 ff.).

Large spatial and financial resources can be derived from the re-allocation of road space now devoted to parking: Shoup estimates the parking subsidies provided to motorists in New York City at US-$ 3 billion or more annually, based on 3 million curb parking spaces covering 17 square miles or 13 times the Central Park, with 97% of these on-street parking spaces unmetered (Shoup, 2018, pp. 50-51). The Centre for London reports "43 per cent of all cars are parked on-street, taking up well over 1,400 hectares of space (equivalent to 10 Hyde Parks in size)"(Barret et al., 2020, p. 12). Furthermore, ample parking supply fosters driving, which in turn leads to more congestion (Weinberger, 2018). Despite the hold that car parking has on land use, – blocking urban redevelopment and the potential for mode shift – political controversies over parking availability frequently arise to impede more stringent parking regulations and enforcement.

Unfortunately, efforts to raise walking and cycling mode shares also suffer from poor levels of safety in road transport. This is further detailed (2.3) after the UBA vision "Tomorrow's Cities" (2.1) and Walking and Cycling-friendly urban design (2.2), and followed by Citizen participation and civic engagement (2.4). Section 3 describes details of CC-Central's Concept for the "Flaniermeile Friedrichstrasse", and Section 4 provides the discussion.

2.1 Tomorrow's Cities

Today, many German cities suffer from the negative effects of fossil-fuel traffic such as exhaust gases, noise and lack of green and recreational space. Therefore, the UBA developed the vision "Tomorrow's Cities" (UBA 2017a) to show how an environment with less traffic, fewer cars and fewer hazards for health and climate can be achieved. The main questions leading to this vision are: How to increase the quality of life in urban areas, while at the same time reducing the burden on the climate and environment? How much mobility is needed to provide the same levels of accessibility as inhabitants enjoy in the city today? What would Tomorrow's Cities look like if sustainable transport had become reality?

The vision for Tomorrow's Cities primarily focuses on large cities with more than 100,000 inhabitants and concentrates exclusively on ecological questions related to noise, emissions and the use of space. The UBA further defines Tomorrow's City as a place where mobility is environmentally friendly, noise levels are low, green spaces are widely seen and compact housing and mixed-use developments are the norm. To sum it up, one can imagine it as a quiet, green, compact, mixed-use and climate-friendly city.

Tomorrow's City is compact, space-saving and reduces unnecessary traffic. Inner cities are built up more densely, but attractively, e.g. by exploiting spaces between buildings, making use of courtyards and repurposing underused parking space. The proportion of publicly accessible green and recreational spaces within walking distance is high. High-end green spaces and tree-lined squares and streets enhance the quality of life in working and living quarters. Everyday destinations can be reached by all with no need for private cars, because short distances can be travelled on foot, by bike or using other mobility aids such as wheelchairs or walking frames. The backbone of the transport system is a safe, reliable, attractive public transit network with high frequency service. Integrated and interconnected mobility services such as car sharing, bike rental systems or online ridesharing platforms have been established throughout the city and complement public transit. A statutory speed limit of 30km/h for inner-city streets adapts the speed of transport to urban life, increasing traffic safety. Therefore, feeling safe in city traffic and the entire urban environment has become widespread. All modes of transport are fully accessible to and affordable for all. Because the role of private cars in the transport system has become less important and measures like consistent parking management have made parking in cities expensive, there are hardly any private cars left that occupy public spaces. The planning policy "Living space rather than parking space" is implemented consistently. All transport within the city (people and goods transport) is greenhouse gas-neutral and (almost) emission-free. Only vehicles with electric motors are allowed in the inner city. Eventually, all public transit is also electric.

The concept of sustainable transport lies at the core of that vision. A compact city with mixed-use developments reduces the need for privately owned motor vehicles, with a long-term target of 150 cars per 1,000 inhabitants. This significant drop in the number of private cars frees up space that can be used for living and recreational purposes as well as environmentally-friendly mobility.

Even if there is currently no German city that comes close to this vision, the UBA is convinced that Tomorrow's Cities are achievable and suggests ten specific bundles of measures. All of them are closely interconnected and should be pursued in concert rather than looked at in isolation. Together, they help realize the envisioned city and stimulate the much-needed U-turn in the transport sector.

The first bundle of measures addresses the implementation of compactness and mixed use in cities. Tomorrow's Cities master the huge challenge of an increasing number of people drawn to big cities by combining compact housing with the further development of green and recreational spaces and consistent incorporation of environmental standards. The reduction of oversized roads and parking spaces frees up land for much-needed urban green spaces and public areas that are integral parts of Tomorrow's Cities and the focus of the second bundle of measures. Accessible green and blue spaces play an important part in social life and are important for ensuring desirable living quarters and vibrant public spaces where people can meet. This includes introducing vegetation to the roofs and facades of buildings, to streets, and to sports facilities and playgrounds as well. The third bundle of measures aims at the reduction of noisy road traffic as one of the biggest sources of sound pollution in cities and a significant health hazard. Therefore, long-term strategic

approaches to traffic prevention are necessary measures as are local speed limits, regular speed checks, soundproofing in residential areas, bans on through traffic and the protection of quiet areas. A fourth bundle of mainly monetary incentives and regulatory measures deals with managing private car traffic in a way that enables its environmental impact to be reduced. Measures of this bundle include managing the supply of parking space and distance-dependent tolls on city roads as well as speed checks and consistent, frequent citation of parking violations. Expanding active mobility networks is a fifth bundle that the UBA defines as fundamental for the realization of Tomorrow's Cities. Walking is promoted by providing a comprehensive, safe and closely connected network of paths that link appealing, pedestrian-friendly shared spaces. For higher ranges of mobility, direct and safe cycle route infrastructures including bike super-highways, as well as safe, accessible and secure cycle parking, make that rolling mode more attractive. The following table shows the detailed measures of the bundle "expanding active mobility networks" as well as the time frame, the decision and the implementation level.

Individual measures **Expanding active mobility networks**	Time frame	Decision	Implementation
Establishing a comprehensive, safe, attractive and direct pedestrian network, making use of supporting funding from the Federal Government and the Federal States	short-term	F S M	F S M
Amending the Road Traffic Regulations by adding pedestrian-friendly shared traffic spaces	short-term	F S	S M
Expanding cycle route infrastructure to create a comprehensive cycle route network that complies with the Road and Transportation Research Association (FGSV) recommendations for cycle routes.	short- to mid-term	S M	S M
Providing suitable bicycle parking facilities (including parking for e-bikes, well adapted to the cityscape) in residential, work and shopping areas as well as access points to public transport, car-sharing points and service stations.	immediate	S M	S M
Expansion of largely intersection-free cycle superhighways, connecting essential destinations (commuter routes)	short- to mid-term	S M	S M

immediate; short-term; short- to mid-term; mid-term; EU; F Federal; S Federal state; M municipality; C company

Tab.1 Bundle "Expanding active mobility networks": Measures, Time frame, Decision and Implementation; Source: UBA (2017a, p.31).

For detailed information about the included measures in the other nine bundles see the respective tables in Tomorrow's Cities (UBA 2017a, pp. 24-43).

For trips unsuitable for walking and cycling, public transit is the most obvious choice and the backbone of environmentally friendly mobility in Tomorrow's Cities. Therefore, a sixth bundle of measures addresses the improvement of public transit quality. Separate lanes and tracks for buses and trains ensure that connections are fast and reliable, services run frequently, give access to remote parts of the city and surroundings as well as appealingly presented and comprehensible information. Fostering participation and collaboration in planning and implementation through a seventh bundle of measures is needed to meet the needs of the people. Planning and decision-making processes in Tomorrow's Cities are characterized by an early involvement of citizens and relevant stakeholders as well as transparency and high procedural standards. Tools like informal dialogue forums and experimental spaces such as urban transition labs are used to involve people and complement formal planning processes. To complete the seven already specified measures, three further bundles address the encouragement of integrated mobility services and e-mobility (such as car-sharing, bicycle

and e-bike rentals as well as car-pooling), environmentally friendly commercial transport within the city (including micro-depots, the consolidation of goods in urban distribution centers, emission-free last mile solutions and parcel boxes) and the exploitation of the benefits of digitization for the environment (e.g. integrated ticketing which improves multi modal travelling, steering freight traffic, electric shared cars and new forms of participation and communication).

After all, a city fit for the future is an ambitious community project that urgently needs the involvement of its citizens. Tomorrow's Cities are for people. Therefore, the core message of UBA's vision is that we must transform our urban transport systems in a way that is climate-friendly as well as environmentally and socially compatible to improve the living conditions in urban environments; see also Schubert et al. (2019). Cities must be transformed in a way to allow people to meet their daily needs by travelling short distances. Walking and cycling-friendly infrastructure, attractive public spaces where people can meet and a speed limit fit for a city built around public shared spaces are some of the most important requirements for a vibrant city with a high quality of life.

2.2 Walking and cycling-friendly urban design

The preceding paragraph about the vision for "Tomorrow's Cities" (UBA, 2017a) shows the relevance of active transport modes like walking and cycling for the much-needed U-turn in the transport sector. Together with public transit, walking and cycling are the fundamental components of sustainable urban mobility and the health of people and contribute to the environment. However, today´s cities are built around private car traffic and both pedestrians and cyclists are highly marginalized. In order to change this, urban planners and decision-makers face the challenge of reducing the space given to motorized transport while at the same time creating attractive space for people and sustainable modes of transport.

A good starting point is the provision of a comprehensive, safe and closely connected network of footpaths and cycle route infrastructure throughout the whole city, as this is the most important prerequisite for a walking and cycling-friendly environment. This includes pedestrian-friendly shared spaces and, wherever reasonable and possible, cycling super-highways (UBA, 2017a; ADFC, 2017, p.20). In order to support this development, the network of paths must be direct, since pedestrians especially do not appreciate time- and energy-consuming detours. This includes ubiquitous, linear, ergonomic and safe crosswalks, priority for pedestrians and cyclists at intersections as well as pedestrian lights and bicycle traffic signals with short waiting and long crossing times (Bauer et al., 2018; Büttner, 2019). The Superblock concept of Barcelona is an interesting example for comprehensive implementation of walking and cycling-friendly infrastructure in neighborhoods (Bliss, 2018). Above, the Global Street Design Guide published by the Global Designing Cities Initiative (GDCI) and the U.S. National Association of City Transportation Officials (GDCI & NACTO, 2016) shows many interesting examples of walking and cycling friendly attractive and livable urban design as well as examples of the reconfigurations of street layouts for that purpose.

Walk-friendly cities like Vienna and cycling-friendly cities such as Copenhagen have already recognized the importance of actively welcoming pedestrians and cyclists using both smaller, symbolic measures and investing in larger-scale infrastructure (Büttner & Weber, 2019, p.10). The United Kingdom also realized the need of investing in walking and cycling friendly infrastructure. Since 2013, the London Mini-Holland scheme, part of the London Mayor's Healthy Streets Approach, is aimed specifically at outer London boroughs where residents are more car-dependent than in inner London (DfT-UK, 2020a). In February, the UK's Department for Transport (DfT-UK) announced a new £2 billion funding package to create new era for cycling and walking (DfT-UK, 2020b).

Furthermore, a standard speed limit of 30km/h and traffic-calming measures such as shared spaces make cycling and walking safer, easier and more comfortable (Bauer et al., 2018, p.43; ADFC, 2017, p.30). Minimum standards are also a crucial part of walking and cycling-friendly urban design: They include sufficiently wide sidewalks and bike lanes, even road surfaces securing a good grip as well as good lighting and barrier-free

accessibility for citizens living with disabilities (Bauer et al., 2018; Grafl & Schulz, 2019, p. 19; HMWEVW, 2017, p.29ff.). In 2018, the UBA developed a draft of a national strategic plan for walking which points out several fields of action and measures to promote walking (Bauer et al., 2018).

Additionally, cyclists specifically need safe, secure and accessible bicycle parking in residential, working and shopping areas, access points to public transit and car-sharing stations for their everyday trips. Repair services, air pump stations and the possibility to take bicycles along for free on public transit (except during rush hours) are additional requirements of a cycling-friendly city (Büttner, 2019). These measures should be complemented by appealing building design, pedestrian and cycling routes leading through green spaces and attractive public areas that provide various possibilities for social encounter, recreation and communication which are not contingent on consumption. The high overall quality of public spaces is further enhanced by numerous seats and benches available, a minimal noise exposure, green and blue infrastructure such as trees and water fountains, and finally by the protection from weather conditions using techniques such as roofing elements or shade-giving trees (Aichinger & Frehn, 2017; HMWEVW, 2017, p. 33; Gehl, 2010). For more information about pedestrian mobility in urban areas as well as criteria and methods for planning and designing networks of urban public spaces giving preference to pedestrian use, see Galderisi & Ceudech (2010).

In summary, a walking and cycling-friendly urban design that incorporates the measures outlined above is crucial for the promotion of active modes of transport (UBA, 2017b). The Danish urban planner Jan Gehl sums up three integral factors for a good urban (street) design that is attractive for pedestrians and cyclists ("Cities for People", 2010): "safety, comfort and cheering" create streets for people (Aichinger & Frehn, 2017, p.7), while Tiboni and Rossetti (2014) identify urban structure, the quality of transport infrastructure, and safety for all road users as the essential success factors for walking and cycling.

2.3 Road transport safety

A large number of industrialized countries saw record highs of road traffic fatality rates around the year 1970. Since then, fortunately, these figures have been substantially reduced through a wide range of road transport safety measures. In the literature, these are structured mainly into a) Human (behavior), b) infrastructure, and c) vehicle technology (cf. OECD-ITF, 2008; BMVI, 2015). The European Transport Safety Council (ETSC) reports 5,180 pedestrians and 2,160 cyclists as road transport victims in the year 2018 (Adminaité-Fodor & Jost 2020). The EU-Commission has declared "Vision Zero" its objective in 2011, and since then repeatedly called for more resolute measures to be taken by EU member states to meet the objectives for safety in road transport by 2030 (EU-Commission, 2011, 2016). Since 2003, EU policies have achieved improvements such as the Pan-European emergency call "eCall 112" (Schaefer, 2019). This effort took more than 15 years to bear fruit and it mainly serves car drivers and car passengers, whereas vulnerable road users (pedestrians, cyclists, motorcyclists) hardly benefit at all.

The overall reductions in the number of road traffic victims (deaths and severe injuries) do not reveal the persistence of the high risk especially for pedestrians and cyclists. For the City of Berlin, recent data (see BMVI, 2020, p. 158) published by the Federal Ministry of Transport and digital Infrastructure (BMVI) show a high disproportionateness of road transport victims in 2018 confronted with their respective transport mode: Cycling mode share 15%. Traffic deaths: 24.4%. Walking mode share 27%. Traffic deaths: 42.2%. Motorised transport (car) mode share 32%. Traffic deaths: 6.7% (All mode share data see: Nobis & Follmer, 2019, p. 52, Table 7).

So far, publications on cycling and road safety have highlighted the Netherlands, in particular the Dutch "Sustainable Safety", or Sweden's "Vision Zero" programs for their successful systematic approach, including international studies on the effectiveness of measures and programs (Adminaité-Fodor & Jost, 2020; Busi, 2010; EU-Commission, 2016; Pirlone & Candia, 2015; OECD-ITF, 2008; Weijermars & Wegman, 2011; Department for Transport UK, 2020; Campisi et al., 2020; Dutch Institute for Road Safety Research, S., 2006; Walker, 2016; Racioppi et al., 2004; Furth, 2017).

The Dutch systematic safety approach overcomes the reactive black spot analysis which is still practice in numerous countries -including Germany- by planning and implementing comprehensive walking and cycling networks throughout the country. This is achieved by separating these vulnerable road users from other traffic wherever possible – else significant speed reductions are the norm which is strongly enforced; furthermore, particular attention is paid to road and intersection geometries: Reduced width of lanes to prevent high speeds, allocating cycle paths at intersections and roundabouts in ways that ensure high visibility of and for all road users, and applying road design standards including the use of colors to enhance the predictability of the next crossing or left-turn situation.

The well-documented Dutch developments of both road safety as well as cycling mode shares impressively prove their interdependency (Wagenbuur, 2011, 2018; BicycleDutch, 2011, 2018); statistical analysis of Dutch data also shows a significant influence of the separation of cyclists from other traffic on road safety and on bicycle usage (Schepers et al., 2013).

For decades, also the UBA has repeatedly been calling for a national speed limit of 30 km per hour for inner-city roads (e.g. Heinrichs et al., 2017). In line with the Dutch and the Swedish approaches, studies commissioned by the UBA and other German Federal administrations and authorities have highlighted that the impact of area-wide and construction-based measures are far more effective than traffic regulations and signage alone (Potthoff, 1994). However, the most recent traffic safety programme published in 2015 doesn't mention "Vision Zero" at all (BMVI, 2015) and the German Federal Ministry of Transport has yet to decide whether to adopt it as federal policy. In contrast to this, the City of Berlin now explicitly pursues "Vision Zero" as stated in the Berlin Mobility Act (SenUVK-Berlin, 2018, §10).

Safety for all road users is an essential prerequisite on the way towards Tomorrow's Cities, and a minimum requirement for the U-turn in the transport sector. Therefore, comprehensive networks for pedestrians and cyclists are inevitable and must be established timely. In order to implement the call for joint action for sustainable transport and road transport safety as agreed upon in the Stockholm Declaration of February 2020 (see Government Offices of Sweden & WHO, 2020, and Whitelegg, 2020) and to secure substantial funding, the EU Commission should integrate these measures into their Research & Development programs and the European Green Deal as well.

2.4 Citizen participation and civic engagement

While safety demands are getting more relevant when it comes to designing urban spaces and transport, citizen participation and civic engagement are also taken more seriously. Especially, against the backdrop of contested infrastructure projects, such as Stuttgart 21 or the expansion of Frankfurt/Main and Munich Airports, public participation in German planning processes has gained momentum. Main points of criticism revolve around the lack of information, transparency and feedback throughout the planning process as well as the lack of public access to hierarchically organized complex planning and approval processes, spanning over long periods of time (Hielscher at al., 2014, p.5f). In fact, a representative study conducted by TNS Emnid in Germany showed that 89% of the people want a greater say when it comes to infrastructure projects and 90% want more information regarding large-scale projects. Nearly two thirds think that it is the duty of the responsible authority to inform people more actively (TNS Emnid, 2012). Since 1992 more and more participatory procedures were introduced in Germany (Sackmann, 2014). With regard to large-scale infrastructure projects legal regulations were developed that make provision for the public to participate at given moments throughout the planning process (e.g. §25(3) German Administrative Procedures Act, BMJV, 2019). Moreover, German ministries filled the gap and published manuals on good public participation that highlight important planning steps, potential pitfalls, hallmarks of good participation as well as good practice examples (BMVI, 2014; Birmesdörfer et al., 2019). While the impact or practical implementation of these formalized participation processes is critically discussed by many scholars as well as practitioners, it has demonstrated a general recognition of the need to interact more closely with citizens (Bock & Reimann, 2017).

Sträb and Topp, for instance, highlight the positive impact that public participation can have in public transit planning. Examples from Mainz and Augsburg in Germany show that including citizens in planning processes can help yield better, cheaper and more acceptable results (Sträb & Topp, 2020).

In addition to formal public participation required by law, informal participation fostering civic engagement, as envisaged in Tomorrow's Cities, is more and more widely adopted. Unlike statutorily required participation that has to follow strict regulatory steps, informal processes are conducted on a voluntary basis, can go beyond the levels required by law (Bock & Reimann, 2017, p.44) and often foster civic engagement. In fact, a multitude of participatory measures, timelines and formats for informal participation processes exist and can be combined according to local needs and set objectives to facilitate a meaningful dialogue with citizens and civil society actors.

Since many infrastructure-related conflicts take place at the local level, the onus is often on local governments to ensure these legal provisions for participatory planning and approval processes are appropriately executed and citizens are properly included at an early stage. Fung & Wright (2001), Geißel (2008) and Mizrahi et al. (2010) suggest that the usefulness of participatory decision-making is very evident at the local level. There exist different levels of participation: Rau et al. (2012) clustered them into four categories ranging from information, consultation, cooperation to self-governance. What level of participation is pursued is decided on a case-by-case basis and depends highly on the amount of time available. The two dimensions vary depending on the extent to which decision-making power is given to citizens.

Some local governments make use of campaigns such as the EUROPEANMOBILITYWEEK (EMW) to engage citizens and civil society actors (European Mobility Week, 2020). The EMW is a campaign of the EU-Commission's DG MOVE and aims at promoting sustainable mobility at the local level. Cities and towns use it as an opportunity to showcase their work on sustainable mobility, raise awareness for related issues such as air quality or sustainable transport choices, and engage citizens and stakeholders through various formats. Both the necessity and the success of such campaigns have been proven in recent studies, e.g. to promote bike-sharing and car-sharing in Malta (Maas & Attard, 2020).

One of the more prominent features of EMW are mobility labs ("traffic experiments") that provide people and local governments the opportunity to test new transport measures and experience streets with a new allocation of space. During these mobility labs, motorized individual transport modes are generally put at a disadvantage compared to cycling, walking and public transit. Cities and towns use EMW to start a dialogue with citizens to get their opinion on proposed measures which demonstrate how a redistribution of space is possible and can benefit everyone. They further cooperate with local actors providing them with opportunities to bring in their ideas and activities, and thereby creating a positive and cooperative environment for urban change.

One of the advantages of these short to medium-term interventions and experiments is the fact that their temporary nature allows for the integration of new insights and ideas from citizens and stakeholders. German cities like Leipzig (see e.g. LIZ, 2019) used the EMW-campaign to offer citizens a glimpse of a potential future implementation of some planned traffic calming measures in order to gain their support for the complex steps that accompany these planned measures.

Another important feature of the EMW-campaign is the theme that changes annually and focuses on one specific aspect of sustainable mobility. In 2020, the theme is "zero-emission mobility for all" and touches upon several important issues such as accessibility, gender equality, distribution of urban space, sustainable mobility and participation. The latter is especially important when it comes to designing and changing public space in a way that considers the needs and interests of all citizens (Attard, 2020). Participatory processes and experiments can be appropriate means to ensure that all voices are heard. However, local authorities need to be extra careful when designing these processes, since participation rates increase with higher levels of education, income and skills, as pointed out by Böhnke (2011, p. 20). Hence, special attention needs to be paid to include marginal groups. In contrast, traffic experiments that change urban settings temporarily are experienced by everybody who happens to travel there.

In what follows, the paper presents an example of an urban mobility lab (traffic experiment) from the hands of the project 'Flaniermeile Friedrichstraße' pursued by the registered association Changing Cities in cooperation with Berlin authorities. In contrast to the participatory planning efforts and traffic experiments pursued by authorities and described so far, the following is an example of a citizen-led initiative to promote more sustainable transport in the center of Berlin.

3. Changing Cities' concepts for the center of Berlin

Flaniermeile Friedrichstraße is a project of Changing Cities Central (CC-Central) which incorporates many of the above-mentioned ideas. It is based on a citizen-led initiative, aims at strengthening both walking and cycling while at the same time improving road safety. Moreover, it is illustrative of many aspects of the UBA-vision for Tomorrow's Cities, and the authors present it here as an exemplary case of future-oriented, inclusive urban-planning in the realm of transportation.

3.1 Changing Cities e.V. – from „Volksentscheid Fahrrad"to "CC-Central" and their concept for the center of Berlin

Changing Cities e.V. is a registered association (indicated by the addendum e.V.) that was originally founded to promote the so called "Volksentscheid Fahrrad" (bicycle referendum) in Berlin. A "referendum" is a political instrument, giving citizens the chance to influence policy in an act of direct democracy through petitioning should the required number of supporters be reached. In 2016, "Volksentscheid Fahrrad" easily surpassed the required quorum of 20,000 supporters by reaching 105,000 supporters within three weeks. It demanded comprehensive support for cycling in Berlin and its legal protection. Changing Cities e.V. provided the administrative backbone of the "Volksentscheid Fahrrad", which was driven by volunteers.

In early 2017, the Berlin Senate began negotiations on the new "Berlin Mobility Act" (SenUVK-Berlin, 2018). The act was passed by the Berlin House of Representatives in July 2018 marking the first time in the history of Berlin that a law was written together with civil society actors in this case largely represented by the initiators of "Volksentscheid Fahrrad".

To maintain momentum, the "Netzwerk Fahrradfreundliche Mitte" (Network Bicycle-friendly Mitte) was founded in the district of "Berlin Mitte" and renamed to "CC-Central" (Changing Cities Central) in 2020. This network differs from other local networks as it counts a very high percentage of urban planners with know-how in transportation planning amongst its members. Since 2017, members of the network have been regularly attending the meetings of the local district council, in particular the transport committee meetings. Over time, a trusting relationship has been established with the councilors of the parties represented there. Through intensive lobbying, the formulation of applications, and other techniques, it is now common practice for CC-Central representatives to be consulted as transport experts.

Parallel to conducting parliamentary lobbying and offering support to established parties involved in the political aspects of this transformation of the transport system, CC-Central also plans its own initiatives and projects. The implementation of Berlin's first bicycle street giving cyclists right of way at intersections, as well as the development of a web-based process enabling citizens to flag their demand for on-site bicycle-parking are just two examples.

CC-Central has developed different approaches for specific transport-related challenges in the district of "Berlin Mitte". All of these concepts share common goals: On the one hand they aim at improving urban climate and air quality, eliminating through traffic and enhancing the quality of public space. On the other hand, they aim at ensuring access by car to the district of "Berlin Mitte" as well as to all property. These are translated into the following planning premises:

- Implementation of the Berlin Mobility Act (SenUVK-Berlin, 2018);
- Further development of sustainable and high quality economic uses;

- Securing and attracting existing residential locations;
- Adaptation measures to create resilience in the face of urban climatic extremes.

With these goals and planning premises in mind, CC-Central developed tailor-made solutions for transport-related challenges in the district of "Berlin Mitte":

- Access and parking options for coaches;
- "Flaniermitte" - creation of the car-free shopping streets "Friedrichstraße" and "Unter den Linden" with an attractive urban setting;
- Ensuring car accessibility while prioritizing walking and cycling through redesigning public space;
- Private parking;
- "Flaniermeile Friedrichstraße - street of the future" – outlining the specifics of a future oriented re-design;
- Inner-city logistics;
- Local public transit improvement.

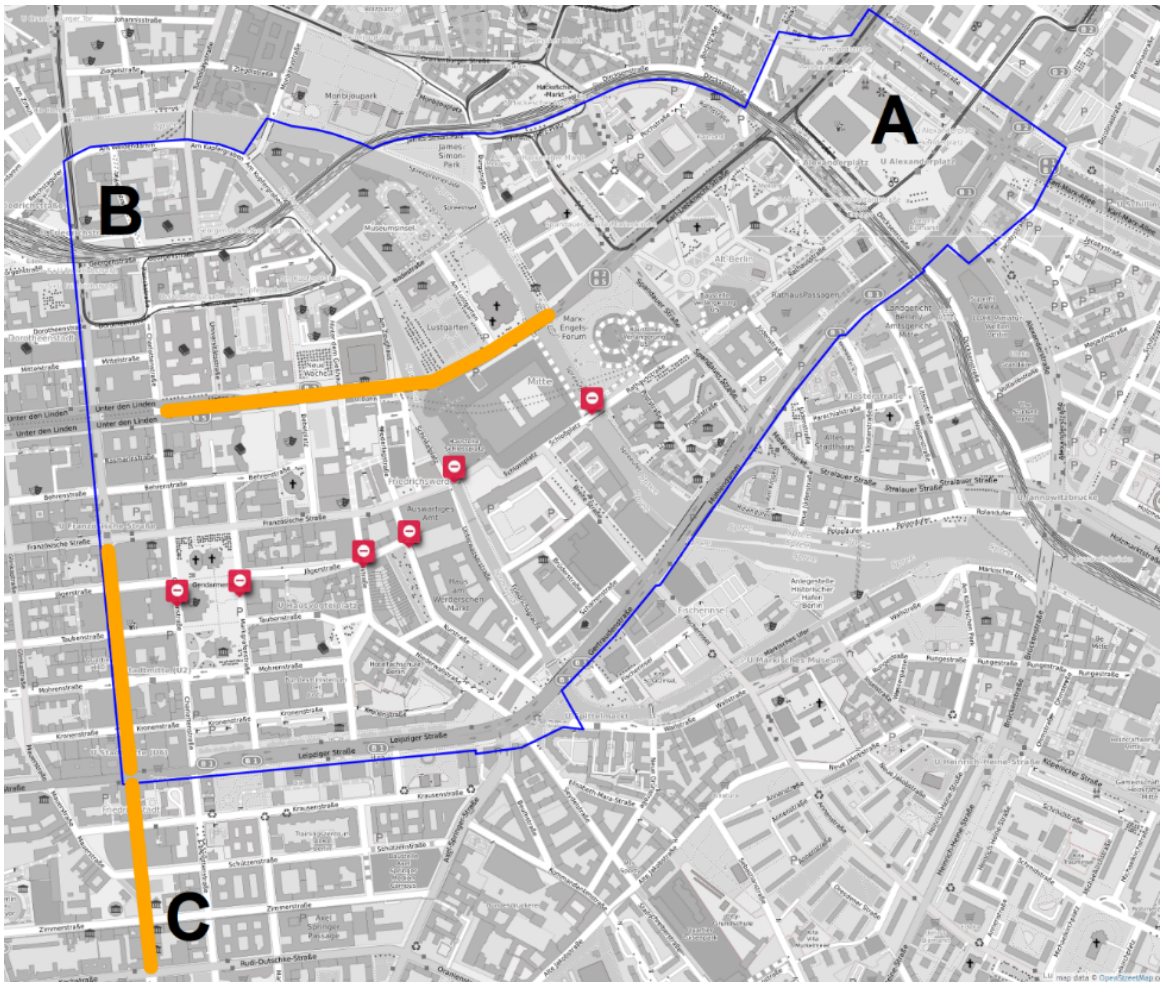

Fig.1 The specific planning area (blue border) with "Flaniermeilen" (promenades in orange; upper one is "Unter den Linden" and the second one, ending at the "C" is "Friedrichstraße") and barriers to prevent through traffic (red markers). For better spatial orientation, Alexanderplatz is marked with "A", Friedrichstraße station with "B" and Checkpoint Charlie – of course – with "C" on the map. Source: Lehmkühler (2020).

By implementing these concepts, it is possible to free the historical centre from through traffic and in a first step, only minimal structural changes (e.g. six retractable bollards; see red marker in Fig. 1) are needed.

One of the most prominent concepts is the re-design of "Flaniermeile Friedrichstraße - street of the future" (Lehmkühler, 2019), which is described in more detail.

3.2 The development-process of the concept for the Friedrichstraße

The Friedrichstraße has continued to present a challenge for urban planning and development in Berlin. The original concept for it as a "high quality shopping mile" implemented after the German reunification remains unsuccessful as evidenced by numerous empty stores and business closures to date (Latz, 2020). The Friedrichstraße fails to attract shoppers seeking more high quality urban space and an appealing environment: Private vehicle traffic currently takes up the bulk of road space, i.e. 13 meters of the 22-meters distance between buildings. Despite the fact that many people – especially tourists – use this street to get from metro-station Friedrichstraße to Checkpoint Charlie, there are no outdoor dining areas or recreational spaces. A lack of greenery and large stretches of sealed surfaces can lead to temperature spikes of up to 45 degrees Celsius in the summer and contribute to the unwelcoming feel of "Friedrichstraße". This situation is partly due to the planning paradigm of the 1990s, pursuing the so-called 'Stone City' concept "Steinerne Stadt" (SenStadtUm-Berlin, 2016). In recognition of the failure of these developments, the status-quo on Friedrichstraße needs to be changed to allow for a more livable and attractive urban environment.

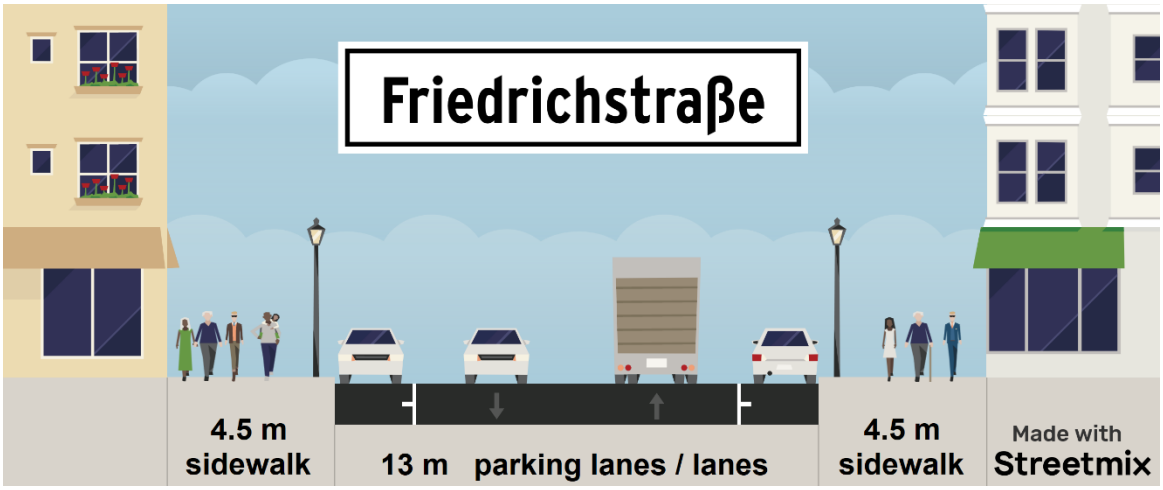

Fig.2 The current layout of the unwelcoming transit area Friedrichstraße is shown in the graphic. Source: Lehmkühler (2020).

In autumn 2016, CC-Central started developing alternative concepts for the Friedrichstraße. Among the first ideas was the radical notion of a "car-free Friedrichstraße", that was met with skepticism even among the core group of "Volksentscheid Fahrrad". Over time, the idea gained momentum and CC-Central started seriously working on the development of a concept focused not only on transport but also considering urban-ecological aspects.

Going back to their roots, CC-Central continued with their participatory planning approach and sought a cooperative discourse with all relevant stakeholders and citizens. By exceeding the legal requirements for citizen participation, CC-Central developed formats to elicit and integrate the ideas and knowledge of the local community. To accomplish their goal, CC-Central joined forces with a regional working group on the topic of mobility within the Green party of Germany (Landesarbeitsgemeinschaft Mobilität Bündnis 90/Die Grünen) in Berlin and founded the initiative "City for People" (Stadt für Menschen).

These associations organized a public demonstration on the Friedrichstraße in 2018. During the event, organizers offered a panel session with open discussion and collected ideas from attendees.

Fig.3 Impression of the current situation in the shopping street Friedrichstraße. Source: Lehmkühler (2020).

Citizens had the chance to write their ideas on a large paper (left picture) or on feedback cards (last picture) during the three-hour event. Most of the ideas submitted focused on the improvement of green spaces and outdoor gastronomy.

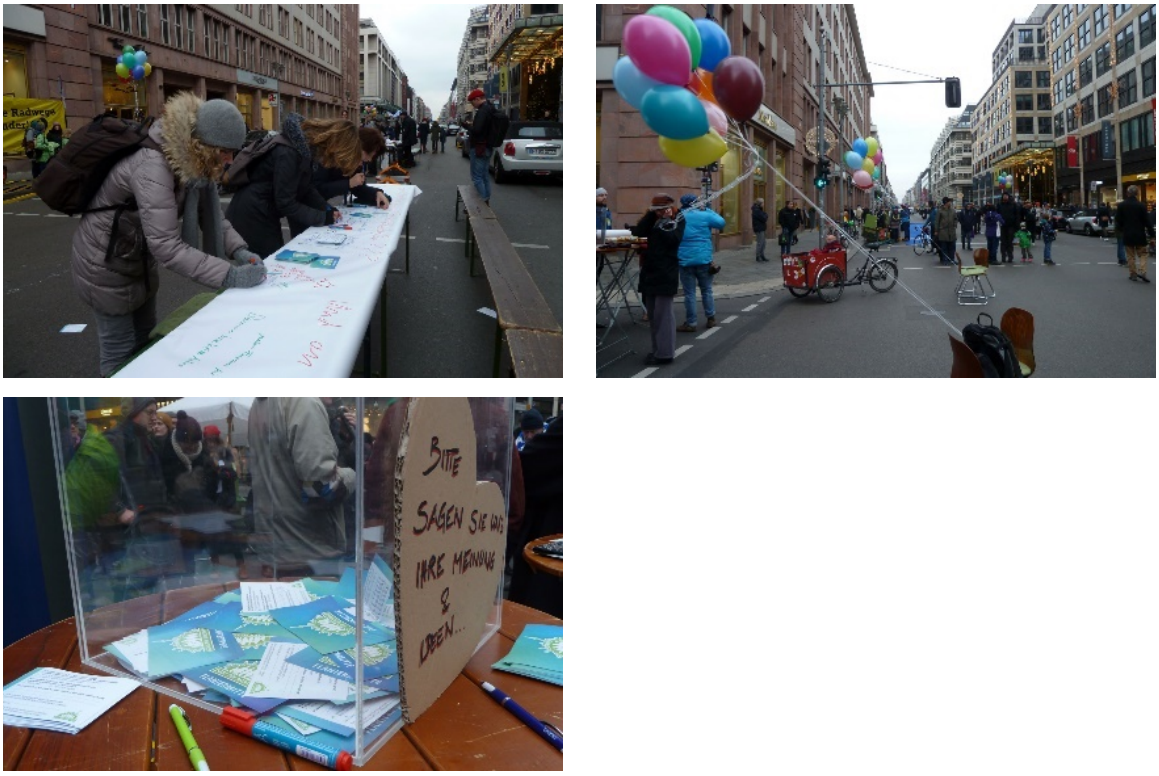

Fig.4 Collection of ideas. Source: Lehmkühler (2018).

CC-Central collected and evaluated all of the ideas and used them in the development of the concept "Friedrichstraße – Straße der Zukunft" (Lehmkühler, 2019). However, not only ideas from citizens, but also wishes and concerns of retailers located on the northern part of Friedrichstraße were considered in the concept

development. Aside from the nearly unanimous view that "Friedrichstraße is in a bad state and something needs to happen to stop the negative trend", retailers pointed out that the sojourn quality, i.e. the experience of dwelling in the area or passing through it, could be significantly improved through the development of green areas and trees. To start the process, CC-Central established direct contact with the active commercial and cultural stakeholders of Friedrichstraße. Additionally, they maintained close contact to the Senate Administration for the Environment, Transport and Climate Protection (Senatsverwaltung für Umwelt, Verkehr und Klimaschutz", SenUVK-Berlin) as well as the Mayor of the district Berlin Mitte.

As a result of this extensive lobbying and the inclusion of numerous stakeholders, the District Mayor of Berlin Mitte arranged for a two-day closure of the northern part of Friedrichstraße to car traffic (see @rbb24, 2019). To enable a first glimpse of the potential "Flaniermeile Friedrichstraße", greenery was provisionally placed throughout the event location. However, due to the short-term nature of the event, relevant elements of CC-Central's concept concerning transport and logistics were not realized. Nonetheless, the new urban space was very well received by numerous visitors.

Fig.5 Citizens and tourists visiting the autumn event "Flaniermeile Friedrichstraße". Source: Lehmkühler (2019).

3.3 CC-Central's concept for the "Flaniermeile Friedrichstraße"

As described, the concept of a "Flaniermeile Friedrichstaße" was developed by CC-Central and is based to a large extent on suggestions and ideas from citizens, stakeholders and retailers. Hence, the primary planning principle of Friedrichstraße is the increase of sojourn quality. In particular, the concept aims at creating a pedestrian zone that also caters to the needs of cyclists. To achieve this and avoid conflict, CC-Central came up with the following concept elements:

- Clear delineation of zones through physical segregation;
- A safety lane for emergency services, including police, fire rescue and ambulances;
- Specific logistics and taxi zones in adjacent streets;
- Blue-green infrastructure.

Relevant elements will be explained in more detail in the following paragraphs.

Traffic routing for a peaceful co-existence of pedestrians and cyclists

The agreeable coexistence of pedestrian and cycle traffic will be achieved through a newly installed "safety lane", which will run through the middle of the Friedrichstraße and move to a lateral position at subway entrances. As the expansion of the pavement shall be on the same level as the existing footpaths, the cycle-path will be in fact lower in the altitude profile and limited by a slanted curb (see Fig. 6 picture). The cycle path, which also serves as a safety lane, has a width of 5 meters, 0.44 meters of which will be taken up by a slanted curb. Additionally, to provide orientation for visually impaired people and in order to prevent other road users from accidentally entering the safety lane, so-called tactile surfaces will be placed along the perimeter of the slanted curb. To prevent misuse of the safety lane through other motor vehicles there is the option to include retractable bollards at either end. London City authorities permit the use of the cycle superhighways for their emergency vehicles (see 4ChordsNoNet, 2016, and ViperUK, 2017). The London Fire and Emergency Planning Authority has investigated attendance times and has found no "discernible impact" as documented in the London Safety Plan 2017 (see London-FEP, 2017, p. 24, #116).
The case of temporary emergency use will be indicated to cyclists and pedestrians through traffic lights installed at the edges of the safety lane (red flashing lights, bilateral, along the whole course of the lane). Upon activation of the red signal, cyclists are to clear the safety lane and pedestrians are to cease crossing it. Once the emergency vehicle has vacated the safety lane, the signals will be turned off and the safety lane can be used as a two-direction cycle path and traversed by pedestrians again.

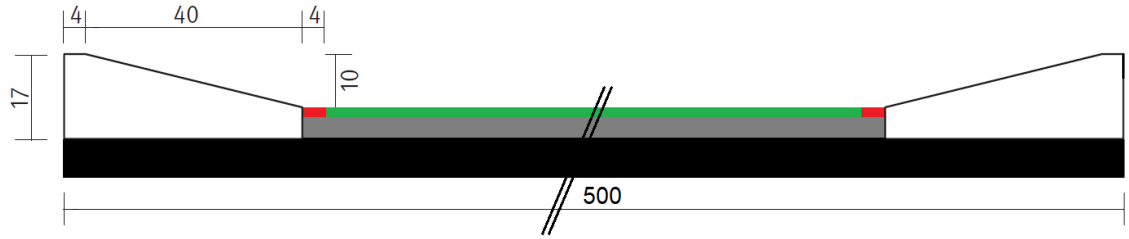

Fig.6 Cross-section of the embedded "safety lane". Source: Lehmkühler (2020).

In this manner, a physically segregated bi-directional cycle path is created in the "safety lane", which only has to be cleared for the temporary use of emergency services. A total of 17 meters out of the overall 22-meter road width is therefore dedicated to pedestrians. The resulting cross-section of the urban space Friedrichstraße is illustrated in the following graphic.

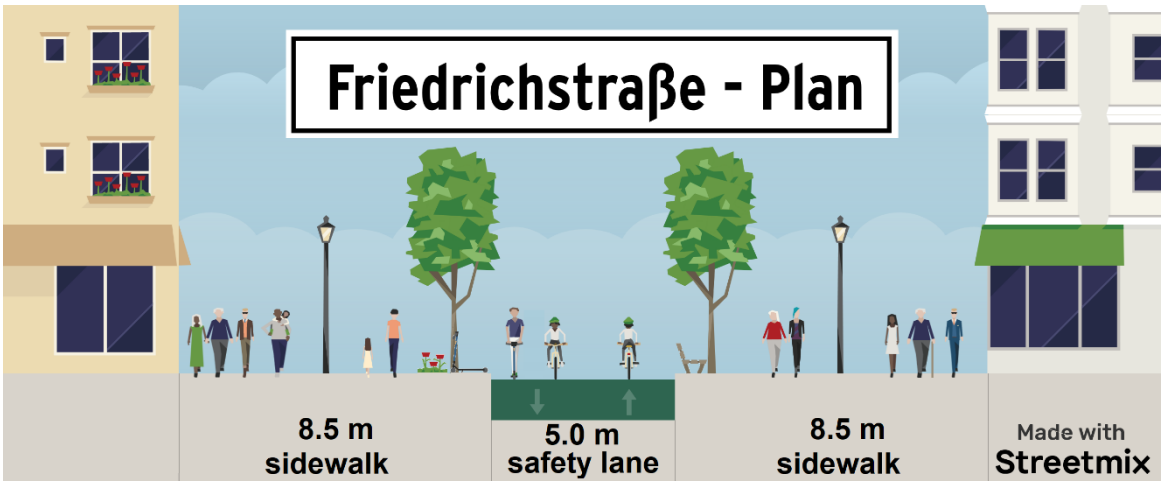

Fig.7 The planned layout of the "street of the future" Friedrichstraße. Source: Lehmkühler (2019).

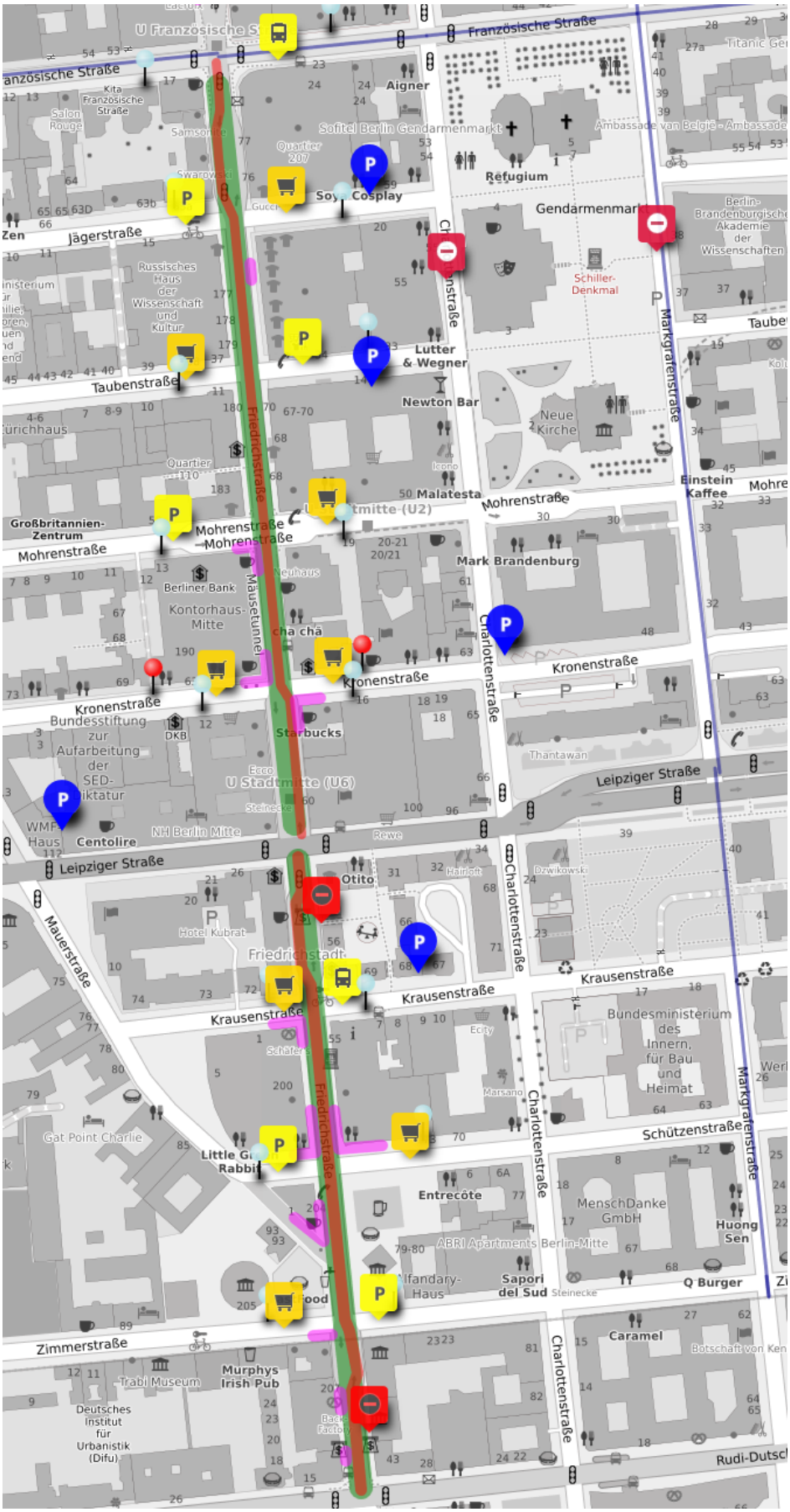

Fig.8 Details of the current and future Friedrichstraße. Source: Lehmkühler (2020). In extract of the plan shown above, the logistics zones are represented in Ochre with the symbol of a shopping trolley and the taxi stops in yellow with a black "P". The turquoise pins highlight the turning areas for 3.5-tonnes vehicles and the red pins the crossing points for larger lorries. The segments in pink show the current outside areas of cafes and restaurants.

Specific logistics and taxi zones

Urban logistics and freight-delivery play an important role in the creation of the concept for the Friedrichstraße. To ensure seamless delivery of goods, the following elements were included in the concept:

- reconfiguration of the adjacent streets to include spaces for logistics;
- logistics zones can also be used by taxis and Berlin's public transit services (BVG) after 07:00 p.m.;
- logistics and taxi zones will be rigorously (and ideally automatically) monitored to prevent misuse.

Logistics zones will be created in the existing space with minimal effort: The creation takes place merely through markings on the street and the installation of signages. The zones will be co-located with entrances to underground carparks in adjacent streets. The width of the side streets and the location of the entrances to underground carparks allows them to serve as turning areas for courier-, express- and parcel-delivery vehicles of up to 3.5 tonnes overall weight.

Larger trucks that are used for deliveries to grocery stores and other shops will require a different "pass through/over" procedure, which is also outlined in CC-Central's concept. In the project area this scenario occurs in the Kronenstraße and is marked by red pins in the following map; the logistics zones will have to be monitored strictly.

In addition, CC-Central's concept considers the transformation of the underground station "Französische Straße" into a logistics hub. The suggestion by CC-Central includes the remodeling of the underground station through demolition of one platform and the potential installation of a freight rail track next to the remaining second platform. While the existing passenger service of Metro Line 6 can continue to run on the remaining outer tracks; the middle track could be used to carry freight on an underground train for subsequent redistribution via e.g. low-carbon carrier bicycles in the local area. However, this innovative approach is still in the development process.

Blue-green Infrastructure

A central element of the improvement of sojourn quality is the integration of blue-green infrastructure. Blue-green infrastructure combines green areas and water supply. Especially in densely populated urban areas this is – in the literal meaning of the word – essential for survival. At its most basic, the blue component requires a concept for rainwater management, in which the areas of vegetation act as a buffer in the event of heavy rainfall (see Fig. 8).

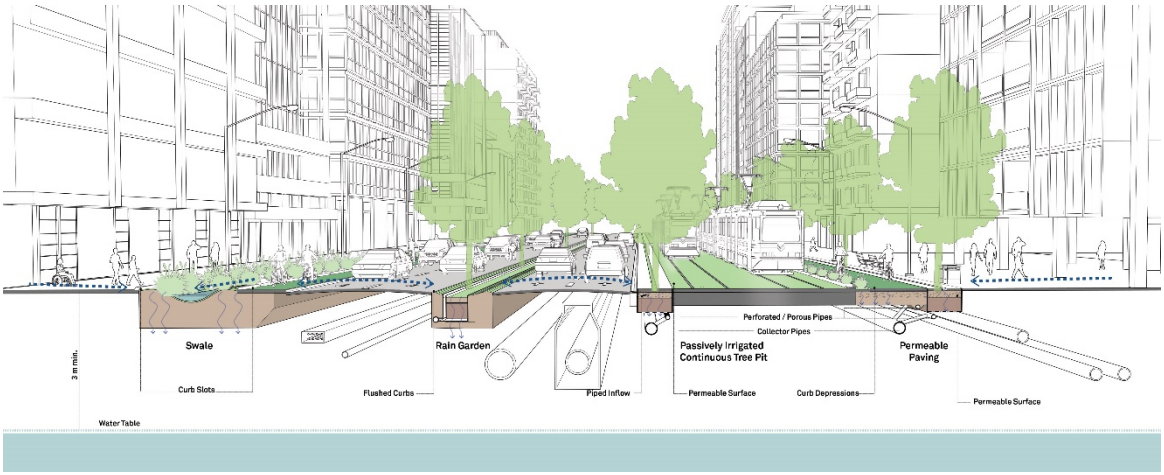

Fig.9 "Green Infrastructure and Stormwater Management", GDCI, 2020, Retrieved 05.07.2020

Even though the "sponge city" is a planning principle adopted by the city of Berlin, its implementation in the context of the Friedrichstraße remains a long-term goal requiring a step-wise approach to several challenges related to the existing underground infrastructure for instance. As a result, CC-Central developed a plan that

enables the revegetation of urban space using temporary measures. Since urban planning regulations demand strict linearity in the planning area, the current plan for the greenery distribution intends to plant a pair of trees every ten meters. To protect the underground rail infrastructure, these trees shall be planted in suitable infiltration trenches, ensuring that there is no damage to the street surface due to tree growth.

3.4 The planned Mobility Lab "Verkehrsversuch Friedrichstrasse": current plan including excerpt of the traffic signage plan

CC-Central's concept will be put to the test in summer 2020 when a six-month mobility lab will start in Friedrichstraße according to §45 of the German Road Traffic code ("StVO", see BMJV, 2020). In Berlin, the central administration (Berlin Senate) is responsible for the concept and authorization of mobility labs. However, the specific implementation of the mobility lab is mandated by the subsidiary administration on the district level. In the context of transportation planning or in particular the layout of traffic signs, a so-called traffic signage plan (Verkehrszeichenplan) (see Fig. 9) forms the basis for the coordination between the different levels of administration and the police. An external service company for traffic safety will use the plan devised by CC-central to implement signage and marking. The traffic signage plan and the diversion plan for motor vehicle traffic for the mobility lab was created by the central administration and coordinated with the traffic authority of the district Berlin Mitte.

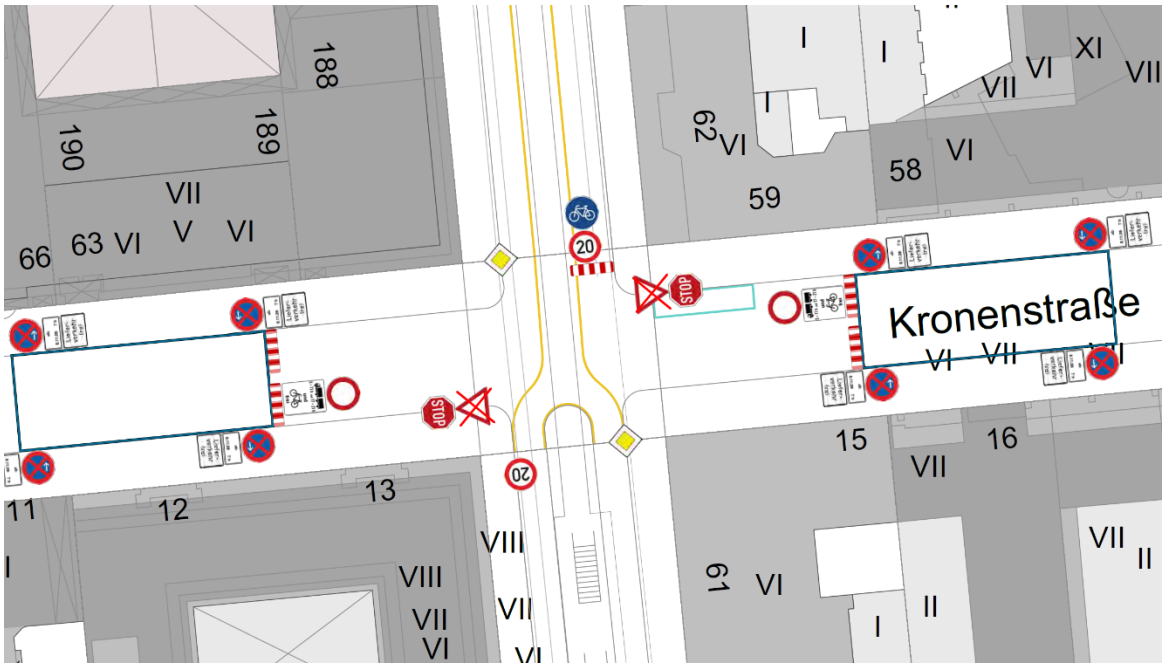

Fig.10 Excerpt of the traffic signage plan. Source: Lehmkühler (2020).

During the time of the mobility lab, several things will be put to a reality check. Firstly, the feasibility of combining pedestrian and cycle traffic will be closely evaluated. Moreover, the mobility lab will assess whether the creation of logistics and taxi zones is sufficient to ensure seamless freight and passenger transport. Due to the above mentioned constraints (e.g. underground line), Friedrichstraße will not see the implementation of complete blue and green infrastructure. However, there shall be a temporary installation of greenery (trees and bushes) without damage of the road surface. Since there is no existing access to groundwater, CC-Central has come to an agreement with BSR (Berlin city cleaning services) that for the duration of the mobility lab they will not only clean, but also supply the temporary greenery with water. Weekly meetings with the local government of Berlin will ensure a closed feedback loop between CC-central, local authorities and stakeholders.

In addition to the evaluation of the above-mentioned physical changes in Friedrichstraße, CC-Central's concept for the usage of the underground station "Französische Straße" as a "micro-hub" for urban logistics will be critically evaluated. Aside from the examination of physical possibilities during the planned evaluation, further aspects such as the costs of constructing a supply point on the urban fringe and possible operational models shall be carefully explored.

The mobility lab shall first be conducted for six months accompanied by scientific research and an independent project evaluation. This duration is unusually long for a mobility lab ('traffic experiment'), but it increases the chances of going directly from the stage of a study into a permanent remodeling of the "Flaniermeile Friedrichstraße" afterwards. Campaigns such as the European Mobility Week could be harnessed to further advertise the mobility lab and implement suitable activities in the newly established urban space. CC-Central and the involved units of the central administration are working together to ensure the implementation of the mobility lab in the timeframe from mid-August 2020 to the end of January 2021. In light of the current Covid-19 pandemic, however, this timeframe could change.

4. Discussion

CC-Central's concept for the "Flaniermeile Friedrichstraße" touches upon many important aspects central to the realization of UBA's vision of Tomorrow's Cities. In fact, the concept provides a holistic attempt to address multiple, concurrent challenges. Most prominently, it addresses measures relevant to the promotion of walking and cycling:

One of the most innovative elements is the concept's traffic routing that fosters a peaceful co-existence of cyclists and pedestrians. More often than not, pedestrian zones are scenes of conflict between cyclists and pedestrians, since they are equally attractive for both road users. For one, they often provide the shortest connection between two places and additionally attract vulnerable road users due to the fact that there is no car traffic. The concept offers a solution for said conflicts by introducing the safety lane, thereby physically separating sidewalks and bikeways.

Additionally, the concept takes into account the importance of blue and green infrastructure, by envisioning trees and water irrigation systems. With repeated maximum temperatures of more than 40 degrees Celsius, German cities also need effective measures to achieve a better state of climate resilience as discussed in detail by such authors as Papa et al. (2015), and Molinaro (2020).

A higher sojourn quality will also improve the attractiveness for pedestrians and cyclists. Suggestions from Tomorrow's Cities on lighting, speed limits, parklets, road surface quality, safe bicycle parking and accessibility can further improve the attractiveness of this urban area.

Considerations concerning urban logistics, which are highly relevant for pedestrian areas that offer multiple shopping opportunities, are also included in CC-Central's concept. Since logistics zones are located in adjacent streets, potential conflicts between cyclists, pedestrians and delivery vehicles are reduced. Moreover, it can help gain support from shop-owners, securing safe and seamless delivery of goods.

Many of the above mentioned elements improve road safety, however, it is important to expand active mobility networks continuously throughout the city and embed the "Flaniermeile Friedrichstraße" in a holistic citywide plan. Other relevant standards from Tomorrow's Cities touched by CC-Central's concept are urban green spaces and public areas, reduction of road traffic noise, managing private car traffic as well as fostering participation and collaboration in planning and implementation. The last on this list plays a prominent role in CC-Central's work as a civil society actor and representative. Hence, this organization has a legitimate interest in including relevant stakeholders in their planning processes and as a result has instigated informal dialogues with several local commercial and cultural stakeholders. The public demonstration on the Friedrichstraße organized together with other civil society actors forms the most important attempt to include the general public. Together, these two approaches tried to include as many opinions, ideas and concerns as possible.

However, limited financial resources did not allow for a district-wide formal public participation process. This is where the planned mobility lab plays a pivotal role. The mobility lab serves several purposes: Firstly, it formally includes the local administration in the operationalization and realization of CC-Central's concept. Moreover, at this stage adaptations that improve the concept might already be needed. Secondly, it puts the theoretical concept to a test. Practical implementation will show how the envisaged idea will work on the ground, where it potentially needs modifications and how it will be accepted by residents, tourists and local business. Thirdly, it establishes the basis for a permanent redistribution of public space in favor of cyclists and pedestrians, by showcasing the concept's feasibility.

The innovative character of the concept calls for a reality check in form of a mobility lab. In order to maximize the benefits of the mobility lab, the district's administration should conduct a comprehensive evaluation of the implementation process, as well as the effects on traffic, economic revenues, safety, air quality and noise. Furthermore, it is advisable to initiate a broad public participation process, ensuring all relevant voices are heard and public acceptance of implemented measures is achieved. Moreover, the district should make use of the non-permanent character of the mobility lab and adapt and/ or improve certain elements of the newly introduced design features on the ground where needed. International examples can provide interesting and relevant solutions to problems the mobility lab might encounter and should be considered where deemed necessary. In addition, participating in the European Mobility Week can help make Berlin's efforts known on an international stage. It might also be interesting to relevant local research institutions to support the city in above mentioned endeavors.

For these various reasons, decision-makers on regional and local levels – the Berlin Senate, the Berlin House of Representatives, and the district administration of "Berlin Mitte", should consider the detailed plans thoroughly. It may constitute a significant gain for the revival of Berlin's famous Friedrichstraße, for climate protection, and – given its origins in the bicycle referendum – for citizen participation in the German capital. It may also offer a blueprint for similar experiments elsewhere and towards the longer-term transition to more carbon-free mobility.

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Image Sources

Fig. 1: The specific planning area in the center of Berlin, source: Lehmkühler, 2020.

Fig. 2: The current layout of Berlin Friedrichstraße, source: Lehmkühler, 2020.

Fig. 3: Impression of the current situation in the shopping street Friedrichstraße. Source: Lehmkühler, 2020.

Fig. 4: Collection of ideas, source: Lehmkühler, 2018.

Fig. 5: Citizens and tourists visiting the autumn event "Flaniermeile Friedrichstraße". Source: Lehmkühler, 2019.

Fig. 6: Cross-section of the embedded safety lane, source: Lehmkühler, 2020.

Fig. 7: The planned layout of Berlin Friedrichstraße, source: Lehmkühler, 2019.

Fig. 8: Details of the current and future Friedrichstraße, source: Lehmkühler, 2020.

Fig. 9: Green Infrastructure and Stormwater Management, source: GDCI, 2020 (s. References).

Fig. 10: Traffic signage plan (excerpt), source: Lehmkühler, 2020.

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Urban accessibility: the paradox, the paradigms and the measures. A scientific review

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Abstract
The literature review presented in this paper represents a part of a wider research focused on the elderly quality of life within urban environments and aimed at designing innovative tools for both public administrations and elderly citizens. The article presents a systematic review of the relevant literature regarding the development of the accessibility concept during the 1959-2020 period. Nearly 6,000 documents were selected from the Scopus database, using the keywords "urban accessibility" and limiting the results to the fields of Urban Studies and Social Sciences to select the documents for the bibliometric analyses run. They were run in R Studio environment through a tool, developed in 2017, named bibliometrix. These analyses were run to highlight the main traits of the urban accessibility concept and developed methodologies and measures, in order to implement it in real-world practices and tools. The extensive and systematic literature review shows that for many years much of this scientific production has a deep theoretical nature, rather than practical. That was mostly due to difficulties in computing and introducing accessibility measures in decision-making practices. The advent of GIS has made much more practical the development of accessibility-oriented planning tools, and many commercial packages are now available.

Keywords
Urban accessibility; Literature review; Bibliometrix.

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1. Introduction

The manuscript aims at defining the scientific frame of a wider research project, whose objective is to develop methods and procedures to assess urban accessibility, especially for the elderly and, hence, support decision-making processes using information technology tools (Papa et al., 2016; Silva et al., 2017; Carpentieri et al., 2020; Gaglione et al., 2019). The scientific literature concerning urban accessibility has been deeply analyzed in order to build future researches, which will be described in future works, on solid theoretical foundation. Hence, this contribution is a positioning paper with a view to further analyses and more detailed methods, that could be applied to urban and territorial planning.

The principle of accessibility had a new rise in Article 9 of the United Nations Convention on the Rights of Persons with Disabilities (2007) and it confirms that every person has the right to live independently and participate fully in all spheres of life (United Nations, 2006). Hence, local authorities are required to take all necessary measures to ensure accessibility to physical environments, transport systems, information and communication technologies and other facilities and services open to public, both in urban and rural areas (Hansen, 1959).

Mobility clearly represents one of the indispensable access conditions to goods and services and to daily activities management, and it can make the difference between people that gain occasions and tools to move and people trapped in increasingly marginal places (Geurs & Van Wee, 2004). The relationship between mobility and accessibility is not easy and direct as it may seem, since accessibility does not only correspond to the possibility to reach more opportunities, but also to the capabilities to access to the activity repertoire, to values and goods, responding to personal expectation (Hansen, 1959; Bhat et al., 2000, Geurs & Van Wee, 2004).

In literature, the concept of accessibility replaced the ordinary notion of mobility paradigm, in order to take also into account both the available resources and the limiting bonds to access services and goods. Through this lens, mobility is just one of the necessary resources for action, available to people, in order to achieve their own aims. More in general, a lack of resources (also temporal, monetary, etc.) and capabilities (physical or psychological limits) represents a potential form of social and spatial exclusion. In the light of this, new and old social inequalities could rise in the next decades: cities and physical environments have always been designed for an average adult person; however, in the 21st century the definition of inclusivity has begun to change as public awareness of sustainable practices has increased. So, public governance and spatial scientists, including geographers, urban planners and architects, are confronted with the push for new definitions and design strategies for designing sustainable cities, which are not just about people with traditionally acknowledged disabilities but about all people regardless of age, gender and race.

Populations around the world are ageing at a faster pace than in the past and this demographic transition will have an impact on almost all aspects of society (World Health Organization, 2018). As stated by the WHO, the share of elderly people in the world will double from 11% (2011) to 22% (2050) and for the first time in human history, in 2018, people aged 65 years and over exceeded children aged under 15 years, because of a longer life expectancy and lower natality rates. Due to improvements in nutrition, sanitation and medical care, older people are healthier than previous generation, but ageing is also associated to an increased vulnerability; these reasons make the elderly a noticeable group of interest (Gargiulo et al.,2018). In this context, making cities more age-friendly is a necessary and logical response to promote well-being for older city dwellers and to keep cities thriving. Urban environments should adapt their form and structure so that they could be accessible to and inclusive of older people, considering their different needs and capacities. Although physical changes in well-established urban fabrics could be very difficult, even small innovations can make the difference to make sure older people continue to play an active role in the community and don't become isolated: reducing the distance between transport stops, shops, benches, trees for shade, public toilets and improving pavements and allowing more time to cross the road all encourage older people to move and,

hence, maintain good quality of life standards. More in general, the natural and the built environments should be prepared to be available for users with low level of mobility capital, rather than being conceived for an average adult person. That makes a challenge to improve elderly quality of life in all sphere of urban society. These statements represent the hypotheses of the research work.

The paper reviews the worldwide literature of urban accessibility definitions and measures, and identifies the main trends and research gaps, through bibliometric and statistical analyses, structured by authors' affiliations and countries. They were run in R Studio environment through a tool, developed in 2017, named *bibliometrix* (Aria & Cuccurullo, 2017).

The number of academic publications concerning urban accessibility has grown exponentially to remain current with everything that is being published about this multidisciplinary and complex topic. According to Scopus database, in the field of Urban Studies and Social Sciences, from 1959 to January 2020 about 6,000 documents were published on the theme, including articles, books, conference papers, with an average annual percentage growth rate of 7.5%. Furthermore, interesting insights could be highlighted studying the academic geography on the topic.

Following this introductive paragraph, the urban accessibility topic is deeply investigated: paragraph 2 is dedicated to the accessibility paradox and to the reasons that brought the scientific academia to further investigate this topic; the third paragraph presents a systematic review of the relevant literature regarding the development of the accessibility concept during the 1959-2020 period; paragraph 4 and 5 are dedicated to the main traits of accessibility paradigms and measures, based on an in-depth literature review, highlighted by the statistical and bibliometric analyses. In the conclusion paragraph, key-elements of the topic are highlighted, as they represent the path for the further developments.

2. The paradox of urban accessibility

Historically, nobody has been responsible for ensuring that people can get to key services, employment sites, places of interest, etc. and, as a result, services have been developed with inadequate attention to accessibility (Farrington & Farrington, 2005). At the same time, accessibility has been often seen as a problem for transport planners to solve, rather than one that concerns and can be influenced by other organizations, for example by locating, designing and delivering services that are easily and conveniently available (Social Exclusion Unit, 2003). Although urban environments have significantly changed their forms and structures, for a considerable long time, the city did not change its main defining characteristic: people with heterogeneous needs and characteristics living in a certain and well-defined urban structure, sharing facilities and activities. During the last century, this frame was completely upset by the widespread of new mobility systems, especially by the increasing use of private cars. This deep changing, started in USA and then in Europe, brought to a process of metropolitan growth to suburban areas (Caglioni et al., 2006; Schneider & Woodcock, 2008). Furthermore, financial and economic events, the global capitalism, the rise of Internet increased the sprawl of activities and people on a wide urban territory (Townsend, 2011), despite first innocent predictions. Consequently, although some services tend to keep a proximity attribute, such as educational systems and infant care (Levasseur et al., 2015; Meşhur, 2016), the strength of privatization processes, rationalization and relocation tend to drop an even higher number of activities from residence: family-based corner shops are replaced by great distribution structures; places out of municipality boundaries are becoming distribution spaces of productive units, shopping and leisure centers. The consequences of these phenomena on the transportation system are significant, deeply transforming people lifestyle, especially for those dwelling in suburbs. Mobility phenomenon has increased even more, in terms of growth of number of movements, daily travelled distances, time spent moving and actors involved. Looking at the Italian scenario (ISTAT, 2018), everyday 30 million people move to get from their residences to work or study places: over one third of them (35.5%) move for work purposes, while 18.5% of them move for study reasons. About one in five people (19.1%) chooses an active mode to

move: 17.4% walks to work or study places, while 1.7% uses a bike. The share of people that move by foot slight increases, from 16.2% in 2007 to 17.4% in 2019, while the use of private car, the most common mode of transport, is broadly stable. Public transit is used by only 8.0% of people that make daily movements. The Italian Institute of Statistics (ISTAT, 2019) proved that there was a decrease of 5 minutes on the journey average in an ordinary weekday (1h 16 minutes) during 2019, with respect to data collected in 2014. This value is in line with the European average, with Germany and Estonia. The European country with the lowest time spent for movements (less than 1 hour) is Romania, followed by Greece and Hungary, while the highest (1h and 32 minutes) is recorded in Luxemburg, followed by Netherlands and Norway (EUROSTAT, 2013). For what concerns the Italian scenario, although the reduction recorded for the mean value, many differences are highlighted for some categories such as working mums or suburban residents, whose movements are sensibly longer than the national average (respectively 1h and 32 minutes and 1 hour and 39 minutes) (ISTAT, 2018). These data hide a widespread forced mobility that can be translated in high individual and collective costs: mobility, indeed, is neither a necessary nor a sufficient accessibility condition (Legacy et al., 2019). A city with great mobility concerns, such as congestion and pollution, can have a good accessibility if its inhabitants live close to the main activities; at the same time, people can have a bad access to urban services even in case of great mobility infrastructure. Having a greater accessibility means having a greater degree of freedom when choosing between available resources and activities. Considering technology and society developments, during the last century, worldwide policies were much more mobility-based rather than oriented towards the accessibility paradigm (Banister, 2019): they focused (and still focus) on transport infrastructure capacity, underestimating the relevance of the land-use and activity systems. As a result, cities' dwellers and users are now facing a deep lack of accessibility, which figures among the challenges that urban environments have to face during the current century.

It may seem a paradox, because, since its birth, accessibility to activities and places for a wide and heterogeneous group of people has been one of the essential and inalienable traits of urban life (Amin, 2006). From the second half of the XX century, the spatial structure of the urban systems deeply changed, because of the technology innovations, the well-being growing and the changes in family lifestyles. The land-use system, the metropolitan functions allocation, the transport system configuration, as well as the multiplication of space-temporal fractures bring, as a result, uncertainties, lack of transparency and inadequacy. Urban complexity and its spatial and temporal fragmentation (Gargiulo, & Papa, 1993; Fusco et al., 2017) make mobility more difficult and fruition times longer, creating new forms of exclusion. In this view, the paradox is only apparent. The principle of accessibility is clearly raised in order to adapt cities to these challenging and wide phenomena. Hence, accessibility cannot be assessed as a simple count of facilities or services by some geographical units, without regard to factors such as spatial externalities, the structure of the transport network and the choice behavior of travelers, the frictional effects of distance, properties of the supply side and measurement issues related to the large scale of analysis. The concept of accessibility, which will be defined in paragraph 4 and calculated in paragraph 5, is a broad concept through various aspects including physical, psychological, economic and social features, which can be dependent on per capita land use and transport network. Through this lens, this idea of accessibility is quite far from the notion of place-based accessibility traditionally used in transport studies, namely related to the costs needed to reach a destination. Following, a bibliometric and statistical analysis of worldwide literature is presented. The main traits developed by these analyses were useful to identify common accessibility definitions in the scientific panorama, as well as some significant accessibility measures.

3. A worldwide literature scenario: a bibliometric analysis

This paragraph presents the results of an extensive and systematic literature review of journal articles, and conference papers published within the 1959 and 2019, from the Scopus database. Between the main

bibliographic multidisciplinary databases (CrossRef, Dimensions, Microsoft Academic, etc.), Scopus and Web of Science are the ones supported in *bibliometrix*, the R-studio tool used to carry out the bibliometric analyses. Since no software currently allows the merging of both databases and due to the high overlapping rate among them, we preferred to use Scopus because it has a greater number of documents then Web of Science (27 M vs 22.9 M) and because it has a better management of BibTex files than the latter. Fig.1 below summarizes the working flow used to select the elements in the sample, which refers to a Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) diagram (Liberati et al., 2009).

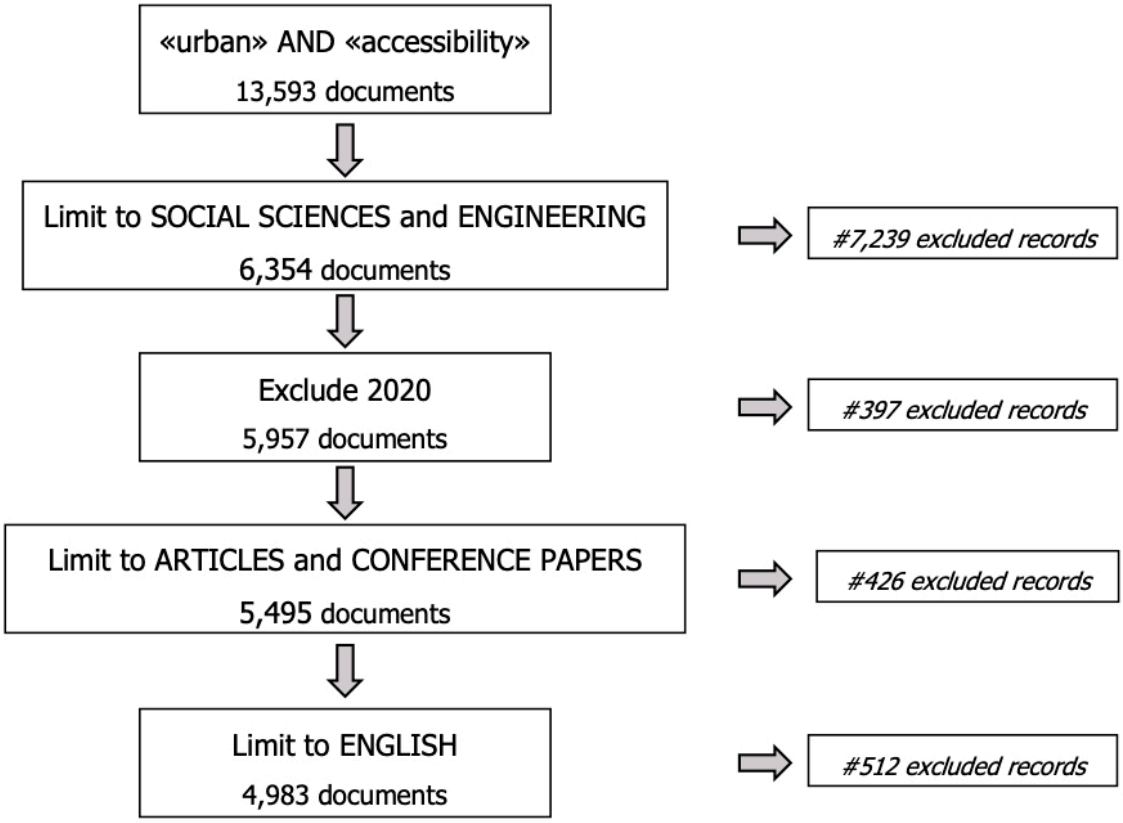

Fig. 1 PRISMA diagram describing documents' selection workflow

The workflow described in the above figure aims at defining a minimum set of items, in order to improve meta-analyses and systematic review. The documents were automatically selected as they contain the words "urban" and "accessibility" in their title and/or keywords, and/or abstract. Then, we limited the results to the fields of Engineering and Social Sciences to select the documents for the bibliometric analyses. We also limited the sample to articles and conference papers. For what concerns the language we preferred to consider only English records, in order to provide an international scientific panorama to the review. According to this selecting procedure, the SCOPUS dataset contains almost 5,000 documents.

Additionally, the average citation count per article is 13.88 while the median is equal to 3, and the curb shows a Pareto's distribution: the number of citations is inversely proportional to its frequency. For what concerns the authorship, the dataset contains 1,467 single-authored articles on urban accessibility. The other 4,495 articles are co-authored by a total of 12,670 different individuals. The average number of co-authors per article is 2.81, which suggests that scientific products concerning urban accessibility tend to be the result of collaborative research efforts. Tab.1 below presents summary bibliographic statistics for urban accessibility documents indexed in SCOPUS, for the 1959 – 2019 period. The trends revealed in Fig.2 correspond with the integration of the urban accessibility concept into government policies and consequently the expansion of its research, in scientific field. This shift is mostly due to the United Nations Convention on the Rights of Persons

with Disabilities entered into force in May 2008. Its purpose was to ensure that the estimated 650 million people with disabilities worldwide could enjoy the same rights and opportunities as everyone else and lead their lives as full citizens who can make valuable contributions to society. For the first time accessibility is defined as the integration of many human rights, from matters of work and employment, to participation in political and cultural activities. The 2008 Convention recognized the importance of accessibility to the physical, social, economic and cultural environments, including health, education and ICT, demanding implementation from governments and local authorities.

Documents	4,983
Sources (Journals, Books, etc.)	1,259
Author's Keywords	9,851
Period	1959 – 2019
Average citations per document	17.12
Authors	11,258
Authors of single authored articles	1,001
Authors of multi authored articles	10,257
Documents per Author	0.443
Authors per Documents	2.26
Co-Authors per Articles	2.91

Tab.1 summary bibliographic statistics for urban accessibility journals indexed in SCOPUS, 1959– 2019

Similar shifts have occurred at the local level and the international level, as suggested by clustering the whole sample, according to the country affiliation of authors.

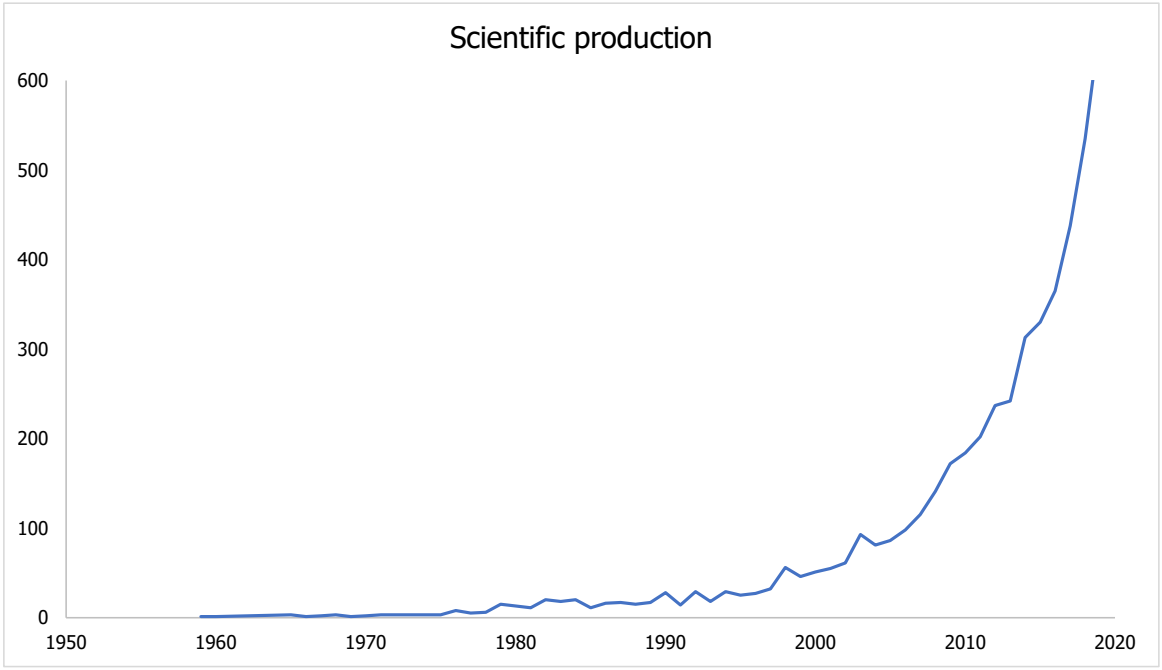

Fig.2 Annual number of urban accessibility documents published in SCOPUS, 1959–2019

The review, through bibliometric analyses run for different clusters of the whole sample of documents, discusses different aspects of accessibility literature at different scales. First, the temporal and geographical evolutions of the studies are examined. Second, considering the most cited documents and authors, a collection of definitions is presented. Finally, since the main objective of the research is to build a scientific

frame in order to develop innovative planning tools to support decision-making processes, a deep insight is given to accessibility measures to urban services.

The large sample of documents from the Scopus database was analyzed using the R-tool named bibliometrix, developed by Aria and Cuccurullo from University of Naples Federico II in 2017. This statistical tool is very helpful in mapping science, providing a structured analysis to a large body of information, to infer trends over time, themes researched, identify shifts in the boundaries of the disciplines, and to detect most the prolific scholars and institutions. Several analyses were run, in order to review the evolution of scientific literature both in temporal, within 60 years of research production on the theme, and spatial frames, clustering documents according to their country affiliation (North America, China and European countries are the places where the most productive institutions are located, as highlighted below). In the 1959 – 2019 period, accessibility studies were geographically distributed as follows: 24.4% of them were performed in North America (USA and Canada); 18.9% of documents were produced in European countries (United Kingdom, Spain, France, Netherlands and Italy are the more productive countries) and, 5.6% were developed in China. The sum of the scientific products of these three regions represents the 50% of the world scientific production on the topic of urban accessibility. On the basis of the geographical distribution of scientific productions, the percentages above suggest that accessibility has not received enough attention in developing countries, most probably due to particular urbanization dynamics and planning practices, at regional and urban levels. In fact, a Sankey plot was obtained from bibliometrix analyses (Fig.3) in order to identify the main research contents and their intellectual and geographical routes: the three-fields plot is helpful to highlight main relationships between most frequent Keywords, their Country Affiliation and Scientific Sources.

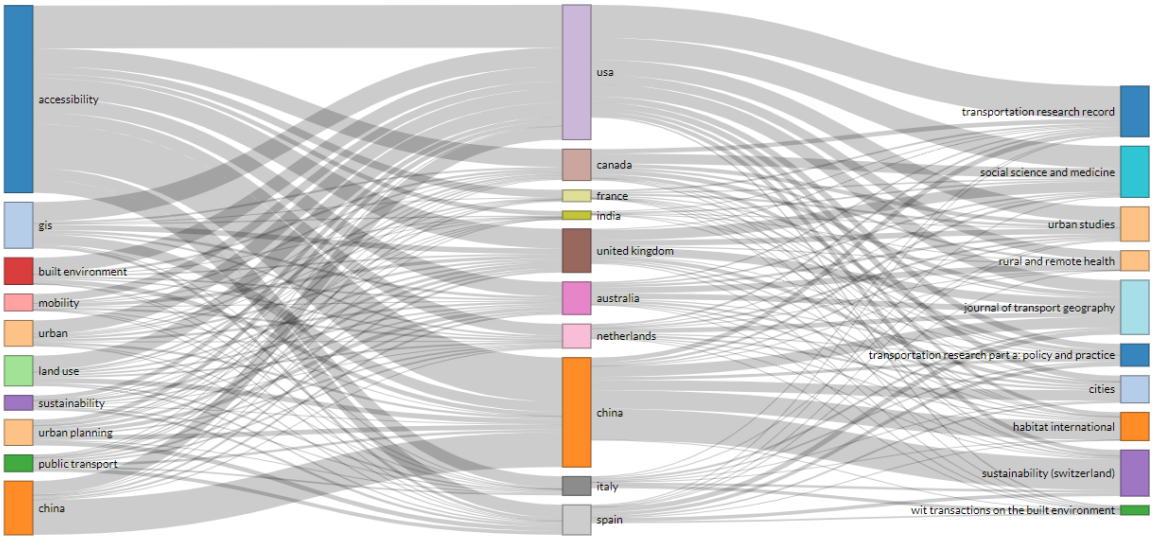

Fig.3 Relationship among most frequent Keywwords, Country Affiliations and Sources

Fig.3 is also helpful to define the weight in the scientific panorama of both country affiliations and urban accessibility main topics. It is worth noting that North America (USA and Canada) and China have both a key-role defining the academic routes of accessibility.

At the same time, looking at the right side, sources like "Social Science and Medicine" or "Rural and Remote Health" show that the topic at the base of this systematic literature review is not only related to urban and mobility studies, but it also concerns health and wellbeing issues that cannot be neglected. The next step of the bibliometric analysis investigated the most recurring keywords, in order to further investigate the accessibility definitions and their temporal and spatial inclinations and developments. The ten most prevalent keywords associated with the articles in our dataset are identified in Tab.2.

Rank	Keywords	Frequency
1	ACCESSIBILITY	683
2	GIS	148
3	CHINA	104
4	LAND USE	94
5	URBAN PLANNING	91
6	PUBLIC TRANSPORT	88
7	BUILT ENVIRONMENT	70
8	MOBILITY	68
9	SUSTAINABILITY	66
10	URBAN	63

Tab.2 Author's keywords ranking for urban accessibility documents indexed in SCOPUS, 1959-2019

The keywords analysis was done in two parallel ways. The first was run on five different groups of documents, according to their publication year. The first period falls between 1959 and 1980, when the number of urban accessibility publications totals about 70 records. The average number of published documents for this period is 4.3. The second period falls between 1981-1990, when the number of documents published increased to 173, with an average production per year of 17.3. During the third period, the number of scientific documents concerning urban accessibility increased to more than 300 with a year production, on average, of 32.7 documents. The 2001-2010 period recorded a number of documents close to 1,100. The average number of published documents for is 108.6. The last period (2011-2019) sample contains more than 3,000 documents and recorded an average publication per year equal to 369.3. Tab.3 presents a summary of the sample classification, according to the year of publication. This classification results from some considerations related to many interesting and significant historical events (economic booms, social crisis, publication of fundamental documents, etc.) that have certainly influenced urban and social studies, as well as the accessibility paradigm evolution.

Period	N. documents
1959-1980	73
1981-1990	173
1991-2000	327
2001-2010	1086
2011-2019	3324

Tab.3 Sample classification per year of production

Indeed, the second keywords analysis was run on three groups of documents, classified by their affiliation country, in order to highlight the main trends of the research on the topic from the European, North American and Chinese perspectives, since they represent about the 80% of the world scientific production on the theme.

Region	N. documents
North America (USA and 156anada)	1702
Europe	1592
China	568

Tab.4 Sample classification per country

Keyword co-occurrence of each manuscript can effectively reflect the hotspots in the discipline field, thus providing auxiliary support in scientific research on the topic. In fact, the temporal segmentation of the whole sample of documents brought to interesting insights due to some significant differences between the ten most recurring keywords for the five periods. For the first cluster of documents (1959 – 1980), the most relevant

keywords are "population", "urban planning", "developing countries" and "health services accessibility" as reported in Tab.5 below. This means that the accessibility concept was closely related to population and their location, in rural or urban environment. Moreover, the issue starts being related to healthcare provision rather than with the whole urban system and that it was considered an essential form of equity between citizens. The presence of the words "Asia" and "developing countries" means that documents from this period were strongly influenced by this matter, even though their production comes mostly from USA, United Kingdom and France.

Rank	Keywords	Frequency
1	POPULATION	14
2	URBAN PLANNING	13
3	RURAL POPULATION	12
4	ASIA	11
5	HUMAN	11
6	URBAN POPULATION	11
7	DEVELOPING COUNTRIES	10
8	HEALTH SERVICES ACCESSIBILITY	10
9	HEALTH	9
10	INFRASTRUCTURE	3

Tab.5 Author's keywords ranking for urban accessibility documents indexed in SCOPUS, 1959-1980

For the second group of documents (1981 – 1990), the most recurring keywords are still closely related to demographic issue and to health provision system: "population", "demography" and "health services accessibility" are the most frequent. (Tab.6).

Rank	Keywords	Frequency
1	ACCESSIBILITY	95
2	POPULATION	77
3	URBAN POPULATION	74
4	HEALTH SERVICES ACCESSIBILITY	63
5	POPULATION DYNAMICS	54
6	DEMOGRAPHY	53
7	DEMOGRAPHIC FACTORS	47
8	HUMAN	45
9	UNITED STATES	45
10	DEVELOPING COUNTRIES	44

Tab.6 Author's keywords ranking for urban accessibility documents indexed in SCOPUS, 1981-1990

Although the 1981-1990 period is significantly different from the 1959-1980 period, which also lived many fundamental historical events that shaped contemporary age (e.g. 60's economic boom and then 70's crisis), it seems that the academic notion of accessibility is still close related to demographic and population dynamics more than with urban system's issues.

The Reference Publication Year Spectroscopy (RPYS) of the first two periods confirms how the academic evolution of urban accessibility paradigm was deeply influenced by economic and social phenomena. Fig.4 above shows the RPYS plot; it represents the temporal profile of cited references for a set of papers, that emphasizes years where relatively significant finding were published. Its method, developed by Marx et al. in 2014, is helpful for identifying historical origins and academic roots of a discipline.

This analysis was used to identify key publications, according to peaks of both curves, which represented kind of milestones developing the urban accessibility paradigm in the academic panorama.

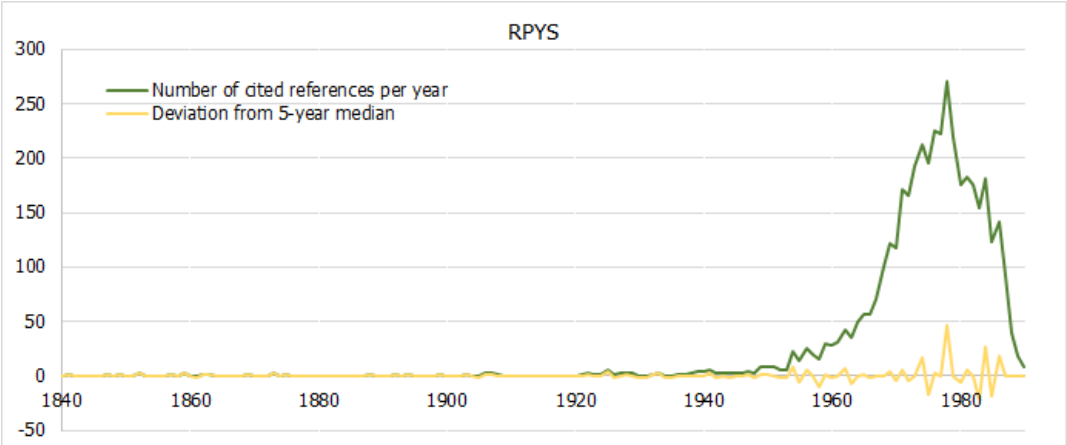

Fig.4 Reference Publication Year Spectroscopy (RPYS) for 1959-1990 period

For what concerns the third period of analysis (1991-2000), it is worth noting that, within the most frequent keywords, there are "female", "adult", "male", "adolescent" (see Tab.7) which represent a step forward in defining urban accessibility according to different groups of people. This information may lead to significant consideration: according to the principle of quality of life, that began to impose itself in the choices of urban planning and management during 90's, there cannot be a unique and universal urban accessibility definition since it must take into account different people's needs and vulnerabilities in urban environments.

Rank	Keywords	Frequency
1	ACCESSIBILITY	110
2	FEMALE	100
3	HEALTH SERVICES ACCESSIBILITY	87
4	HUMAN	85
5	ADULT	77
6	URBAN PLANNING	77
7	MALE	70
8	UNITED STATES	66
9	URBAN POPULATION	61
10	ADOLESCENT	54

Tab.7 Author's keywords ranking for urban accessibility documents indexed in SCOPUS, 1991-2000

For the four period of analysis (2001-2010), the most frequent keywords significantly change, as reported below, in Tab.8.

Rank	Keywords	Frequency
1	ACCESSIBILITY	321
2	GIS	312
3	LAND USE	256
4	URBAN	254
5	URBAN FORM	247
6	CHINA	246
7	MOBILITY	238
8	URBAN PLANNING	222
9	RURAL	201
10	SUSTAINABILITY	191

Tab.8 Author's keywords ranking for urban accessibility documents indexed in SCOPUS, 2001-2010

This may reflect the development of a different perspective to urban accessibility concept, which becomes affected both by the urban form and by the land use system, also thanks to the wide spread of Geographical Information Systems (GIS), developed at the end of XX century. This confirms that the knowledge of space and its representation in GIS environment are essential elements to thoroughly investigate the accessibility concept and to integrate it in urban planning practices. Moreover, it is worth noting the word "sustainability" which underlines that, at least in the academic scenario, the accessibility concept is being developed according to the sustainability perspective and consequently with referment to the reduction of use of non-renewable, or difficult to renew, resources, including land or infrastructure (Bertolini et al., 2005).

The annual percentage growth rate of the 2001 – 2010 period is of almost 14%. The more productive countries are still USA, UK and Canada, with respectively 26.2%, 6.3% and 6% of documents produced for the first decade of XXI century. In the fourth place, with more than 5% on the total of worldwide scientific production, there are Chinese institutions, which start playing a key role in developing contents concerning urban accessibility.

In fact, for the third analyzed period, with an annual percentage growth rate of about 13%, scientific production of Chinese affiliations doubled in half of the time, compared to the previous ten-years period. USA remains the more productive country with more than 17% of total scientific production, while Italy and European countries (such as Spain, France and Netherlands) start having a more significant role in the global scientific panorama. Moreover, it is worth noting that 2011-2019 period is the most numerous sample of analysis. From the keyword analysis, it appears the strong occurrence of "mobility", "land use" and "urban planning" issue when dealing with accessibility matter, as shown in Tab.9 below.

Rank	Keywords	Frequency
1	ACCESSIBILITY	317
2	GIS	81
3	LAND USE	44
4	MOBILITY	43
5	URBAN PLANNING	41
6	CHINA	39
7	PUBLIC TRANSPORT	35
8	BUILT ENVIRONMENT	33
9	SPACE SYNTAX	31
10	BEIJING	26

Tab.9 Author's keywords ranking for urban accessibility documents indexed in SCOPUS, 2011-2019.

Hence, the bibliometric analysis of scientific productions shows a coherence with the development of the main policies and instruments of the years considered. The R-tool was used to perform other analysis on the same sample of products, divided according to their country affiliation, as explained above. This second way of analysis was run to highlight potential geographical trends on the topic of urban accessibility, and their strengths.

The countries selected for the second analysis are characterized by a wide variety of urban forms, spatial and urban transportation structures, as well as associated social and economic systems: the dense urban cores of many European and East Asian cities, for example, enable residents to make between one third and two-thirds of all trips by walking and cycling; on the other end of the spectrum, the dispersed urban forms of most North American cities, which were built more recently, encourages automobile dependency and are linked with high levels of mobility; still, Chinese cities have experienced a high level of motorization, implying the potential of convergence towards more uniform urban forms. Consequently, the accessibility paradigm has been differently

developed and applied to real world practices. However, Fig.5 shows how the accessibility issue was contaminated, internationally and intercontinentally, involving developed and developing countries. In fact, the improvement of accessibility in urban areas is an aim that has now made its way into mainstream transport planning and policy making worldwide.

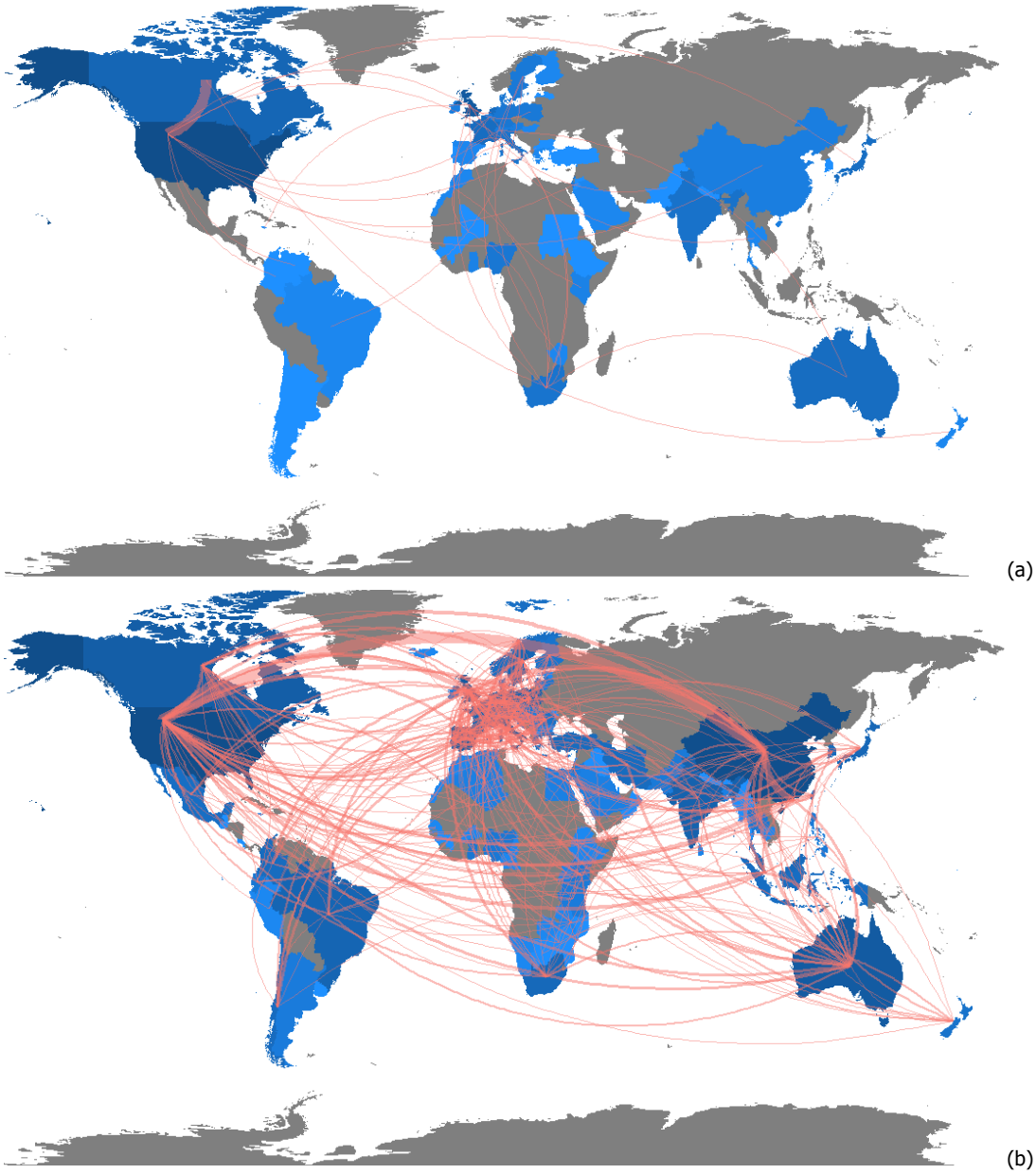

Fig.5 Elaborations from *biblioshiny*: Collaboration WorldMap for scientific products developed within 1959 and 2000 (a) and within 2016 – Jan 2020 (b).

For what concerns urban accessibility research in U.S., the analysis was carried out for more than 1,700 documents, which have an average citation per article equal to 24.9. Some of the most cited documents focus on the potentialities of spatial analysis tools (Ewing & Cervero, 2010; Proffitt et al., 2019), developed in Geographical Information System (GIS) environment, to explore the relationships between the build environment and mobility. The statistical analysis classified the authors keywords in three main clusters: the first one refers to land use and transport planning, which are both recognized as the main features to define accessibility; the second cluster contains words related to age and sex of population, which shows the strong

influence of accessibility on the individual perceptions; the third words cluster refers to socioeconomic and demographic context, which also plays a key role in urban accessibility research.
For what concerns the European context, almost 1,600 documents were produced, with an average citation close to 10. As the most cited articles show, much more attention has been paid to the sustainability paradigm (Bertolini et al., 2005; Mayaud et al., 2019) and walkability (García-Palomares et al., 2013; Lamíquiz & López-Domínguez, 2015) as two key elements defining urban accessibility. In fact, two main keywords clusters were identified through the bibliometric analysis: the first one concerns, as for the US, land use and transport systems but words like "sustainable development" and "smart city" prove a different approach to the research topic.
China is the third productive country, 568 documents that collected an average citation equal to 7.5. As for Europe and US, the keywords analysis shows that accessibility concept is closely related to urban and transport planning. A third word cluster refers to interesting and significant applications, mainly focused on measurement of accessibility to grey infrastructures, such as high-speed rail (Wang et al., 2009; Shaw et al., 2014), green areas, learning centers, etc.
These first statements represent the premise to further analyze the broad concept of urban accessibility, and all its multidisciplinary features, which will be in depth explained in the following paragraphs. The more cited products were selected from the whole sample of documents in order to define lines of research, through space and time, both for definitions and computational measures of urban accessibility.

4. The paradigm(s)

Accessibility is often defined as the number of places that can be reached within a given travel time and/or cost (Bertolini et al., 2005). Hansen (1959) defined accessibility as the different possibility/ability to negotiate space and time in the everyday life to accomplish practices and maintain relationships that people take to be necessary for normal social participation. According to Hansen (1959), a greater accessibility among a society is a means of achieving greater social inclusion, social justice and hence, social sustainability. Geurs and van Wee (2004) give another gateway to accessibility, as the extent to which the land-use and the transport system enable (groups of) individuals or goods to reach activities or destinations by means of a (combination of) transport mode(s). This definition suggests that accessibility is closely related to the interplay between transport system and land use pattern and is used when referring to a location's perspective. Bhat et al. (2000) define accessibility as a measure of the ease of an individual to pursue an activity of a desired type, at a desired location, by a desired mode and at a desired time.
According to scientific literature, different physical, social, physiological and economic variables need to be taken into account. In particular, four types of components can explain the accessibility paradigm:

- the land-use component, which is made by both demand characteristics, such as people origin locations, and the supply system features (activities, jobs, services, etc. within the study area);
- the transportation component, which is made, as well as for the land-use component, by both supply and demand systems, in order to define accessibility, in terms of passengers (or freight) and in terms of network infrastructures and generalized costs (pocket money, travel time, comfort, etc.);
- the individual component that considers people's needs, abilities and opportunities (annual income, age, household car-ownership, etc.);
- the temporal component which is useful to match transport and activity schedules to the individuals' available time, to participate in certain activities.

Fig.6 below shows the main relationships between components. Accessibility needs to relate to changes in travel opportunities and land-use, in constraints on demand activities and/or personal capabilities and limits; it should also consider personal access to travel and land-use opportunities.

The main consequence of this multidisciplinary and complex approach to accessibility issue is the hiatus between rhetoric and real practices. In contrast, the mobility paradigm assesses empirical measures that are easier to compute and to interpret (road or transit capacity, travel frequencies, level of service, etc.), but they are not able to holistically consider the urban environment.
Moreover, the accessibility paradigm considers mobility and proximity both as parts of it, in tension with one another (Weast & Proffitt, 2018). In fact, densifying urban areas and mixing uses, to bring origins closer to destinations (or vice versa), could result in decreasing vehicle congestion but increasing in pedestrian congestion and non-roadway users; indeed, pursuing auto mobility improvements could decrease accessibility over the long term by including more vehicle trips and encouraging sprawling development that increases dependence on automobiles. This is a cause-and-effect loop.

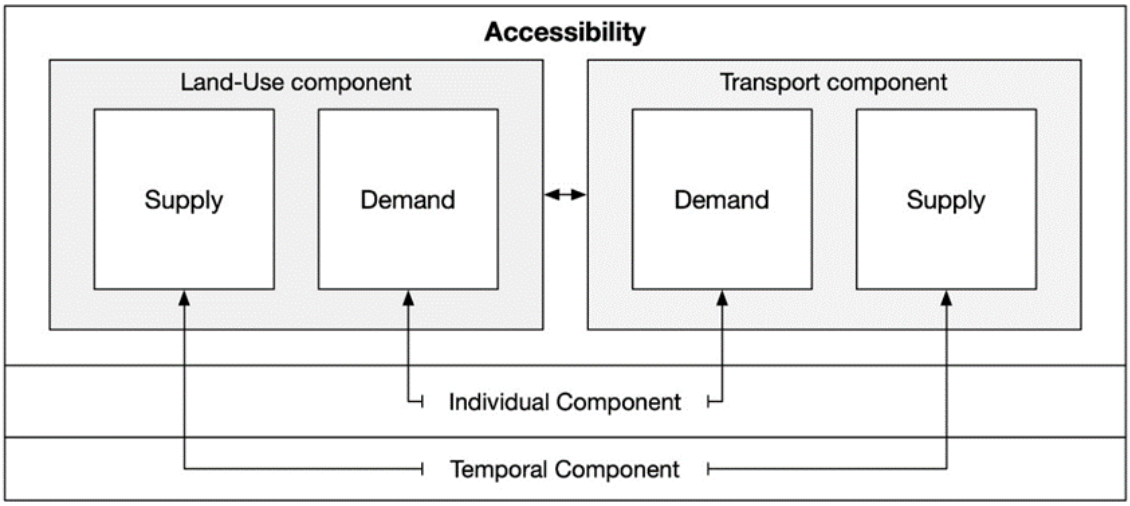

Fig.6 Accessibility components

In the light of this, accessibility measures need to be designed considering three different criteria: strong theoretical basis, to take into account the multidisciplinary aspects of the accessibility concept; easy operationalization, so that the measures can be used in practice policies; they also have to be easy to interpret and communicate, in order to use them in social and economic evaluations. Next paragraph summarizes the main developed accessibility measures, highlighting for each of them advantaged and drawbacks. The following paragraph summarizes the most used and known measures to assess urban accessibility.

5. The measures

The systematic literature review, supported by bibliometric statistical analysis, was helpful to highlight some of the main scientific products developed on the theme. Since the main purpose of this study is to design an accessibility-oriented planning tool for local authorities, the research through SCOPUS database was further improved, to highlight some of the scientific measures developed to assess accessibility to services in urban environments. This paragraph presents drawbacks and advantages of the most used and studied measures, in order to develop a methodology and implement it in urban and transport planning practices.
During last decades, scientific literature developed several accessibility measures. They vary a lot for main objective, theoretical basis and application: usually, the more they tend to include urban system features, the more they are complex both to compute and interpret. Following, a review of the most used measures is presented.
Contour measures (or opportunity measures, or isochrones measures) define catchment areas by drawing one or more travel time contours around a node and measure the number of available opportunities within each boundary. The general formula of contour measure is reported below:

The accessibility around the node i, Acc_i, is the sum of the opportunities represented by n zones j. The weight W_j is equal to $1/C_{ij}$, if C_{ij} (monetary cost, distance, or travel time between i and j) is lower than a threshold C_{ij}*, or 0 otherwise.

$$Acc_i = \sum_{j=1}^{n} W_j \quad (1)$$

This measure takes into account the land-use component and infrastructures constraints, by using, for exemple, travel time between two zones as indicator for impedance, even though the definition of travel time contours can be arbitrary, and it could be difficult to differentiate it in relation to different activities and travel purposes. On the other hand, this measure is easy to compute and interpret.

Gravity-based measures (or potential accessibility measures) were introduced in scientific literature field during the late 1940s. Since then, they were widely used in social and geographical studies, defining catchment areas by measuring travel impediment on a continuous scale. The general formula of gravity-based measures is reported below:

$$Acc_i = \sum_{j=1}^{n} a_j \times f(C_{ij}) \quad (2)$$

The accessibility around a node i is the sum of the opportunities in n zones j (a_j), multiplied by an impedance function $f(C_{ij})$, depending on distance, travel time, efforts or monetary costs. In literature, several impedance functions were developed to evaluate accessibility such as power, Gaussian or logistic functions; the most used is the exponential function since it is more closely related to travel behavior theory.

$$f(C_{ij}) = e^{-\beta C_{ij}} \quad (3)$$

The measure evaluates the combined effects of land-use and transport elements and incorporates assumptions on a person's perceptions of transport by using a distance decay function. One of the main drawbacks is that this method neglects the variations across individual living in the same area. Despite this disadvantage, gravity-based measures are the most used in academic and practical fields because they can be easily computed using state-of-practice land-use models and transport demand models.

Utility-based measures interpret accessibility as the outcome of a set of travelers' choices. They are able to measure individual or social benefits on accessibility, even in monetary terms. Utility-based measures have a sound theoretical ground, because of the Domencich and McFadden (1975) random utility theory: it is founded on the assumption that people select the alterative with the highest utility:

$$U_{k|n} = V_{k|n} + \varepsilon_n \quad (4)$$

The perceived utility ($U_{k|n}$) of the alternative k for the decision-maker n is the sum of systematic utility ($V_{k|n}$), depending on choice cost attributes (travel time, pocket money, etc.), and a random rate ε_n. The outputs of utility-based models are the probabilities of choice within the set of perceived alternatives and they vary a lot in relation to the statistical distribution of the random rate ε_n. In this framework, the choice set is given and no variability in individual behavior can be modelled. A utility-based accessibility measure is the logsum, the denominator of Multinomial Logit model (MNL).

$$Acc_i = ln(\sum_{k=1}^{m} e^{V_k}) \quad (5)$$

The main drawback is that measures obtained with different specification of ε_n cannot be compared.

The explained measures vary a lot for what concerns main hypotheses, application as well as results. What all these researches have in common is that, when dealing with C_{ij} (cost to reach destination *j* from origin *i*), they do not only refer to monetary costs or travel distances, but they also take into account living and walking environments, number of available activities, safety and security issues, overall congestion level, etc. The complexity of the urban system is the main hypothesis at the base of the methodology we are working on. Hence, with respect both to infrastructure and activity demands and supplies, we deepen our knowledge about methods and procedures to assess urban accessibility, also in real-word practices. In the scientific panorama the floating catchment area (FCA) method is one of the most recent and popular approaches to measure spatial accessibility. It is a special application of a gravity model, with its main positive aspects, proposed for the first time by Radke and Mu (2000). Since then, the FCA method was modified and improved several times and mostly used in healthcare access researches (Hu et al., 2012; Ahn et al., 2014; Ding et al., 2015; Tao et al., 2018) public transport (Langford et al., 2012; Kanuganti et al., 2016) and green areas (Dony et al., 2015). In fact, the method evaluates access to a service site in terms of provision (with variables describing the supply side) and need (considering the social features of the demand) as well as the distance between them to identify unserved areas, which make the FCA method a great candidate to investigate the spatial accessibility for the elderly.

6. Conclusions

The present study gives a comprehensive overview about urban accessibility literature and its current research status, in order to introduce its assessment in planning practices. The systematic literature review presented in this contribution aims at defining the scientific frame for a wider research oriented to develop accessibility-oriented urban planning tools to improve elderly's quality of life within urban areas.

According to the survey, made of almost 5,000 scientific documents (articles, and conference papers), accessibility to essential services in urban areas has gained greater attention in recent decade, due to ever increasing interest in planning practices. By dividing the whole sample of documents in different groups, according to their year of production and country affiliation, and then by applying a keywords analysis, findings showed that the term "accessibility" has been differently associated to broad and heterogeneous concepts. In fact, the extensive and systematic literature review, whose main results have been reported in this document, shows that for many years much of this scientific production has a deep theoretical nature, rather than practical. That was mostly due to difficulties in computing and introducing accessibility measures in decision-making practices. The advent of GIS has made much more practical the development of accessibility-oriented planning tools, and many commercial packages are now available. Furthermore, the systematic literature review highlights that accessibility is a function of the main urban accessibility components and of their interrelations, especially for what concerns the land use and transport systems. Urban infrastructures are notably fixed, while cities are dynamical entities, even if changes can take decades. Social and demographical changes will lead to different attitudes and needs, and urban places may eventually face spatial obsolescence. Accessibility-oriented urban planning practices may prevent this issue and enhance social equity and justice, considering personal mobility capitals especially of those who are more vulnerable than others.

The literature review presented in this paper represents a part of a wider research focused on the elderly quality of life within urban environment and aimed at designing innovative tools for both public administrations and elderly citizens. An interesting result of the systematic literature review is that urban accessibility to essential urban services from the elderly perspective is not yet statistically appreciable.

Our research is focused on developing an accessibility-based tool to support decision-making processes in urban practices. We are working on the development of a gravity-based measure to assess accessibility to primary healthcare services, as a proxy of quality of life for the elderly. From the very first application of the methodology, that will be further described in future manuscripts, it results that features of urban fabric, such

as slopes, proximity to activities and services, as well as of the urban supply of transports and healthcare provision play key roles for the elderly quality of life. The scientific experiences which are reported in the above paragraphs are some of the researches that we studied to develop the methodology framework at the basis of the incoming products. They were selected and studied in greater depth since they have potential to transform academic experiences in real world urban planning practices, supporting decision-making processes and, eventually, best practices. In fact, the scientific frame developed in this paper represents a summary of the hypotheses at the base of a wider research program: when dealing with urban accessibility for the elderly it is essential to provide a minimum level of quality of life, which depends on many features such as availability of essential services and activities, good walking environment as well as public transport infrastructures, high level of safety and security in cities. The challenge of the research project is to include all these elements in a GIS-based methodology, in order to model the complexity of urban system, and, at the same time, transform it in a tool available for decision-making processes and procedures.

In more detail, as a future work, we are interested to develop a measure that aims at assessing urban accessibility to essential services for the elderly and, in general, for the most vulnerable city users, and to introduce the measure in a wider urban planning tool.

Author Contributions

The paper represents a first step of a research programme that involves the Department of Civil, Building and Environmental Engineering of the University of Naples Federico II and the Department of Geography of Universitè Côte-d-Azur.

The authors contributed to the article as follows: Carmen Guida carried out the scientific literature review, run bibliometric analyses and discussed results and research lines; Matteo Caglioni supervised the work and the draft of the paper.

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Assessment of land use/land covers changes linked to oil and gas exploration

Developments under changing climatic conditions in Lokichar Basin, Turkana County

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Abstract

Understanding land use/land cover changes (LU/LC) linked to oil and gas exploration under changing climatic conditions in South Lokichar Basin is crucial. This knowledge will inform policy makers on appropriate sustainable vegetation cover management strategies for the sake of pastrolism practiced in the area. The LU/LC changes were assessed using multi-spatial and multi-temporal remotely sensed imageries acquired through Landsat 5TM and Landsat 8OLI/TIRS by use of ArcGIS. The study assessed medium resolution spatial imageries acquired for the area in both rainy and dry seasons, before oil and gas exploration developments begun in South Lokichar Basin between 2006-2011 and after commencement between 2012-2017. The study established that the average area in hectares under vegetation cover had declined since oil and gas exploration developments begun. A one sample t-test statistics indicated that the area under forest, shrubland and grassland cover had significantly reduced at 90% confidence interval with a p-value of 0.072, 0.074 and 0.061 respectively. The study established a decline in NDVI from 1 to 0.433 for the rainy season and 0.411 to 0.122 for the dry season between 2006 and 2017 with a p-value of 0.009 <0.05 on paired t-test implying a significant change on vegetation cover. Sustainable management of vegetation cover is important to safeguard livestock forage.

Keywords

Land cover; Land use change; NDVI; Oil; Gas; Exploration.

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1. Introduction

Oil and gas exploration developments have been documented to cause extensive changes on LU/LC changes in regions perceived to host crude oil reservoir (Ogwu, 2011). These developments directly affect the biodiversity, hydrology of the area, agricultural activities, fishing and water quality (Stanley et al., 2013). The activities such as clearing of vegetation, emission of natural gases from the opening of the earth crust during drilling and flaring of gases that ensues oil well testing causes indirect impact including alteration of global and local climate (Huang & Huang, 2014). The impacts resulting from the oil and gas exploration developments are felt in both long term and short term. Food insecurity, human vulnerability to hazards, health challenges, are experienced in the short terms. In the long-term climatic changes that may affect the viability of the mother nature arise if proper environmental management approaches are not taken (Kuch et al., 2019). According to Elum et al. (2016) community goals immensely changes when recreational, educational, religious and grazing lands gets turned into oil and gas exploration fields. Oil and gas exploration developments globally have been seen to alter the nature of the landscape from a rural to a more urbanized setting (Ogwu, 2011). Even though climate change is being attributed to LU/LC changes, the rate at which this happens is gradual and in the absence of drastic change in rainfall and temperature, the LU/LC changes may take time to detect (Khosravi et al. 2017).

Traditional techniques for gathering and analysis of environmental samples are not sufficient for complex environmental studies. Satellite Remote Sensing and Geographical Information Systems (GISs) usage in this field of study is playing a very critical role. These technologies are able to avail data for studies and monitor the dynamics of natural resources for sustainable environmental management (Adamu et al., 2018). In modern studies remote sensing is proofing to be an important tool relevant in developing and comprehending the global, physical processes affecting the planet. Current growth in usage of satellite data is to capitalize on growing amounts of geographical data accessible in conjunction with Geographical Information Systems to help in analysis and interpretation (Mierzejowska & Żogała, 2018). Geographycal Information Systems is a unified system of computer software and hardware that can capture, store, retrieve, analyze and potray spatial data for the purpose of aiding in decision making processes in resource utilization, planning and management (Sokoła-szewioła et al., 2016). Several studies have focused on land use land cover changes because of their adverse effects on ecology in addition to socio-economic characteristics of the locals (Seki et al., 2017). The area of study falls under arid and semiarid regions of Kenya and grass, shrubs and dry forest vegetation are the predominant flora species. 84% of the locals in South Lokichar Basin oil region depends on pastoralism as their main economic activity hence vegetation cover which 60% consist of grassland and 25% shrubs land forms the basis of the locals source of livelihoods (Opiyo et al., 2015). Understanding LU/LC changes in South Lokichar Basin oil fields is very significant even as oil and gas exploration developments intensifies in the region. This is because it will inform appropriate planning and management of vegetation cover mostly grass and shrubs resources that the pastoralist depend on. It is of great interest to mention that there are few academic studies on oil and gas exploration impacts on LU/LC changes that have been conducted in the study area since the discovery of oil and gas in 2012 and therefore this study adoptated an exploratory case study research design approach. The study endeavors to establish the level of contribution of climatic factors changes to LU/LC changes in the area by assessing the changes in both dry and wet seasons in the area before oil and gas exploration developments began and after. The paper is structured as follows. An overview of the impact of oil and gas exploration developments on land use/land cover achieved by systematically reviewing empirical studies from a global scene. Effects of changing climate on land cover vegetation.

The effects of land use land cover changes linked to oil and gas exploration on climate and socio-economic characteristics of the surrounding communities, methodological approach, result and discussion, conclusion and recommendations on sustainable oil and gas exploration approaches to safeguard vegetation cover.

2. Literature review

Exploration of oil and gas has been there since 2, 000 BC (Kuch et al., 2019). The first modern oil and gas exploration and drilling was done in Titusville, Pennsylvania in 1859. This triggered a significant explosion in the oil and gas industry and this marked the beginning of the modern oil and gas industry (Hassan, 2013). According to ADB (2018), oil history in post-independent Africa stretches over a period of six decades. The report indicates that 16 of the 54 countries in Africa are exporters of oil and gas with Angola, Algeria, Nigeria and Libya being members of the Organization of the Petroleum Exporting Countries (OPEC). East African countries have only depended on agriculture as the primary economic activity for a long time until 2006 when oil was discovered in Uganda (Zhou et al. 2013). In Kenya, commercial crude oil quantities discovery was made in 2012 in Oil Block 13T South Lokichar Basin, Turkana County (Eliza et al., 2015). This discovery has brought with it LU/LC changes within the study area and these changes are expected to rise as more oil and gas exploration developments gets carried out in the area.

Concerns for the modification, loss, and fragmentation of indigenous vegetation species such as grassland and shrubland has been articulated in an array of scientific literatures (Yu et al., 2015; Sonter et al., 2014; Takeuchi et al., 2017). However, few studies have quantified landscape-scale alterations as a result of oil and gas development (Garman, 2018). In addition to land fragmentation due to well pads construction and development of access roads, highways and trails that tampers with the wildlife habitats and biological systems, vehicles traffic colossally affects wildlife (Oduro et al., 2020). An empirical study carried out by Osei et al., (2006), in Niger Delta ecosystem by use of geospatial data processing and analysis observed that oil and gas exploration developments between 1985-2005 had resulted to a slight decline in water bodies from 343, 654 to 343, 513 hectares, mangrove and closed forest showed a decline from an initial estimate of 55, 410 hectares in 1985 to 37, 117 hectares and closed forest from 250, 161 hectares in 1985 to 175, 609 hectares and the Settlement/bare areas increased from 52, 738 to 108, 725 hectares. However, the land use land cover changes cannot be attributed to oil and gas developments alone in the mentioned oil field as climatic changes too resulting from anthropogenic activities do play a role in these changes (Galderisi, 2014). A study done by Larry et al., (2020) observes that climate change causes extra stresses on land, intensifying prevailing risks to biodiversity. However, Yin et al. (2014) observes that the link between climate and land cover changes is complex. First, the land cover is changed by changing land use such as oil and gas exploration developments, which affects the atmospheric concentration of greenhouse gases. On the other hand land use change is a key driver to climate change, a changing climate, can cause LU/LC changes.

Nonetheless the rate at which this happens is gradual and in the absence of drastic change in rainfall and temperature parameters, the LU/LC changes may take time to be detected (Khosravi et al., 2017). This implies that in an area where precipitation variation and other weather conditions are minimal the LU/LC changes resulting from climatic conditions are insignificant. According to Bhatt et al. (2013) through analysis of Advanced Very High Resolution Radiometer (AVHRR)-derived (NDVI), the index trend in arctic tundra vegetation cover was observed to be consistent with increasing temperature and precipitation in the entire arctic. The observation is consistent with Frost et al. (2014) who noted that substantial tall shrub extension had been reported in the past five decades at a number of undisturbed sites in West Siberia and and this was attributed to stable local climatic warming. These studies imply that areas with little climatic variations, the status quo of the land cover vegetation remained while; fluctuating climatic conditions such as precipitation and temperatures proportionately affected the vegetation cover. However, with the human impactive interventions, assessment of long-term vegetation change due to climate change at the regional scale is complex (Klostermann et al., 2018). According to Wang et al. (2018), economic and social infrastructures is always associated with disruption that clears natural vegetation cover, modifies surface and subsurface hydrology, soil structure and texture. Larsen et al., (2014) observes that, anthropogenic induced LU/LC changes can aggravate impacts of climate change, triggering potentially harmful consequences for

ecosystems. It is worthy noting that anthropogenic induced land cover land use change is gradual, and it has cumulative effect in the long run to the environment. Engineering works, such as transportation corridors entailing pipelines for oil and gas transportation, oil and gas production fields, power plants and boom towns that around the oil rich regions normally get developed (Kumpula et al., 2012). In addition a broad network of vehicle tracks and fundamental trails, crosses the areas outside of engineering facilities to evacuate the oil and gas resources to the potential users. It is such anthropogenic stresses that causes extensive land degradation in most oil and gas rich regions (Kumpula et al., 2011). The observations made above are consistent with Al-haleem et al. (2013) who underscores that colossal clearance of vegetation emerging from oil and gas exploration developments results to instant LU/LC changes of the surrounding ecosystems. Kadafa & Ayuba (2012) established that LU/LC changes in the oil rich Niger delta region in Nigeria resulting from oil and gas exploration developments affected immensely the regions' ecosystems, which affected communities' livelihoods. Many communities were dependent on land and water resources for their livelihoods through agriculture, pastoralism and fishing. Although there were some positive effects such as improvement of social amenities, the cutting down of trees and other vegetation cover during oil seismic surveys and construction of roads and pollution of water bodies by the oil-exploring companies affected people's livelihoods immensely (Julius et al., 2011).

A similar empirical study on how LU/LC changes emanating from oil and gas exploration developments can negatively impact people's socio-economic aspect is that of West Kordofan State in Sudan as recorded by Chavunduka & Bromley (2011). The researchers observed that the economy of West Kordofan State was predominantly dependent on agricultural production consisting of rain-fed cultivation and traditional livestock practiced by nomadic and semi-nomadic agro-pastoral and sedentary groups. However, Ibrahim et al., (2013) established that the communities lives began to change as a result of oil and gas exploration developments that resulted to drastic LU/LC that could not sustain their pastoralism way of live. According to Anis et al., (2015) sustainable environmental management strategies has been a mirage in many oil and gas producing countries. They further note that the focus has always been on oil and gas resource exploration and its economic benefits with little attention on its ecological effects and its implication on the pre-existing sources of livelihoods. As a result, the resulting LU/LC changes affect negatively people's sources of livelihoods and this can cascade to other social challenges. It is imperative for any developer on the environment to appreciate the nexus between the social cultural, economic and ecological environmental systems since, negligence in one will result to unsustainable development (Papa et al., 2015). Globally there are mitigation measures that are being adopted to minimize land use land cover changes emanating from oil and gas exploration. Key among these approaches entails restoration of the dry wells encountered during exploratory drilling and landscaping of the excavated areas with indigenous plant species within the globally acceptable period. In addition oil explorers in conjunction with oil and gas resources host governments are adopting horizontal well drilling technology. This approach is minimizing the ecological footprints on the ecosystems and this fuses well with the concept of sustainable developments where utilization of ecosystems resources does not outstrip the regeneration process (Salvati et al., 2013). According to Zhao, Xu. (2019) horizontal drilling technology enhances sustainable management of vegetation cover in well-drilling. Vandenberg, observes that horizontal drilling is the method used in drilling a well from the outward to a subsurface point just overhead the aimed oil reservoir commonly referred to as a kickoff point. The process entails deviating the wellbore around the curve from the vertical level to interconnect the reservoir with a near-horizontal inclination and the drill continues until the bottom hole needed is reached. Zhao, Xu. (2019) records that horizontal wells are superior producers than the vertical wells and are more suitable when it comes to the aspects of environmental conservation. A single horizontal well can penetrate and produce oil from multiple parcels and single horizontally drilled pad can be used to drill several wells, and this minimizes the footprint of drilling operations (Salleh et al., 2019). According to Vandenberg (2015), the University of Texas at Arlington drilled 22 wells on

a single platform from an area spanning to 1,100 acres and hence conserving on surface biodiversity and infrastructures. Horizontal drilling approach has also been adopted in East African Countries in the biodiversity-rich region of Albertine Graben in Uganda whose sedimentary rock geologic formations forms part of the East Africa Riftvalley Tertiary Basin whose South Lokicar Basin falls in on the republic of Kenya side (MacKenzie et al., 2017). The technology was used in drilling Jobi-6 appraisal well in the environmentally sensitive Albertine Graben in Uganda. According to Lokeris et al(2014), the reason behind the adoption of this technology was in the spirit of wildlife conservation in this ecosystem zone. Manshad et al. (2019) notes that horizontal well drilling is more costly than the vertical drilling for it can cost over 300% more to drill one horizontal well than a vertical one. However, he reveals that the distance of penetration of the pay zone can go up to a distance of 10 kilometres.

Commercial oil quantities were first discovered in Kenya in 2012 in South Lokichar Basin, Turkana County (Eliza et al., 2015). According to Opiyo et al., (2015), South Lokichar Basin, Turkana County is among the arid and semi-arid regions of Kenya with harsh environmental conditions unsuitable for rain-fed agriculture. They further point out that pastoralism is the primary economic activity of the communities dwelling in this area; hence sustainable management of land and existing vegetation resources is of paramount importance. Changes on land use and land cover resulting from oil and gas exploration developments in the absence of proper ecosystems management strategies will have extremely negative implications for the well-being of the locals pastrol way of life in the study area as noted from the cited publications.

3. Materials and method

3.1 Area of study

The main aim of this study was to determine the impact of oil and gas exploration on vegetation cover in South Lokichar Basin and make recommendations on sustainable vegetation management practices. This is because the locals depend on the grassland and shrubs vegetation for their livestocks since pastoralism is the main economic activity in the area. The South Lokichar Basin is found in the Tertiary Rift Basin a Cenozoic sedimentary basin in Kenya. It is part of the East African Tertiary Rift system. The basin is approximately 25 Km wide, 80 Km long and has a maximum depth of above 7 km (Repubic of Kenya, 2016). The Tertiary Rift basin is divided into 9 oil blocks and among them is oil block 13T whose this study was carried out purposively because it is the oil block with the highest number of drilled and developed oil wells hence suitable to show the oil and gas developments impacts to the environment. Block 13T straddles in three sub-counties of Turkana County, i. e., Loima, Turkana Central and Turkana South. The study was carried out in Turkana South Sub county, Lokichar Ward located at latitude 02. 3838o N and Longitude 35. 6478o E as shown in figure 1 below. The total surface area of the Ward is 2, 899 km² and by 2017, 38 well pads with a total of 320 oil wells had been drilled (Repubic of Kenya, 2017). The study examined 11 randomly sampled constructed well pads and assessed their impacts within a distance of 10 kilometres equidistance from each well pad. The rationale for sampling the 11 well pads was due to the fact that, the well pads were far apart from each other, an average of 20 kilometres posing a limitation of accessibility. The study in addition evaluated the well pads access roads network within the study area.

The area has diverse vegetation cover including, dwarf shrubs, shrubs and dry forest trees. The grazing areas are dominated by Cadaba farinosa mellifera, Tribulus terrestris, Dactyloctenium aegyptium, Boscia coriacea, and Digitaria milanjiana. Among the Dwarf shrubs includes the condyloclada Balanites orbicularis, Aristida mutabilis and Tragus berteronianusTetrapogon cenchriformis, Mollugo cerviana, Seteria sphacelata173irgate173te and Becium obovatum. The shrubs found in the area includes Enneapogon cenchroides, Chloris virgata173irgate, Aristid mutabilis, Acacia reficiens and Cordia sinensis as shown in Fig. 1 (Schilling et al, 2015). The study adopted a combination of case study and exploratory descriptive research

design in describing the trends of land cover changes in the study area, by use of digital imagery acquisition and analysis an approach adopted from Huang & Huang (2014).

3.2 Sampling and data analysis procedure

Document analysis, observation through ground trothing/mapping and digital imagery acquisition and analysis were used as data collection methods.

The study acquired rainfall data from 2006 to 2017 from the Meteorological Department of Kenya for the region for both long and short rain and this data was used to determine the rainy and dry seasons. The dry and rainy seasons determinism was crucial in assessing the implication of climate variability on LU/LC changes in the study area comparative to the oil and gas exploration developments induced impacts. ArcGIS was used in remote sensed digital satellite Imagery analysis and classification.

According to Pande et al. (2011), Arc-GIS has two ways of classifying digital imageries that is supervised and unsupervised. The study adopted the National Land Use Landcover classification system model and made use of supervised classification, which mostly depends on the researchers understanding of the study area to achieve the set objectives. The classification process entailed imagery restoration, classification, and enhancement.

The analysis was carried out as follows band composite imageries where the bands of interest which were ([Band 4=Near Infrared] and [Band 3=Red]) and ([Band 2=Green, for Landsat 5T. For Landsat 8 OLI/ TIRS the bands of interest were=[Band 5=Near Infra-red] and [Band 4=Red] and [Band 3=Green] were exhibited followed by selecting of symbolic training samples for the preferred classes.

The signature file was made, managed and appraised. Maximum likelihood classification tool was implemented, and categorized imageries were color coded and displayed. For higher precision, imageries were further processed to eliminate noises and insulated areas for enhanced output quality. These further processing involved smoothing and clumping, filtering and simplifying output maps. Apart from the land cover imageries classified, the NDVI for the study area was determined and compared for the periods before and after commencement of oil and gas exploration developments using the ARCGIS image analysis NDVI window. Yin et al. (2012), denotes that the NDVI process creates a single-band dataset that mainly represents greenery.

The negative values represent clouds, water and snow and values near zero represent rock and bare soil. The Red and NIR represent the spectral reflectance value as noted in the Red and Near-infrared (NIR) ranges in the spectrum. The value for NDVI ranges between -1 and +1. Vegetation have an NDVI range of between 0. 1 and 1 according to Wang & Gong (2009). They further indicate that the higher the NDVI, the higher the fraction of live green vegetation found in a given area. The documented and default NDVI equation according to Kaspersen et al., (2015) is; NDVI = (IR - R)/(IR + R).

The IR is the pixel values from the Infrared band, and the R is the pixel values from the Red band. In calculating the NDVI using Landsat 5 TM imagery the equation applied is; NDVI = ([Band 4] – [Band 3]) / ([Band 4] + [Band 3]) while that of Landsat 8 OLI/ TIRS is NDVI = ([Band 5] – [Band 4]) / ([Band 5] + [Band 4]). Low values (0. 1 and below) of NDVI correspond to barren areas of rock, sand, or snow. NDVI make use of the green colouring matter existing on plants leaves. Chlorophyll takes in light energy at 0.65 ~L (red) and ~0.45 ~L (micron) (blue). It moderately reflects ~0.55 L. (green) and intensely reflects ~0.86 ~L (NIR). This accounts for the green colouration of most plants.

According to Huang & Huang (2014), NDVI makes use of this distinctive spectral pattern of chlorophyll for visualization, described by the difference amid determined solar reflection from a satellite band very sensitive to chlorophyll (~0.65~L) and a band in the red part of the visible spectrum (~0.65 ~L).

The procedure for data collection entailed mapping the eleven oil well pads purposively sampled in the study area and other excavations done such as access roads by use of a GPS mapper.

The mapped coordinates were then used to acquire the Landsat 5TM, Landsat 8OLI/TIRS satellite imageries with 10 km radius being used to determine the areas of interest, six years before the oil and gas exploration activities began, and six years after the oil and gas exploration activities began for both rainy and dry seasons from the United State Geological Survey (USGS) earth explorer. The study compared the imageries of the dry and rainy season pre and post oil and gas exploration activities commencement. The imageries were processed using the ArcGIS 10.3 software and Erdas. The study made use of pearson linear correlation and paired t test to test significant change on NDVI. One sample t test was used to determine significant change on area under vegetation cover. Simple linear regression was in addition used to analyse the relationship between the increase in the bareland and the NDVI value in the study area

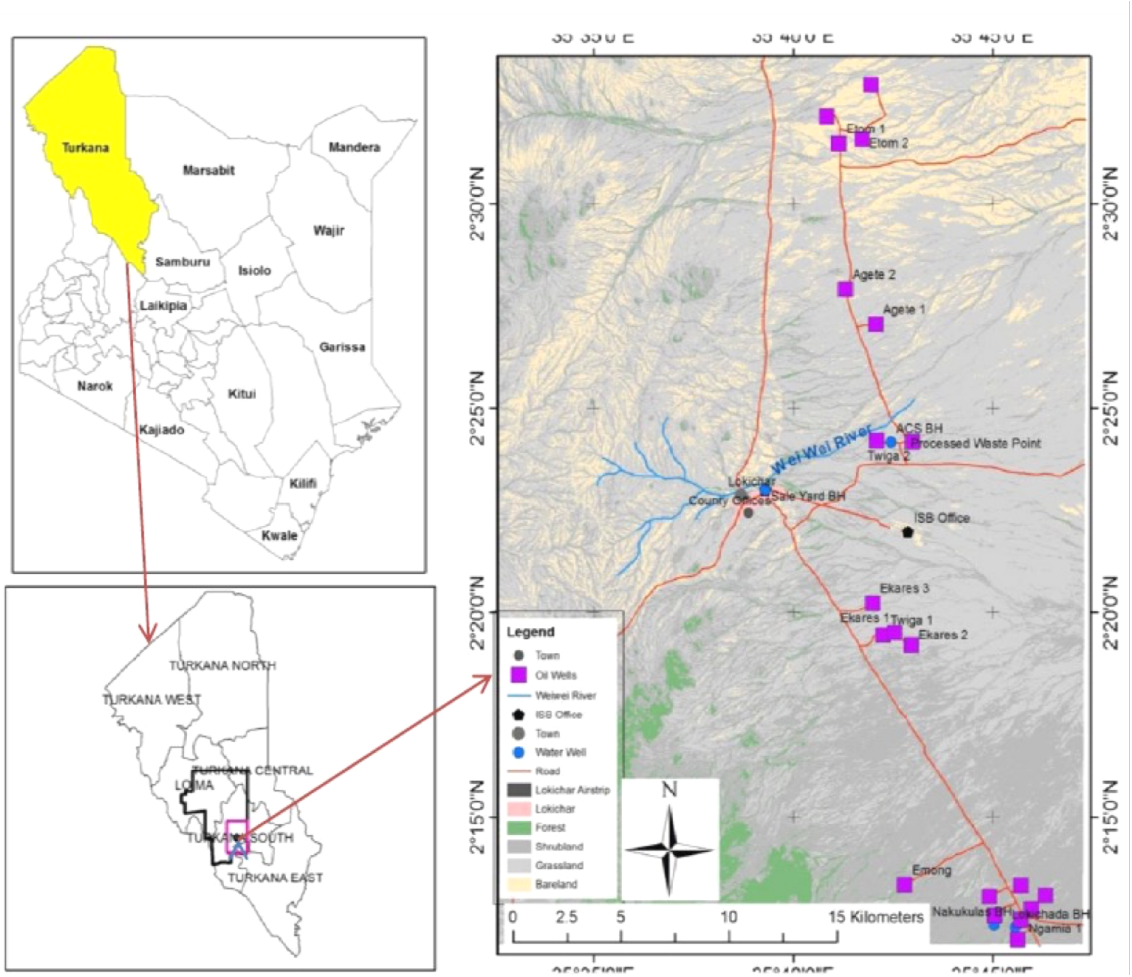
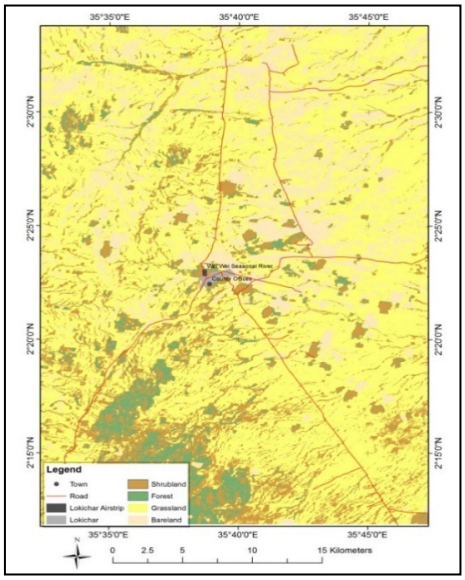


Fig. 1 Map of the study area made in 2017 showing Turkana County marked in yellow and ballooned out to show Oil Block 13T marked in black border line. The study was carried out in Lokichar Ward marked in purple borderline and ballooned out and pointed by a red pointer. The polygons shaded in purple shows the well pands across the study area whose the study focused on. The map also shows various land use land cover with the dorminant land cover being grassland and shrubland marked in grey

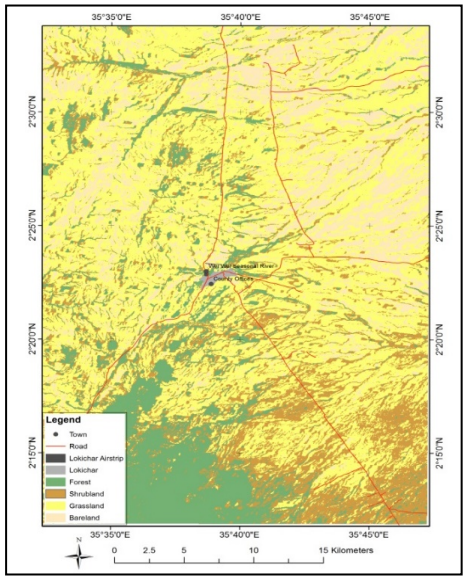
4 Results and discussions

Plate 1(k1; k2, l1; l2, m1; m2, n1; n2, and o1; o2) (Figs. 1 and 2) shows the land use land cover changes maps of the study area for years 2006, 2008/2009 2012, 2015 and 2017 for both dry and rainy seasons**.** Plate 1(*k*1 and *k*2, *l*1 and *l*2) (Fig. 1) shows the classified maps for both dry and rainy seasons of the study area for the year 2006 and 2009/2008.

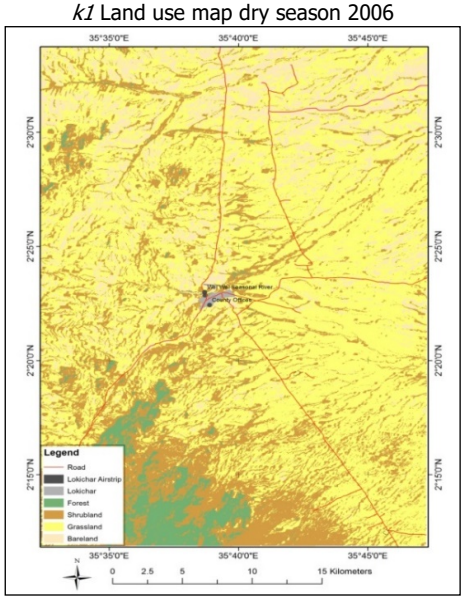
The area is covered with shrubs, riverine forest, and grassland which are the predominant vegetation cover in South Lokichar Basin, Turkana County.



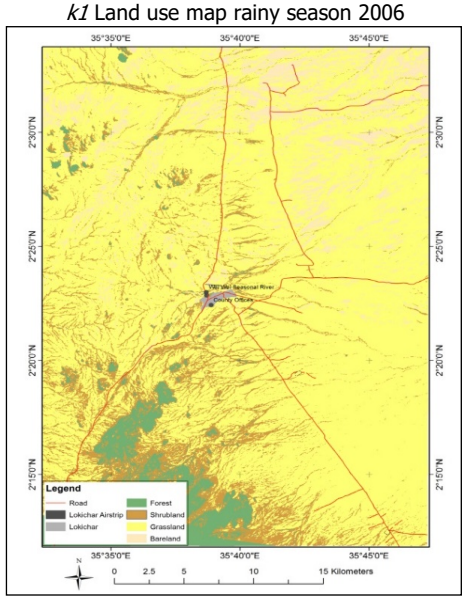
k1 Land use map dry season 2006



k1 Land use map rainy season 2006



l1 Land use map dry season 2009



l2 Land use map rainy season 2008

Fig.2 Plate 1 (k1, k2, l1, l2)

YEAR 2006

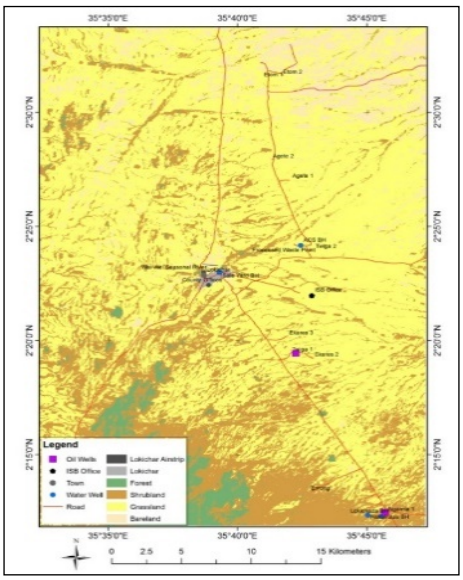
Land use	Area in hectares: rainy season	Area in hectares: Dry season
Forest	7,656.98	5,255.73
Shrubland	33,578.92	32,828.31
Grassland	71,933.61	65,824.56
Bareland	10,625.22	19,886.13
TOTAL	**123,794.84**	**123,794.84**

YEAR 2008

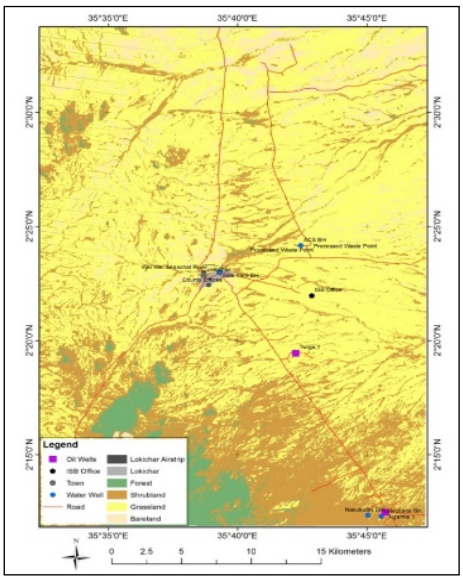
Landuse	Area in hectares: rainy season	Area in hectares: Dry season
Forest	5,648.49	4597.83
Shrubland	29,106.36	28,600.12
Grassland	80,007.40	73,212.80
Bareland	9,032.50	17,384.00
TOTAL	**123,794.84**	**123,794.84**

Tab. 1 Landuse/Landcover changes in hectares before the oil and gas exploration begun

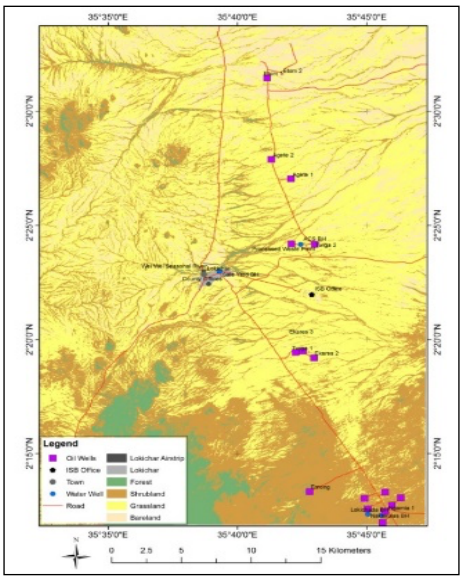
The oil and gas exploration developments had not begun and therefore the minimal changes on the land cover were as a result of climatic factors. Table 1 below shows a total of 12,3794.84 hectares of land within the study area and the extent of LU/LC changes across the years. The bareland increased by 41% from 10,625.22 hectares during the rainy season to 19,886.13 hectares for the dry season in year 2006 within the area of study. The other vegetation cover indicated a decline during the dry seasons in both 2006 and 2008/2009. The bareland decreased by 15 % between 2006 to 2008 for the rainy season and increased by 12% for the dry seasons. More than 60% of the vegetation cover in the study area consists of grassland, followed by shrubland at 25% in both rainy and dry seasons.



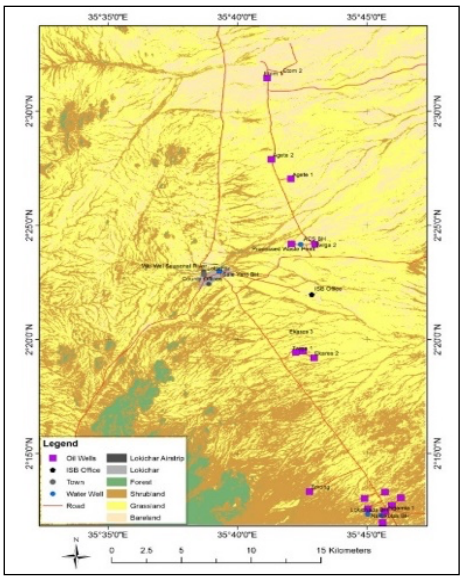
m1 Land use map dry season 2012



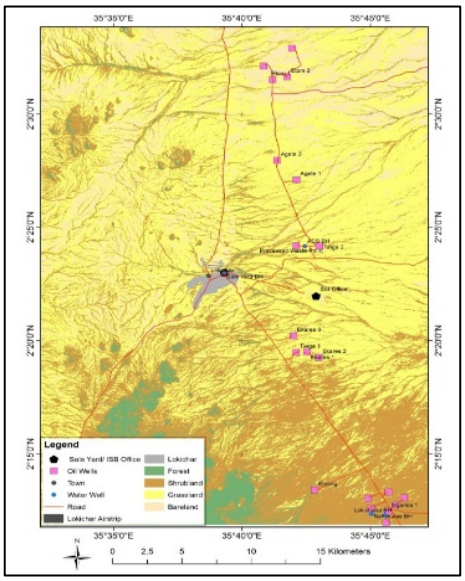
m2 Land use map rainy season 2012



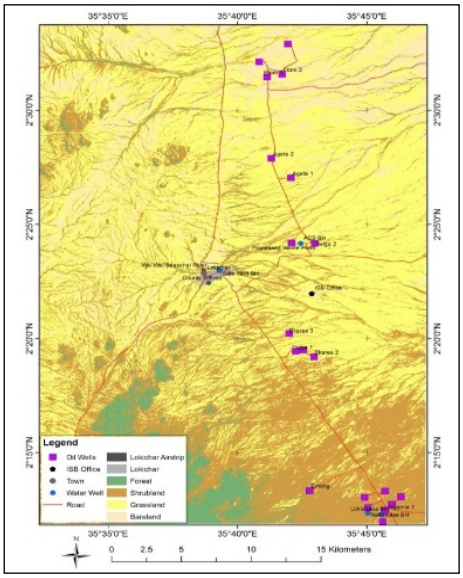
n1 Land use map dry season 2015



n2 Land use map rainy season 2015



o1 Land use map dry season 2017



o2 Land use map rainy season 2017

Fig. 3 Plate 1(k1;k2, l1;l2, m1;m2, n1;n2 &o1;o2):LU/LC maps for dry and rainy seasons of South Lokichar Basin: The maps shows the land use land cover maps from k1 to l2 for the area before oil and gas exploration commencement and maps from m1 to O2 for the area after commencement of oil and gas exploration developments. The various well pads are shown in purple. The access roads and the various vegetation cover are shown which are dry forest cover, shrubland, grassland and bareland (Source: Landsat 5TM & 8OLI/TIRS)

Plate 1 (*m*1 and *m*2, *n*1 and *n*2 and *o*1 and *o*2) (Fig. 3) shows the study area after the commencement of oil and gas exploration. Well pads and access roads which are increasing in number with each subsequent year from 2012 to 2017 are visible. The developments of well pads and access roads led to the decline of the dominant grass cover vegetation and shrubland since the bareland was increasing with each subsequent year since 2012 as shown in table 2 below. The Southern part of the study area had a dense riverine vegetation since the seasonal river Wei Wei shown in the study map passes through the area. Table 2 below shows extent in hectares of the various LU/LC changes of the study area from year 2012 to 2017.

Year 2012		
Landuse	**Area in hectares: Rainy season**	**Area in hectares: Dry season**
Forest	5,922.09	4,908.42
Shrubland	36,450.75	28,639.39
Grassland	76,798.00	75,094.80
Bareland	8,224.00	12,452.20
Well pads	21.68	21.68
TOTAL	**123,794.84**	**123,794.84**

Year 2015		
Landuse	**Area in hectares: Rainy season**	**Area in hectares: Dry season**
Forest	5,876.31	5,531.67
Shrubland	33,800.10	33,334.20
Grassland	67,271.80	66,820.40
Bareland	16,667.60	17,929.00
Well pads	273.00	273.00
Total	**123,794.84**	**123,794.84**

Year 2017		
Landuse	**Area in hectares: Rainy season**	**Area in hectares: Dry season**
Forest	5,691.56	3,641.40
Shrubland	35,357.44	34,045.10
Grassland	64,926.68	64,200.10
Bareland	17,640.10	21,729.20
Well pads	282.00	282.00
Total	**123,794.84**	**123,794.80**

Tab. 2 Land use/land cover changes in hectares after oil and gas exploration begun

From Tab.2, the vegetation cover during the rainy seasons declined from 5,922.09 hectares for the forest, 36,450.75 hectares for the shrubland and 76,798 hectares for the grassland in 2012 to 5,691.56 hectares for the forest, 35,357.44 hectares for the shrubland and 64,926.68 hectares for the grassland in 2017 respectively determined during the rainy seasons. Each land use area calculated for the rainy season in each year declined during the dry season indicating the negative impact of lack of adequate precipitation on vegetation cover. The bareland in 2012 increased by 51% in 2015, the variation between the size of the bare land during the rainy and dry season was 7% increase while in 2017 the bareland increased by 23% during the dry season.
The bareland increased from 8224 hectares during the rainy season and 12,452 hectares during the dry season in 2012 to 17,640.10 hectare and 21,729.20 hectares respectively in 2017, an increase of 114% and 74% for rainy and dry seasons respectively. The fact that the percentage increase of the bare land for the rainy seasons was higher than that of dry seasons between 2012 and 2017 demonstrates other factors apart from precipitation affected the vegetation. This is also evidenced by the fact that between 2006 and 2009 before the oil and gas exploration developments begun the bareland in the study area decreased by 15% for the rainy seasons and increased by only 12% for the dry seasons. The land acquired for well pads construction increased from a total of 21.680 hectares for all the well pads constructed in 2012 to 282 hectares in 2017 for the 11 well pads sampled within the study area. The area under the constructed access roads was integrated in the area under the bare land. This area seemed to increase as oil and gas exploration developments intensifies in the region. Exploratory drilling appraisal and developments oil wells are spread across South Lokichar Basin as shown in figure 1 of the study area map and this is causing fragmentation of the community grazing land when compounded with access roads, boom towns, oil transportation corridors such as pipelines, highways and trails.

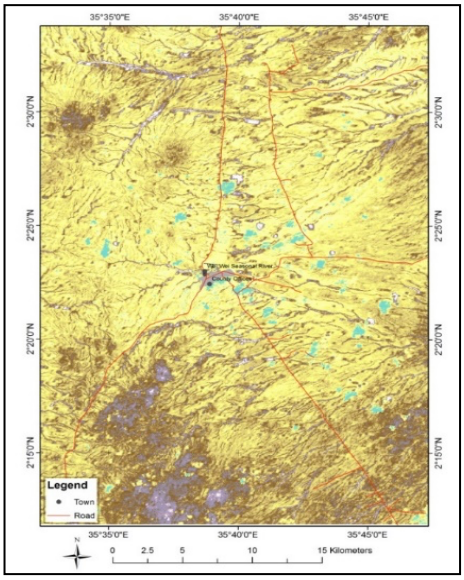
4.1 Two sample t-test on area under vegetation cover pre and post commencement of oil and gas exploration in south Lokichar basin

Table 2 shows that the area under vegetation cover had declined since the oil and gas exploration developments begun**.** Results of a two-sample t-test gave a mean difference between the size of the land covered by forest, grassland and shrubland before the oil and gas exploration begun and after of 1589. 12 hectares 6248 hectares and 7,274.21 hectares were recorded respectively with standard deviations of 937.69, 6,549.10 and 5,359.42 respectively.
The analysis had standard errors of the mean of 454.45 hectares, 7,221.57 hectares and 2,984.92 hectares respectively and 90% confidence intervals of -2,343.947-5,522.19, 66,590.73-54,104.72, -4,352.19 – 18,900.61 respectively. The obtained *t*-values were 3.4968, 0.8645 and 2.437 at, 1.199, 1.2225, 2.2363 respectively degrees of freedom and the statistical significance (2-tailed *p*-value) of the two sample t-test (Pr(|T| > |t|) under Ha: mean(diff) != 0), which were;0.0718, 0.07381 and 0.0609 respectively.

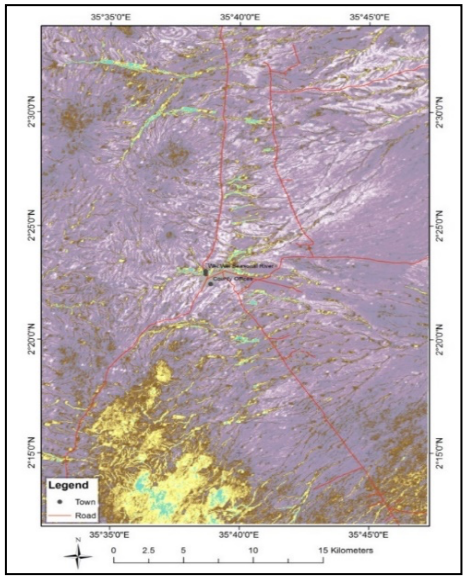
As the *p*-values were less than 0.1 (i.e., $p < 0.1$), the study concludes that there is a statistically significant difference between the area under vegetation cover before the oil and gas exploration developments begun and after. This is consistent with Osei *et al*. 2006 for a study done in Niger Delta.
The clearing of the vegetation in the study area had led to the decline of NDVI value.

4.2 Oil and gas exploration developments effect on normalized distribution vegetation index of the study area under changing climatic conditions

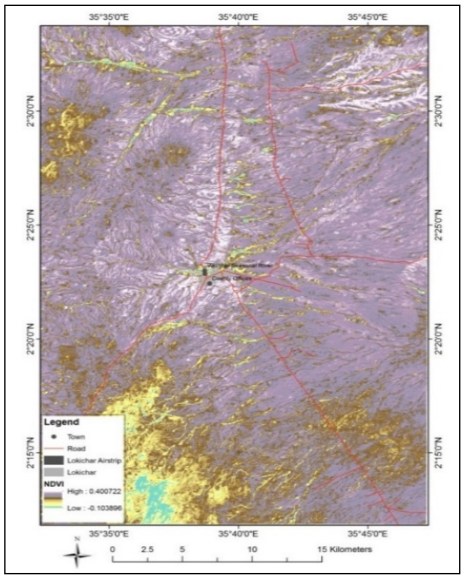
NDVI depicts the density of green vegetation on a patch of land. Decimation of the vegetation cover immensely lowers the NDVI. The study hypothesized that commencement of oil and gas exploration did not have a significant effect on the NDVI value of the study area. The study did an analysis of the NDVIs of the years 2006, 2008 and 2009 for the dry and rainy season, this was before the oil and gas exploration developments began in South Lokichar Basin. This was compared with the NDVIs of the study area after the commencement of oil and gas exploration developments for the years 2012, 2013, 2015 and 2017. The NDVIs were calculated and shown in the NDVI maps in plate 2 (f1;f2 g1;g2, h1;h2, i1;i2, j1;j2, k1;k2, l1;l2, m1;m2).



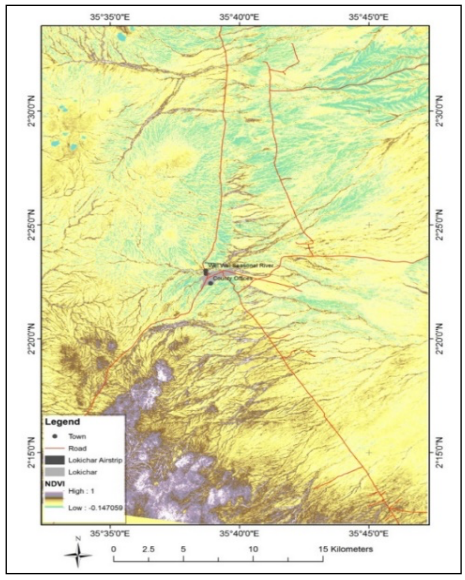
f1 dry season NDVI 2006



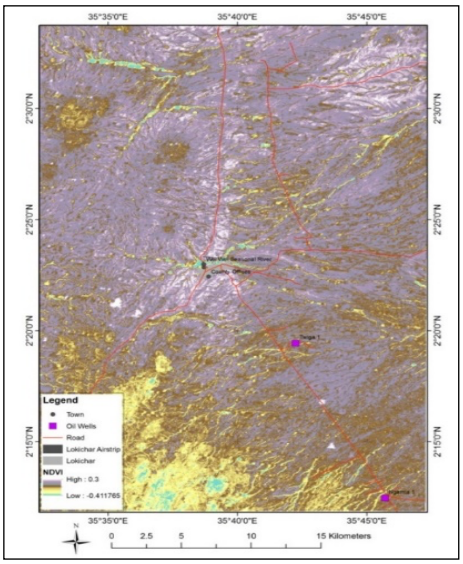
f2 rainy season NDVI 2006



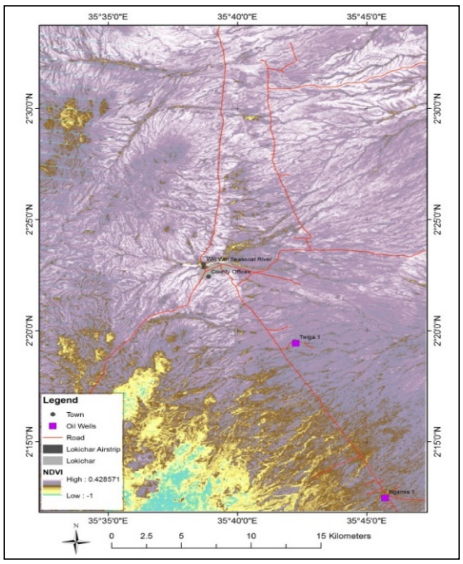
g1 dry season South Lokichar Basin NDVI 2009



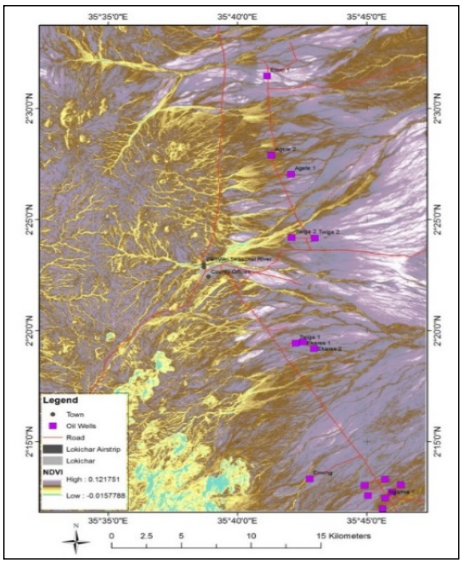
g2 rainy season NDVI 2008



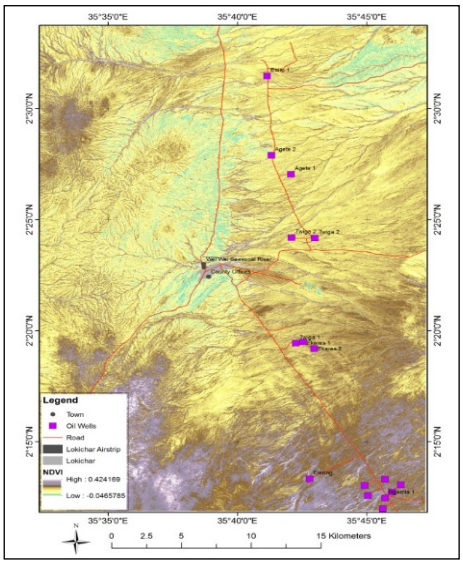
h1 dry season South Lokichar Basin NDVI 2012



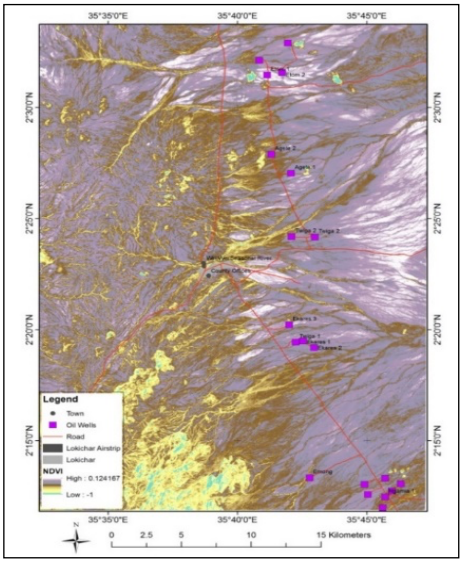
h2 rainy season South Lokichar Basin NDVI 2012



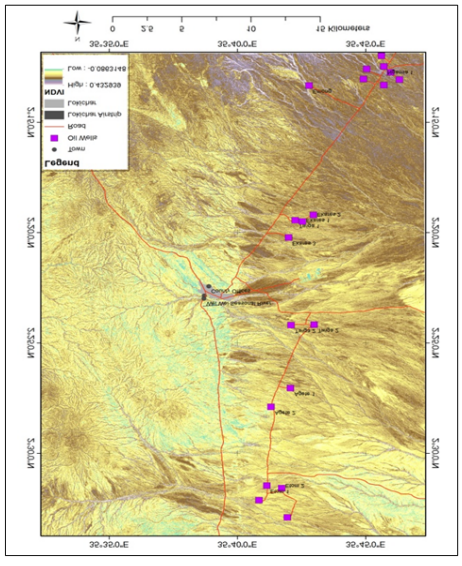
i1 dry season South Lokichar Basin NDVI 2015



i2 rainy season South Lokichar Basin NDVI 2015



j1 dry season South Lokichar Basin NDVI 2017



j2 rainy season South Lokichar Basin NDVI 2017

Fig.4 Plate 2 (f1;f2 g1;g2, h1;h2, i1;i2, j1;j2, k1;k2, l1;l2, m1;m2):Showing NDVI for dry and rainy seasons of South Lokichar Basin. The NDVI maps shows the high and low NDVI values for2006(f1;f2), 2009(g1), 2008(g2), 2012(h1;h2), 2015(i1;i2), 2017(j1;j2)(source:Landsat 5 and 8 imageries)

From plate 2 (f1 and f2) above the study established that the area high and low NDVI values were 1 and -0.12 respectively for the rainy seasons experienced between October-December. The dry season recorded NDVIs were 0.4107 and -0.138 and were determined between May-July as shown in Fig. 5.

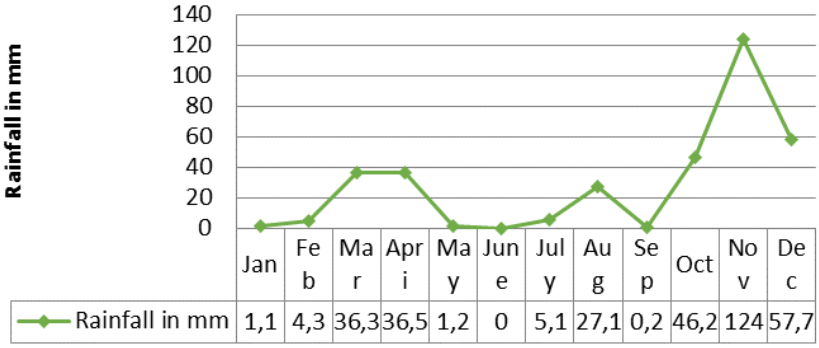


Fig.5 Rainfall received during the rainy and dry seasons for the year 2006 in South Lokichar Basin (Source: Republic of Kenya (RoK), 2017)

Plate 2(*g2*) had a high and low NDVI values of 1 and -0.147 respectively. These recordings were done during the rainy season experienced between September and November 2008 as shown in the rainfall data graph in Fig.6.

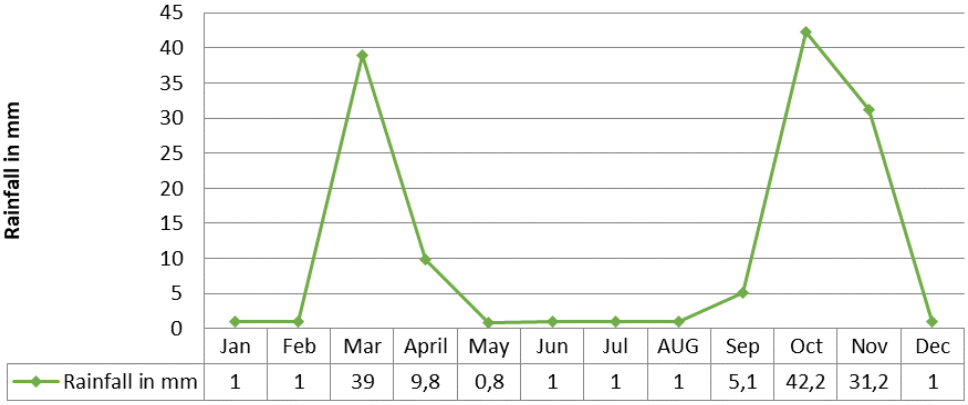


Fig.6 Rainfall received in September-November rainy season for the year 2008 in South Lokichar Basin (Source: RoK, 2017)

Though the year did not receive as much rainfall during the rainy season as compared to the years 2012, 2015 and 2017, the fact that there was no disturbance on the vegetation cover emanating from oil and gas exploration developments may have contributed to the high NDVI recorded. The NDVI of the study area for the dry season shown in *g1* was less than the one in *g2* for the rainy season since rainfall is a significant factor that affects the NDVI. The highest and the lowest NDVI values for the dry season between July and September shown in figure7 were 0.4007 and -0.1038 respectively.

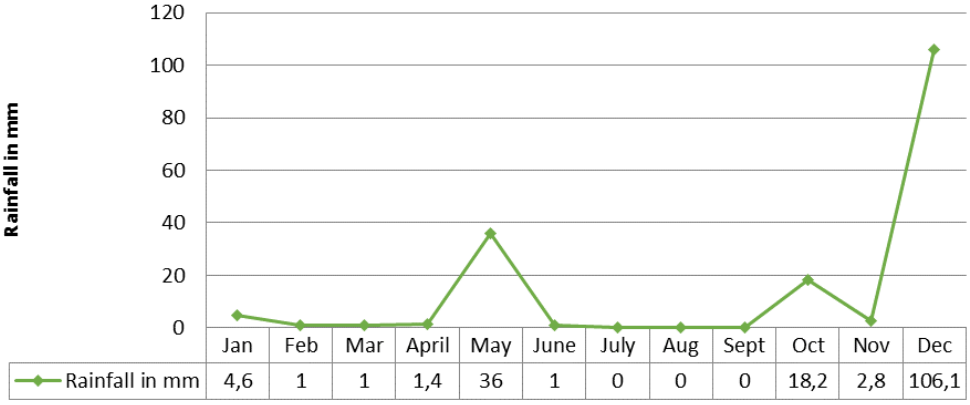
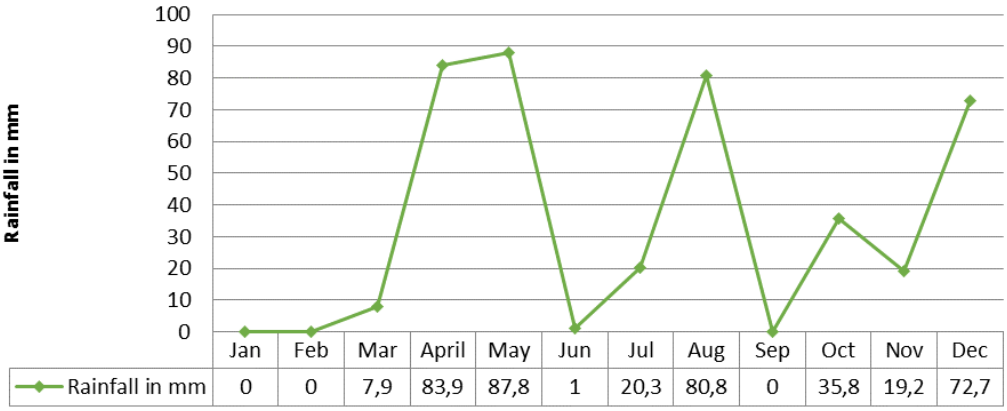


Fig.7 Rainfall received in June-September dry season for the year 2009 in South Lokichar Basin (Data Source: RoK 2017)

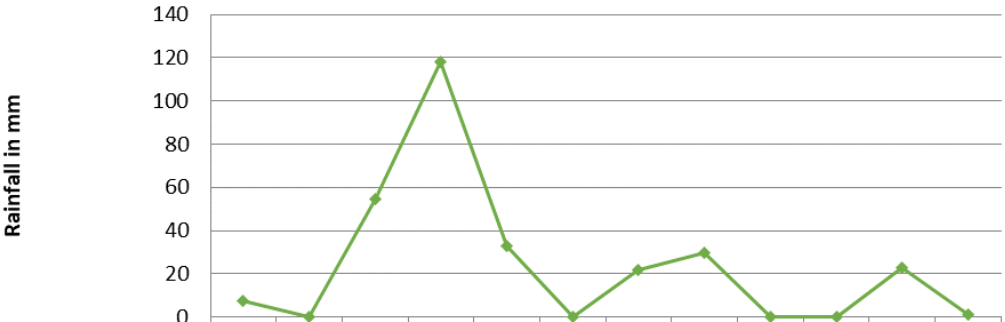
The NDVI of the study area in 2012 determined during the rainy season shown in figure 8 did indicate a slight variation when compared to the 2008 values for a similar season.



	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall in mm	0	0	7,9	83,9	87,8	1	20,3	80,8	0	35,8	19,2	72,7

Fig.8 Rainfall received in March-May rainy season for the year 2012 in South Lokichar Basin. (Source: RoK, 2017)

The highest NDVI during the rainy season experienced between March and May was 0.4285, and the lowest was -1 as shown in plate 2 (h2). The NDVI of the study area for the dry season experienced between September and November 2013 as shown in figures 6 was slightly lower than that of the dry season in the year 2009. The highest value recorded was 0. 3, and the lowest was -0.4117 as shown in plate 2 (h1). The finding implies that in 2008 before the excavation and exploration developments began the area had some more vegetation cover as compared to 2012 under the same environmental condition. The rainy season of 2008 experienced more rainfall as shown in Fig. 5 than the amount of rainfall experienced in a similar season in 2012 shown in Fig. 8. Both dry seasons in 2009 and 2013 received less than 1 millimeters of rainfall indicating that the reduction in NDVI was as a result of an external factor rather than climatic conditions in the study area.



	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Rainfall in mm	7,7	0	54,5	117,9	33,1	0	21,6	29,6	0	0	22,6	1,2

Fig.9 Rainfall received in September-November dry season for the year 2013 in South Lokichar Basin (Source:RoK, 2017)

The highest NDVI value of the study area for the rainy season experienced between March and May shown in Fig.10 for the year 2015 was 0.4241, and the lowest was -0.0455 as indicated in plate 2 (i2). The value was lower than the one for year 2012 for a similar season despite the fact that the amount of rainfall received in the two seasons was almost the same as shown in Fig. 8 and Fig. 10. The highest NDVI for the dry season determined between July and September of the year 2015 as shown in figure 109 was 0.124167, and the lowest was -1 shown in plate 2 (i1) which was slightly lower than the one recorded in the year 2012 in a similar season.

The study area recorded the lowest NDVI value in the year 2017. The highest NDVI value determined during the rainy season between August and October shown in figure 11 was 0.410939 and the lowest value was -0.0863 indicated in plate 2 (j1).

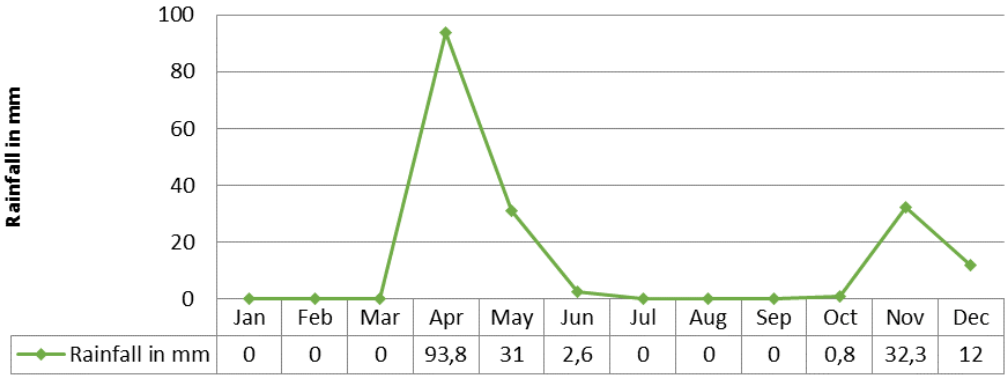


Fig. 10 Rainfall received in both March-May rainy season and July-September dry seasons for the year 2015 in South Lokichar Basin (Source:RoK, 2017)

The highest and lowest NDVI values for the dry season experienced between May and July shown in Fig. 11 was 0.12157 and 0.0157 as indicated in plate II(*j2*). These values were lower compared to the NDVI determined under similar environmental conditions in 2015.

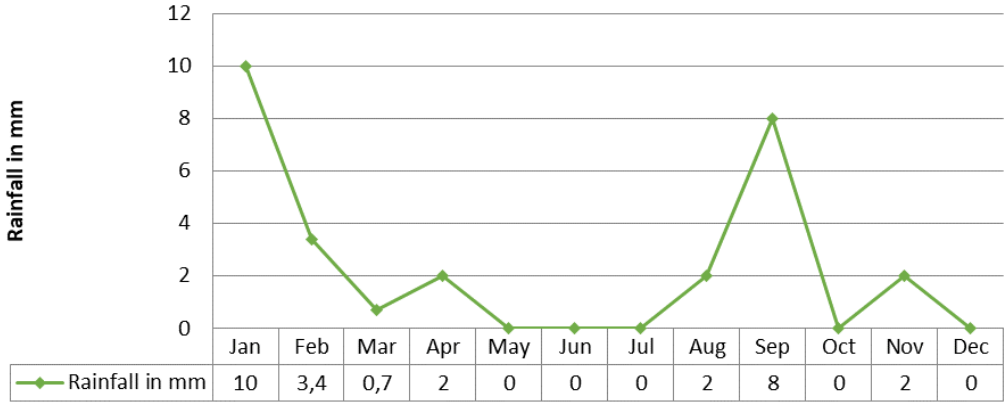


Fig. 11 Rainfall received in both August-October rainy season and May-July dry seasons for the year 2017 in South Lokichar Basin (Source: RoK, 2017)

The NDVI of the study area between 2006 and 2009 was constant in both dry and rainy seasons but started to decline from the year 2012 through 2017.

The study attributes the decline to the developments of the oil well pads and other infrustructures to aid in extraction and conveyance of crude oil such as access roads, pipelines, highways and trails in South Lokichar Basin. This is due to the fact that these developments in the study area affected the vegetation abundance hence the decline in NDVI. Climatic conditions and human activities leading to vegetation clearance may affect the NDVI of an area (Bagherzadeh et al., 2020). The fact that the NDVI declined in both dry and rainy seasons means that rainfall was not the only factor contributing to the reduction of NDVI. The variation in the amount of rainfall experienced during the rainy seasons was minimal indicating that rainfall had little significance on the NDVI value variations over the different year's rainy seasons. This means that declining vegetation cover and increasing bare land was the primary factor causing the decline in NDVI value.

The bare land as noted in table 1 increased by 117% from 2012 to 2017 from an area size of 8245 hectares to 17922 hectares. The study attributes the increased bareland to the developed well pads and access roads. This led to a significant change in NDVI of the study area.

4.3 Pearson linear correlation analysis for the trend of ndvi for the rainy season from 2006 to 2017 in the study area

The analysis in figure 11 indicated a very strong negative linear correlation with a Pearson correlation R-value of -0.86. This means that the NDVI was decreasing with time from 2006 to 2017. The NDVI declined due to the Land cover/land use change. As noted in the figure, the decline between 2006 and 2012 was quite minimal as compared to the decline of the NDVI between 2012 and 2017. This could be explained by the fact that there were little oil and gas exploration developments between 2006 and 2012 with only two well pads developed in 2012 and limited road infrastructures were constructed.

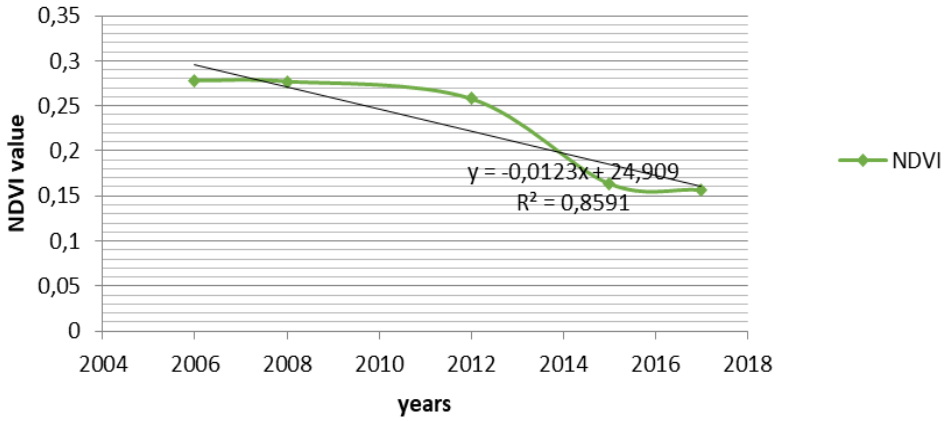


Fig. 12 Trend of average NDVI value for South Lokichar Basin for the rainy seasons (*Source:Landsat imageries 2006; 2008, 2013; 2015 & 2017*)

This is contrary to the period between 2012 and 2017, a period whereby most of the well pads and transport corridors such as access roads to the various well pads were developed.

The fact that all these NDVIs values were determined during the rainy seasons across the years, affirms this study assertion that, another factor could have contributed to the declining NDVIs value and this could only be the clearing of vegetation due to excavation from oil and gas exploration developments.

Figure 13 shows the trend of the NDVI of the study area across the years determined during the dry season. It shows a strong negative linear correlation with an R- correlation factor of -0.97.

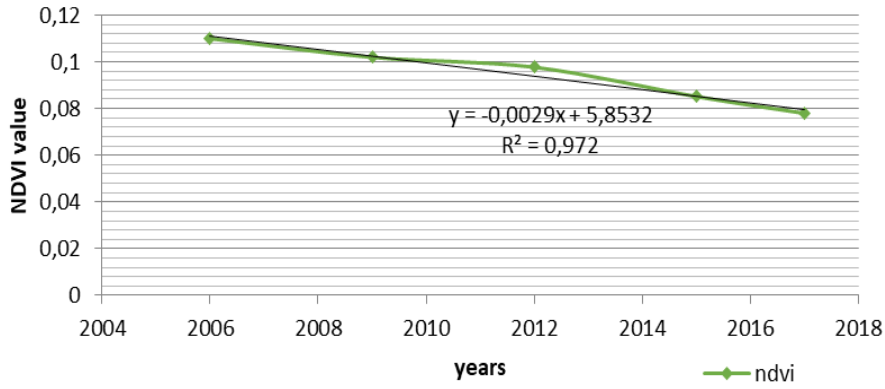


Fig.13 Trend of average NDVI value for the South Lokichar Basin for the dry seasons (*Source:Landsat imageries 2006; 2009, 2013; 2015, 2017)*

The fact that the NDVI values for the study area during the dry seasons were less than those recorded during the rainy seasons is a clear indication that rainfall influences the NDVI value. The NDVI values determined for the rainy seasons without any other external influence in the study area should have been the same since the area has homogenous vegetation. However as noted this was not the case as the NDVI value for the rainy

season declined from 1 for high value and -0.147059 for lower value in 2006 to 0. 121751 for high value and -0.0157788 for lower value in 2017.

4.4 Results of paired t-test and simple linear regression analysis on significant change of ndvi value pre and post commencement of oil and gas exploration

Results of the paired t-test of the average NDVI value of the study area pre and post oil exploration gave a statistical significance (2-tailed) paired t-test had a calculated *p*-value of 0.0091. As the *p*-value was less than 0. 05 (i.e., $p<.05$), the study concludes that there was a statistically significant difference on the NDVI value before and after oil and gas exploration developments began in South Lokichar Basin. The difference can be explained by decreased vegetation cover and increased bared land due to construction of well pads and access roads as evidenced by simple linear regression analysis of bare land area size and average NDVI across the years did show a strong linear regression relationship with R value of 0.953. The statistical regression coefficient signifance (2-tailed p-value) was -0.012 at 95% confidence interval as shown in Tab. 3. As the p value was < than 0.05 and the statistical significance was negative as shown in Tab. 3, the study concludes that increased bareland due to vegetation clearance as access roads and other oil and gas developments infrastructures led to a decline in NDVI value in the study area.

Coefficients

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**T**	**Sig.**
		B	Std. Error	Beta		
1	**(Constant)**	0.388	0.031		12.512	0.001
	land area	-1.286E-005	0.000	-0.953	-5.471	-0.012

Tab.3 Linear Regression Analysis in Determinng the Relationship Between Changing Bareland and NDVI of the Study Area

5 Conclusion

The findings of this study implies that, since rainfall was abundant across the years during the rainy seasons, then vegetation clearance that resulted from oil and gas exploration developments contributed immensely to the decline of the NDVI value across the years. Ground trothing and literature review established that in regard to the exploration well drilling, vertical well drilling was the technology that was being used in South Lokichar Basin despite its impacts on increased ecological footprints in areas where it has been used. In addition this study established that five dry wells had been encountered since exploration drilling began in 2012, and restoration was yet to be done by 2017.

This study has established that Land use land cover changes are taking place in South Lokichar Basin with increasing oil and gas exploration developments. As observed the area of study falls under Oil Block 13T which is one of the 9 oil blocks of Rift Tertiary Basin.

As much as the study focused on South Lokichar area of the Basin, the oil and gas developments work is going on across the entire Rift Tertiary Basin. The land use land cover changes noted in South Lokichar Basin, within Lokichar Ward is happening in other parts of the entire Rift Tertiary basin. Lokichar Ward was adopted as a case study area in this research. It is of interest to note that before oil and gas developments commencement in 2012, there was minimal variations on land use land cover changes in addition to minimal decline in biophysical index NDVI. The study attributes this minimal changes to limited oil and gas developments between 2006 and 2012 with only two well pads and few access roads having been developed. The decline in NDVI between 2012 and 2017 was higher and this could be explained by the fact that many well pads and access road infrastructures were developed within this period.

The fact that all these NDVIs values were determined during the rainy seasons across the years, and as observed there was minimal variation in average rainfall received, the study concludes that another factor was immensely contributing to the declining NDVI and in this case vegetation clearance due to oil and as gas developments of well pads and access roads. As oil and gas developments is projected to continue, a thorough understanding of the ecological and environmental concerns is crucial to the sustainability of the fragile grassland ecosystems. Proper measure needs to be taken to ensure sustainable management of the indigenous vegetation land cover such as adoption and implementation of sustainable drilling technologies and indigenous species restoration approaches. This is due to their ecological and socio-economic role especially that of supporting pastrolism, bearing in mind that this is the main economic activity in the region.

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Image sources

Fig.1: Author 2020

Figs. 2-8: Author 2020 with data from Kenya meteorological Department

Figs. 9 and 10: Author 2020 Imageries from United State Geological Survey

Plate 1 and 2: Author 2020 Imageries from United State Geological Survey

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An investigation of challenges in the existing pattern of intra-city traffic in Enugu metropolis

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Abstract
Cities all over the world are characterized by a set of activities, which account for the concentration of people in them, achievable by means of transportation. However, this integral aspect of urban infrastructure face great challenge in most urban areas. This research examines the challenges in the existing pattern of intra-city traffic in Enugu metropolis. Six neighbourhood make up the study population drawn from three high, two medium and one low residential densities neighbourhoods based on stratified and simple random sampling technique. Data collection instrument were questionnaires administered to 400 respondents. The result of the study indicates that major travel mode within Enugu metropolis is mini buses and tricycles while commuters undergo stress during their trips regardless of the good condition of roads within the metropolis. Furthermore, it highlights traffic congestion during peak period and narrowness of most roads within the metropolis as the main challenge to existing pattern of intra-city traffic. It concludes and recommend for the re-introduction of Non-motorized transport mode of walking and cycling complemented by the Coal city public transit shuttles that once existed. It also advocates for policies that ensure decentralization of activity to reduce congestion and the need for daily travel.

Keywords
Transportation; Enugu metropolis; Intra-city traffic; Congestion.

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1. Introduction

Transportation is a process that involves movement of commuters, goods and services from a given point of origin to a specific destination (Ikya, 1993). It determines the regional patterns of development, economic viability, environmental impacts, and maintenance of socially acceptable levels of quality of life (Solanke, 2013). It also paves way for growth of economic activities in both rural and urban areas, which serves as a catalyst to rapid development of all nations. Thus, just like the circulatory system in the human body, transport system in urban metropolis are the veins and arteries that drives development, links people, connects local communities to the world, build markets and facilitates trade. According to Moeinaddini et al. (2012) Mobility and accessibility are important indicators of urban growth. However, Intra-urban mobility, in particular, functions to integrate various parts of the city into a unified whole (Solanke, 2013). This implies that transportation is an integral part of the functioning of any society and advances in transportation have made possible changes in the way we live and the way societies are organized.

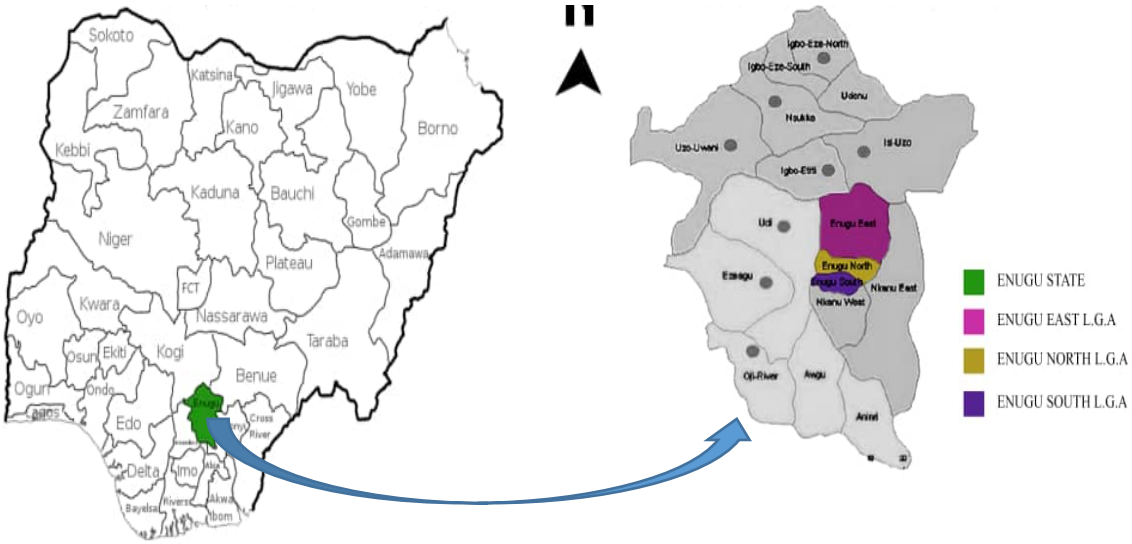
The major urban challenge of the twenty-first century includes the rapid growth of many cities (Nnaemeka-Okeke, 2016) which has given rise to concerns about their sustainability. Cities in developing economies, including Nigeria, are currently expanding to a point where it is threatening to smother the transportation system that prepared and promoted its growth. Specifically, in recent time, urban transportation in Nigerian cities have metamorphosed into a chaotic, complex and almost intractable nature such that most of them are perceived to have almost reached a level of relative immobility (Ikya, 1993; Solanke, 2013). Urban transport problem in most Nigerian cities can be adduced to incessant urban growth associated with rising urbanization which inevitably has resulted to an increased demand for the provision of transport. This increasing demand has, however, not always been met and efforts to provide adequate transport infrastructural facilities are ad-hoc, uncoordinated and poor (Aderamo, 2010). This situation has resulted to plaguing urban transport challenges such as excessive high travel demand relative to supply, traffic congestion, reduced accessibility to and through commercial centres, contumacious driving, parking problems, increased travel time, loss of productive hour, increased spending on automobile-friendly infrastructure, urban sprawl, etc. (Ekong, 1977).

Similarly, Enugu metropolis, which is also one of the cities in south-east Nigeria, has been experiencing a huge population increase in the past few decades. This situation has been adduced mainly to the effect of galloping urbanization and massive rural exodus. For instance, the population of people in Enugu metropolis in 2006 was given to be 276,337 but it was observed to have increased to about half a million people as at 2018. The profligate urbanization rate has promoted and ingrained various changes in urban structure characterized by urban sprawl with the obvious effect of generation of traffic congestion, longer trip distances, and traffic accidents. According to Okeke et al, (2020) the colonial city of Enugu is gradually drifting with signs of urban fragility and consequently is currently faced with enormous challenges in terms of infrastructure provision and the need to cope with the increasing demand of transport. More worrisome is the fact that the dominant mode of intra city transport is usually by road (90%) with automobiles having the largest modal share (between 70 – 72%). Thus, high dependence on private cars as well as poorly developed alternative transport systems in Enugu metropolis is currently reported to have adverse effects on intra-city mobility in Enugu metropolis in recent times (Ogunsanya, 2002). Considering the fact that effective transportation system is essential for the economy of a city, the priority and attention accorded to the planning of intra-urban transportation system by policy makers in Enugu metropolis should be given urgent consideration. Therefore, this study was carried out in order to examine the challenges in the existing pattern of intra-city traffic in Enugu metropolis with a view to proffering solution to traffic and transportation problems experienced in the study area. The importance of carrying out such a study draws from the fact that none of such study, had been carried out in Enugu state. Consequently, the outcome of the study will advance and contribute to measures towards formulating appropriate policy for enhancing intra-city travel in Enugu and other Nigerian cities.

The research faced a limitation of non-availability of the current demographic statistics and population of residents in Enugu urban, based on the fact that the no population census had been carried out in recent time. Nonetheless, the findings from the study proffers solution for policy makers and transportation experts to ensure that current transport planning in Enugu metropolis reflects all the essential preferences/requirements of commuters in the metropolis.

1.1 Context of the study

Enugu State is one of the states in the south-eastern part of Nigeria. It shares borders to the south with Abia State and Imo State, to the east with Ebonyi State, to the northeast with Benue State, to the northwest with Kogi State and to the west with Anambra. Enugu is the capital city of Enugu State which lies between latitude 06˚ 21˝ N and 06˚ 30˝ N and between longitude 07˚ 26˝ E and 07˚ 37˝ E. It is bounded in the East by Nkanu East Local Government Area, in the West by Udi Local Government Area, in the North by Enugu East Local Government Area and in the South by Nkanu West Local Government Area (see figure 1).



(a) (b)

Fig. 1 (a) Map of Nigeria Showing Enugu State and (b) Map of Enugu State Showing the study area

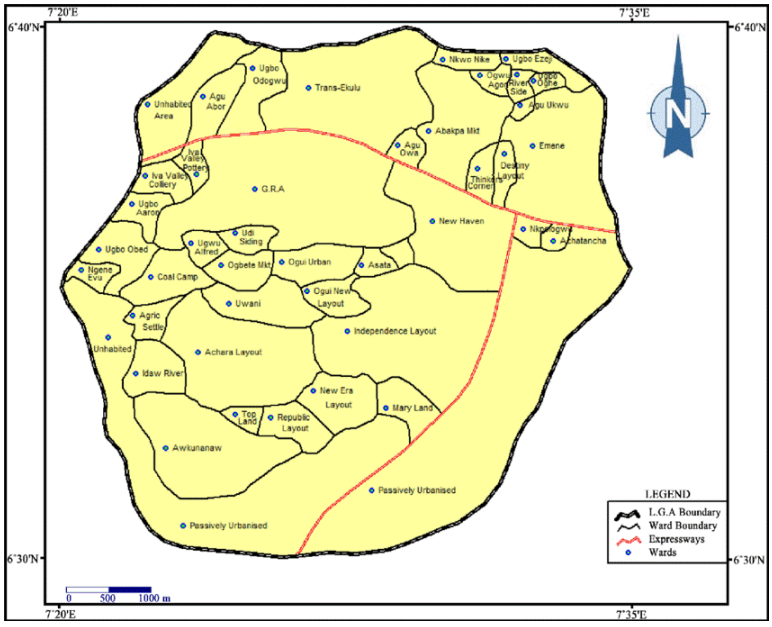


Fig. 2 Map of Enugu Metropolis (Study Area) showing the Neighbourhoods

Enugu metropolis is made up of three Local Governments areas namely Enugu East, Enugu South and Enugu North Local Governments (see figure 1). Dominantly populated by people of the Igbo ethnic group, it is a medium-size, but rapidly growing urban centre witnessing immense growth in the size of built-up areas, a number of immigrants, transportation and commercial activities (Okeke et al., 2019). It ranks 9th most populous city according to the 2006 Nigerian population census and covers a total area of 215m^2 (556 km2) with a population density of 3,400/sq mi (1,300/km^2). The increasing growth of the city is evident from the various population census figures from 1952 to 2006 and projected for 2018. It recorded a population of 62,764 in 1952; the 1991 Census puts the population figure of Enugu to be 462,514, accommodated in the residential layouts. The 2006 Census records the population of Enugu to be 722,664 (NPC 1991, 2006). The projected population of Enugu in 2018 is 1,064,983 with Abakpa and Maryland (neighbourhoods) having the highest and lowest population figures respectively.

Road transport is the chief means of transportation and as shown in Fig.2 above the city has only two major expressways and the main modes for intra-urban transportation in Enugu metropolis are private cars, coal city shuttles, buses, mini-buses, taxi/cabs and tricycles (keke NAPEP). Traffic data of Enugu metropolis reveals that private cars have the highest modal share (71%). This is followed in descending order by buses, taxis, tricycle, lorry, articulated vehicles and bicycles (18%, 9%, 1.4%, 0.9%, 0.2%, and 0.03% respectively). As the urban area have grown in population, it also have spread outward organically. Undeniably, the lack of land-use controls and effective planning has occasioned rampant sprawled developments extending rapidly in almost all directions and stretching far beyond old city boundaries. Increased number and length of trips for most resident is inevitable, causing growing reliance on motorized transport. Longer trip distances have also made walking and cycling less feasible, while increasing automobile traffic makes walking and cycling less safe. Consequently, high dependence on private cars as well as poorly developed alternative transport systems in Enugu metropolis is currently reported to have adverse effects on intra-city mobility in the metropolis in recent times. This scenario is believed to have encouraged informal transport services (such as the use of tricycles) to gradually become a dominant mode for intra-city travel in the metropolis since, commercial motorcycles (popularly called "okada") that once served as a public means of intra city transportation with the advantages of short travel time and convenience was placed on outright ban by the government from plying the road in 2012. Majority of the roads in the metropolis are mostly single lane with little or no sidewalks and has a gridlock road network inherited from the past colonial administration.

2. Literature review

2.1 Intra-city mobility pattern in Nigeria

Oladipo (2012) defined a city as an area or town inhabited by a large population of people while intra-city transportation involves the movement of goods and people within a city. He opined that intra-city transport is an integral element necessary for development in any rapidly urbanizing city. Haider and Badami, (2004) postulated that mobility is the backbone of the activity system of human race and observed that improved mobility or accessibility to employment, education, health and other urban services is necessary for enhanced welfare of the urban poor. This was further buttressed by Kumar, (2011) who posited that the key modes for mobility in a city include non-motorized (walk, bicycle) and motorized modes of transport. He revealed that the motorized modes include vehicles owned and operated by individuals for private use and those available to the public under public or private ownership.

Oyesiku and Odufuwa (2002) said that the situation of mobility in Nigeria is disheartening considering the fact that road movements accounts for about 90 percent of the movement of passengers and freight. Usually, the provision of intra city public transport is considered to be government's responsibility however, due to resources and weak management capacity government-provided intra city transport is inadequate and

dysfunctional. Informal public transit services owned and managed by private individuals or establishment have dominated the transport sector and exploiting the poor masses with higher fare rates. Similarly, Schintler (2001) revealed that a significant positive relationship has been found between intra-urban travel and psychological distress in various Nigerian cities. He adduced mobility distress in Nigerian cities to differences in gender mobility pattern, namely, journey-to-work trip, complexity of trip making, shorter work trip, making of domestic related trips, trips generated by substitution of home production to market production and females' preference for public transport as well as their conservative nature in selection of travel alternatives.
Kumar, (2011) attributed mobility stress in Nigerian cities to deficient basic infrastructure which he opined is usually characterized by insufficient quantity and quality of the road networks. He opined that roads were poorly managed, intersections were spaced closely together and ill-designed for turning. Also, commercial activities (such as street vendors) and parked vehicles force pedestrians off the sidewalks into the roadway thereby reducing the capacity of the roadway and posing safety hazards.

2.2 Challenges in existing intra-city traffic in Nigeria

Despite the significant role of transport in the life of city dweller or society, there are problems that affect this sector and have made its operations sluggish and disappointing. Hougendoorn and Bovy, (2001) and North County Times (2004) opined that traffic flow, traffic growth and congestion are some of the main economic and societal problems related to transportation in industrialized countries. These problems according to Ogunsanya, (2006) manifest in the form of environmental pollution, delay, accidents and land use severance amongst others. However, Pucher et al. (2005) noted that in developing countries much of the population is so poor that they cannot afford any means of motorized transport at all and must spend up to three or even four hours a day for travel. While the poor suffer the most from severe and worsening transport problems in cities, government policies generally focus on serving the needs of an elite minority. Although the nature and extent of intra urban transport challenges obviously vary from one country to another, virtually all developing countries are plagued with one or all of the following challenges as elicited by Pucher et al. (2005):

- Unplanned, haphazard development at the suburban fringe without adequate infrastructure, transport, and other public services;
- Limited network of roads, often narrow, poorly maintained, and unpaved;
- Extremely congested roads with an incompatible mix of both motorized and non-motorized vehicles traveling at widely different speeds;
- Rapidly increasing ownership and use of private cars and motorcycles;
- Inadequate roadway accommodations for buses and non-motorized transport;
- Primitive or non-existent traffic control and management, often without even the most basic street signage;
- Extremely high and rapidly rising traffic fatalities, especially among pedestrians and motorcyclists;
- Overcrowded, uncomfortable, undependable, slow, uncoordinated, inefficient, and dangerous public transport;
- Extremely high levels of transport-related pollution, noise and other environmental impacts, especially in large cities.

According to Ayeni (1983) these problems are some of the most pressing and perhaps most visible urban problems in Nigeria. He argued further that one of the most serious problems in the cities is "livability" which manifest itself inform of environmental deteriorations, overloading and congestion (Ayeni, 1992). While the average income citizen struggle with inadequate housing accommodation and transport, the poor are already disadvantaged. The limited supply of decent and affordable housing around the city centres forces a rising proportion of the middle class to reside in distant suburbs leading to long, exhausting commutes to daily

activities by either private automobile or slow, overcrowded public transport or dangerous motorcycles. Adefolalu (1993) observing the city of Lagos, stated that traffic congestion is the most serious and intractable transportation challenge. This explains why the transport sector in the city of Lagos is described as 'organized chaos' (Oni, 2002). In examining the causes of urban traffic congestion, Adefolalu (1993) attributed the causes to inadequate road infrastructure to accommodate the increasing number of vehicles and poor driving habits. Roadside and on-road parking, roadside trading and total disregard for traffic regulations by road users are significant human contributions to urban traffic congestion (Ibrahim–Adedeji, 2014). However, Ogunsanya (2006) study in Ilorin stated that traffic delays, congestion and parking problems are mere systems of malfunctioning urban traffic design.

Some of the other basic reasons advanced for urban traffic problems are route inadequacy, human misuse of available road infrastructure, poor traffic management, absence of effective traffic and transportation planning and the unprecedented surge in urban travel demand these urban traffic problem is believed to induce stress, some level of discomfort and affect the psychological health of many commuters during and after daily trips. Observing the effect of traffic congestion on the environment, Ogunsanya (2006) argues that automobiles emit pollutants into the urban environment. Its effect on the health of people, community values and environs ecology, to say the least, are deplorable.

3. Research methodology

The study employed a cross-sectional survey design aimed at determining the challenges in the existing pattern of intra-city traffic in Enugu metropolis. Disaggregate data for this study was obtained from transportation survey (questionnaire) conducted by the authors in 2018. The survey was structured in such a way that the researchers can easily achieve the objectives of the study. The questionnaire had 2 sections; A and B. Section "A" contained 6 items eliciting socio-demographic information while Section "B" contained 5 items eliciting information on challenges of intra-urban traffic in Enugu metropolis. Considering the fact that majority of the commuters in Enugu metropolis speak English, the questionnaire was designed in English language.

The study identified three study groups for investigation from the different residential densities that categorize residential areas in Enugu metropolis, namely, the high, medium and low residential density areas. From the eighteen neighbourhoods that make up the study area, the researchers randomly selected 3 neighbourhoods from the high density residential area, 2 neighbourhoods from the medium density residential area and 1 neighbourhood from the low residential density using a combination of stratified and simple random sampling technique. Specifically, this was done by dividing the study area into three different strata representing the residential densities from which households were randomly selected without replacement in order to ensure a proportionate representation of the densities. The randomly selected neighbourhoods were Abakpa, Gariki and Ogbete (high density), New haven and Uwani (medium density) and Trans-Ekulu (low density). The population of residents that make up the randomly selected neighbourhoods was given as 418,122.

Neighbourhoods	Density	1991 Population Figure	2006 Population Figure	2018 Projected Population
Abakpa	High	90,619	126,232	190,998
Ogbete	High	25,994	36,209	54,789
Gariki	High	19,662	27,389	41,442
Uwani	Medium	31,875	44,401	67,183
New haven	Medium	18,753	26,123	39,526
Trans Ekulu	low	11,474	15,983	24,184
Total		**198,377**	**276,337**	**418,122**

Tab.1 Selected Sample Neighbourhoods and their Population (Source: National Population Commission, 2006 projected to 2018 by researchers).

This was arrived at by projecting the 2006 Nigerian population census figure to 2018 using the Thomas Malthus exponential model (NPC, 2006) because no other official national census has been conducted in Nigeria since 2006. This is shown in Tab.1.

In determining the sample size that was adequate for the study, the Taro Yamane (1967) model was used. The formula is stated thus:

$$n = \frac{N}{1 + N*(e^2)}$$

Where:

n = required sample size

N = the whole population under study

e = the level of precision or sample error i.e., 0.05.

Applying this formula with 418,122 as the population of the study (Enugu metropolis), we have

$$n = \frac{418,122}{1 + 418,122*(0.05^2)}$$

$$n = \frac{418,122}{1046}$$

$$n = 400$$

Thus, a total of 400 respondents (members of households who were within the ages of 18 years and above) were involved in the study. In addition, the researcher also used proportionate allocation strategy to get the sample size for each of the neighbourhoods using their various household sizes. The formula that was used is stated thus:

Sample size of the neighbourhood = percentage of neighbourhood's household population multiplied by the total sample size for the study

For instance, the sample size for Abakpa is expressed as 46% of 400 which gives 184 respondents. Further details in shown in Tab.2.

Neighbourhoods	2018 Projected Population	Household Population	Percentage %	Sample Size
Abakpa	190,998	31,833	46	184
Ogbete	54,789	9,132	13	52
Gariki	41,442	6,907	10	40
Uwani	67,183	11,197	16	64
New haven	39,526	6,588	9	36
Trans Ekulu	24,184	4,031	6	24
Total	**418,122**	**69,687**	**100**	**400**

Tab.2 The Sampled Neighbourhoods and Sampled Sizes (Source: Researcher's Survey, 2018)

In analysis, the data collected was subjected to descriptive and inferential statistics. Specifically, correlation model was used for the analysis at 0.05 level of significance with the aid of Statistical Package for Social Sciences (SPSS) version 23. Correlation model was used to ascertain if there was a significant relationship between the various residential densities in Enugu metropolis and the challenges in intra-city traffic pattern in Enugu metropolis.

4. Results and analysis

Neighbourhoods	No of questionnaires	Successfully filled	Incomplete	Response rate
Abakpa	184	174	10	94.6
Ogbete	52	50	2	96.2
Gariki	40	38	2	95.0
New haven	36	34	2	94.4
Uwani	64	60	4	93.8
Trans Ekulu	24	24	-	100
Total	**400**	**380**	**20**	**95.0**

Tab.3 The Response rate in each of the Sampled Neighbourhoods (Source: Field Survey, 2018)

From Table 3, it is observed that Trans Ekulu had a 100% response rate unlike other neighbourhoods in Enugu metropolis. Perhaps, this could be adduced to the more superior educational status of the respondents in this neighbourhood (when compared to other neighbourhoods). Similarly, it could be based on the stance that the number of questionnaires that was allocated to Trans Ekulu was relatively smaller. However, other neighbourhoods also reported an encouraging response rate. Generally, the findings indicate that the response rate of the respondents was highly encouraging as 95% success was achieved.

4.1 Personal data and socio-economic characteristics of the respondents

Characteristics	Frequency	Percent (%)
Gender		
Male	195	51.3
Female	185	48.7
Age Groups (years)		
20 years and below	54	14.2
21 – 40 years	227	59.6
31 – 60 years	97	25.5
> 60 years	2	0.5
Mean ± SD (years)	33.4 ± 8.6	
Marital Status		
Single	199	52.4
Married	163	42.9
Widowed/Divorced/separated	18	4.7
Level of Education		
Primary school	24	6.3
Secondary school	80	21.0
OND/NCE	117	30.8
HND/B.Sc	98	25.8
Post-tertiary	61	16.1
Occupation		
Civil servant	86	22.6

Business person/ Self-employed/ Trader	100	26.3
Private employed	63	16.6
Unemployed	35	9.2
Student	96	25.3
Monthly income (N)		
Below N 10,000	24	6.3
N 10,001 - N 20,000	68	17.9
N 20,001- N 30,000	91	23.9
N 30,001 – N 40,000	63	16.6
N 40,001 - N 50,000	39	10.3
Above N50,000	95	25.0
Mean ± SD (income)	32,224 ± 13,940	

Tab.4 Socio-demographic characteristics of respondents (n = 380) (Source: Field Survey, 2018)

Tab.4 above shows the socio-demographic characteristics of the respondents. A little More than half (51.3%) were males and 48.7% female showing almost equal representation of gender in the investigation while their mean age was 33.4 (± 8.6) years indicating that respondent were adults, matured enough to give valid responses. More than half (59.6%) were within the ages of 21 – 40 years while 52.4% were singles. Majority of the respondents had one form of formal education and therefore were considered literates. Also, their major occupation was business/trading (26.3%) and civil servants (22.6%) while their average monthly income was 32,224 (± 13,940) Naira.

4.2 Commuters' perception and the challenges of intra-urban traffic in the city

This section presents data focused on the commuters' perception as well as the challenges in the existing pattern of intra-city traffic in Enugu metropolis.

Options	**Neighbourhoods**						**Total**	**percentage %**
	Abakpa	Gariki	Ogbete	New haven	Uwani	Trans Ekulu		
Daily	174	38	50	34	60	24	380	100
Thrice a week	-	-	-	-	-	-	-	-
Weekly	-	-	-	-	-	-	-	-
Fortnightly	-	-	-	-	-	-	-	-
Occasionally	-	-	-	-	-	-	-	-
Total	**174**	**38**	**50**	**34**	**60**	**24**	**380**	**100**

Tab.5a Frequency of Trips within Enugu Metropolis (Source: Field Survey, 2018)

Tab.5a shows the frequency of trips that commuters undertake in Enugu metropolis. It revealed that all the respondents in each of the selected neighbourhoods stated that they made trips daily within Enugu metropolis to reach for desired goods and services. The purpose for making the intra-urban travel was investigated and presented in table 5b below.

Tab.5b revealed the trip purpose of commuters in Enugu metropolis. It shows that 94 respondents (representing 24.7%) stated that the major trips that they made within Enugu metropolis was work trips, 74 respondents (representing 19.5%) stated that the major trips that they made within Enugu metropolis was school trips, 43 respondents (representing 11.3%) stated that the major trips that they made within Enugu

metropolis was social trips, 44 respondents (representing 11.6%) stated that the major trips that they made within Enugu metropolis was religious trips, 110 respondents (representing 28.9%) stated that the major trips that they made within Enugu metropolis was commercial trips while 15 respondents (representing 3.9%) stated that the major trips that they made within Enugu metropolis were not included in the afore-mentioned categories (e.g. recreational trips). This means that the major trips made in Enugu metropolis were commercial, work and school trips. Their travel mode was also investigated and presented below in the figure below.

Options	**Neighbourhoods**						**Total**	**percentage %**
	Abakpa	Gariki	Ogbete	New haven	Uwani	Trans Ekulu		
Work trips	41	10	14	5	18	6	94	24.7
School trips	36	10	8	6	10	4	74	19.5
Social trips	11	5	5	8	9	5	43	11.3
Religious trips	18	5	2	5	11	3	44	11.6
Commercial trips	60	6	21	5	12	6	110	28.9
Others	8	2	-	5	-	-	15	3.9
Total	**174**	**38**	**50**	**34**	**60**	**24**	**380**	**100**

Tab.5b Reason for Trips Made by the Respondents (Source: Field Survey, 2018)

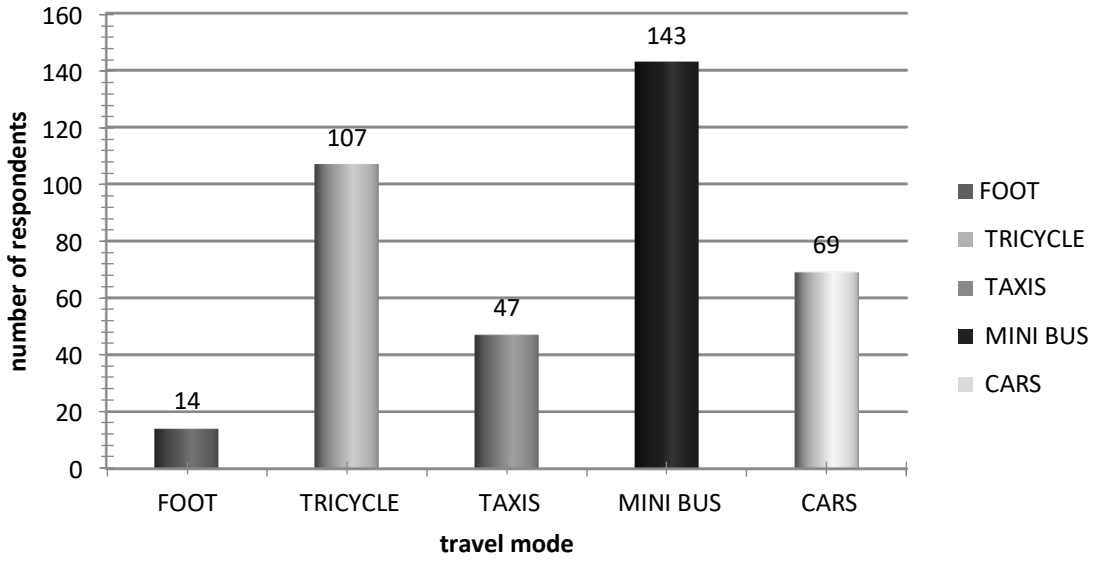


Fig. 3 Travel Mode used for Trips by the Respondents

Figure 3 revealed the travel mode used by commuters for trips within Enugu metropolis. It shows that 14 respondents (representing 3.7%) stated that the travel mode that they used predominantly was foot, 107 respondents (representing 28.2%) stated that the travel mode that they used predominantly was tricycle, 47 respondents (representing 12.4%) stated that the travel mode that they used predominantly was taxis, 143 respondents (representing 37.6%) stated that the travel mode that they used predominantly was mini bus while 69 respondents (representing 18.2%) stated that the travel mode that they used predominantly was

private cars. This means that the predominant travel mode used for intra-city mobility in Enugu metropolis was mini-bus and tricycle.

Options	Neighbourhoods						Total	percentage %
	Abakpa	Gariki	Ogbete	New haven	Uwani	Trans Ekulu		
Excellent	-	-	-	10	19	3	32	8.4
Good	90	30	45	20	31	18	234	61.6
Fair	57	8	5	4	10	3	87	22.9
Poor	27	-	-	-	-	-	27	7.1
Very poor	-	-	-	-	-	-	-	-
Total	**174**	**38**	**50**	**34**	**60**	**24**	**380**	**100**

Tab.6 State of Road Infrastructure in Enugu Urban (Source: Field Survey, 2018)

Table 6 reveals respondents' perception of the state of road infrastructure in Enugu metropolis. It showed that 32 respondents (representing 8.4%) stated that the roads within Enugu metropolis was in an excellent condition, 234 respondents (representing 61.6%) stated that the roads within Enugu metropolis was in a good condition, 87 respondents (representing 22.9%) stated that the roads within Enugu metropolis was in a fair condition while 27 respondents (representing 7.1%) stated that the roads within Enugu metropolis was in a poor condition. This means that majority of the roads in Enugu urban are in good condition.

Options	Neighbourhoods						Total	percentage %
	Abakpa	Gariki	Ogbete	New haven	Uwani	Trans Ekulu		
Strongly agree	52	8	11	7	15	6	99	26.1
Agree	61	10	23	4	14	3	115	30.3
Indifferent	6	4	6	3	4	1	24	6.3
Disagree	24	6	8	17	12	7	74	19.5
Strongly disagree	31	10	2	3	15	7	68	17.9
Total	**174**	**38**	**50**	**34**	**60**	**24**	**380**	**100**

Tab.7 Respondents' Perception on Stress during Trips (Source: Field Survey, 2018)

Tab.7 showed respondents' perception on mobility stress in Enugu metropolis. It revealed that 99 respondents (representing 26.1%) strongly agreed that stress during trips was a challenge of intra-city mobility in Enugu metropolis, 115 respondents (representing 30.3%) agreed that stress during trips was a challenge of intra-city mobility in Enugu metropolis, 74 respondents (representing 19.5%) disagreed that stress during trips was a challenge of intra-city mobility in Enugu metropolis while 68 respondents (representing 17.9%) strongly disagreed that stress during trips was a challenge of intra-city mobility in Enugu metropolis. This means that stress during trips was a challenge of intra-city trips within Enugu metropolis.

Tab.8 shows the major impediment facing commuters' in their daily travel in Enugu metropolis. It revealed that 170 respondents (representing 44.7%) stated that traffic hold ups was a major impediment to free flow traffic in Enugu metropolis, 51 respondents (representing 13.4%) stated that bad roads was a major

impediment to free flow traffic in Enugu metropolis, 34 respondents (representing 8.9%) stated that high transport costs was a major impediment to free flow traffic in Enugu metropolis, 45 respondents (representing 11.8%) stated that 'dropping and picking passengers' was a major impediment to free flow traffic in Enugu metropolis while 76 respondents (representing 20%) stated that narrowness of roads was a major impediment to free flow traffic in Enugu metropolis.

Options	**Neighbourhoods**						**Total**	**percentage %**
	Abakpa	Gariki	Ogbete	New haven	Uwani	Trans Ekulu		
Traffic hold ups	53	18	21	26	38	14	170	44.7
Bad roads	41	5	5	-	-	-	51	13.4
High transport costs	12	2	4	6	10	-	34	8.9
Dropping & picking passengers	18	7	6	2	12	-	45	11.8
Narrowness of roads	46	6	14	-	-	10	76	20.0
Few roads	4	-	-	-	-	-	4	1.1
None	-	-	-	-	-	-	-	-
Total	**174**	**38**	**50**	**34**	**60**	**24**	**380**	**100**

Tab.8 Major Impediments to Free Flow Traffic (Source: Field Survey, 2018)

This means that the major impediments to free flow of traffic within Enugu metropolis were traffic hold ups and narrowness of roads. Furthermore, major transport challenge experience in the study area were highlighted and the perception of inhabitant investigated and shown in the figure below.

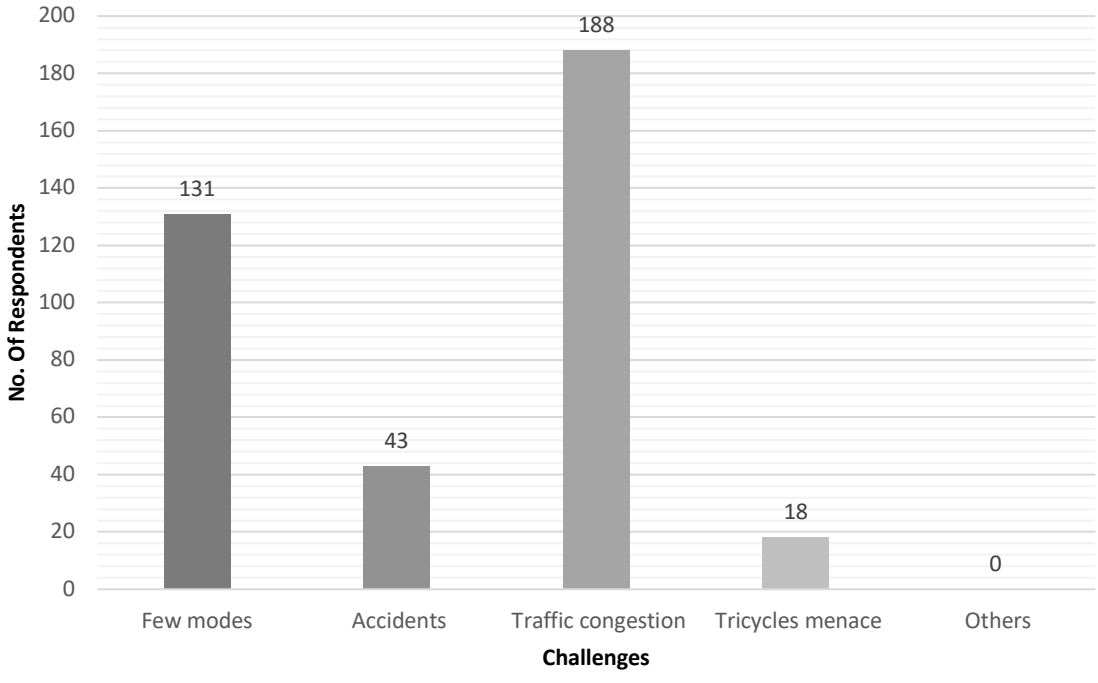


Fig. 4 Respondents' Perception on Major Transport Challenges

Fig.4 reveals respondents' perception to transport challenges in Enugu metropolis. It revealed that 131 respondents (representing 34.5%) stated that few public transport was a major challenge of transportation in Enugu metropolis, 43 respondents (representing 11.3%) stated that vehicular accidents was a major challenge of transportation in Enugu metropolis, 188 respondents (representing 49.5%) stated that traffic congestion was a major challenge of transportation in Enugu metropolis while 18 respondents (representing 4.7%) stated that menace of tricycles operators was a major challenge of transportation in Enugu metropolis. This means that the major challenges of transportation in Enugu urban were traffic congestion and fewer modes of public transport.

4.3 Test of hypothesis

H_0: There is no significant relationship between the various residential densities in Enugu metropolis and the challenges in intra-city traffic pattern in Enugu metropolis.

T_0 test the hypothesis, the responses to questions bordering on the location of respondents as well as their perception on intra-urban transport challenge were used. The result was presented in Tab.9.

		Location	**Transport challenges**
Location	Pearson Correlation	1	0.138**
	Sig. (2-tailed)		0.007
	N	380	380
Transport challenges	Pearson Correlation	0.138**	1
	Sig. (2-tailed)	0.007	
	N	380	380

** Correlation is significant at the 0.05 level (1-tailed).

Tab.9 Correlation Test (Source: Researcher's SPSS Analysis, 2018)

The result of the Pearson Product Moment Correlation shows that there was a statistically significant relationship between the various residential densities in Enugu metropolis and the residents' perception of the challenges in intra-city traffic pattern (i.e. $p < 0.05$ at 0.05 significance level). It also indicates that the relationship between the respondents' location and their perception was positive. Also, it indicates that the strength of relationship between the residential density and perception of challenges in intra-city traffic pattern was weak ($R = 0.676$).

In addition, the coefficient of determination (R^2) which explains the variance explained between residential densities in Enugu metropolis and residents' perception of the challenges in intra-city traffic pattern indicates 0.02% percent shared variance. This implies that the residents' neighbourhoods influence their perception of the challenges in intra-city traffic pattern in Enugu metropolis by 0.02%. This is quite a little amount of variance explained.

5. Discussion

From the findings of the study, it was reported that residents of Enugu metropolis make daily intra-urban trips with the primary purpose being to access goods and desired services regardless of the day of the week. Interestingly, this finding suggests that residents in Enugu metropolis, regardless of their residential neighbourhood, make trips ranging from work trips, school trips, recreational trips, religious trips, etc. At Abakpa, the predominant trips made by residents were commercial trips and work trips (34.4% and 23.6% respectively). At Gariki, the predominant trips were work and school trips (26.3% each). At Ogbete, the predominant trips were commercial and work trips (42% and 28% respectively). At New haven, the

predominant trips were commercial and work trips (23.5% and 17.6% respectively). At Uwani, the predominant trips were work and commercial trips (30% and 20% respectively) while at Trans Ekulu, the predominant trips were commercial and work trips (25% each). Impliedly, the major trip purpose of residents in high density residential area in Enugu metropolis were commercial trips, work trips and school trips while the major trip purpose of residents in medium density residential areas in Enugu metropolis were commercial and work trips. The same applies for commuters residing in low density residential area in Enugu metropolis whose major trip purpose were work and commercial trips. Having commercial, work and school trips as the major trip purpose in Enugu metropolis, corroborated the results in Tab.4 that the occupation of most residents are businessmen/trading or civil servants who work for the government and other establishments.

It can be deduced from the finding that the trip purpose in Enugu metropolis across the neighbourhoods was similar apart from those in the high density area which varied a little. This finding can be supported with the result on Table 9 which showed that the residential neighbourhood of residents in Enugu metropolis was found to only influence their intra-urban trip pattern by 0.02% ($R = 0.138$, $P = 0.007$). These findings agree with the assertion of Okeke et al., (2020) who said that transportation is the hallmark of every city growth and development, the artery to which all land uses are accessed and the requisite for mobility. Unlike, other countries in East Africa and Kingdom of Saudi Arabia where due to cultural and religious beliefs intra-urban trips has limit for the female gender (Tesoriere & Errigo, 2018), in Enugu (the study area) there is no such restrictions as everybody have equal right to movement and free to use any means of transportation readily available. However travel behaviour is equally affected by other socio-economic and socio-demographic factors. (Stamos et al., 2015)

Generally, it can be deduced that the major travel mode in Enugu metropolis for intra-urban travel was mini-buses (37.6%). This was followed by use of tricycles (28.2%), private cars (18.2%), taxis (12.4%) and use of foot (3.7%). This can be attributed to the fact that travel modes are under the influence of infrastructures and facilities which are fragments of availability factors. Although the prevailing intra urban travel mode in the city of Enugu varies with that of other developed cities like Jakarta, Verde, Guatemala, Dublin, Auckland etc. Possible reasons could be adduced to the low socio-economic status of majority of residents in Enugu metropolis with majority reported to be earning an average of 32,224 (± 13,940) Naira/month and also non availability of other forms of non-motorized transportation modes. The findings confirm part of the postulations of study of Koushki (1987), which focused on the effects of socio-economic traits such as family size, family income, employment and car ownership utilized as the explanatory variables in transportation choice. Furthermore the above findings is in-line with the study of Adeel, (2018) who revealed that majority of urban transport demand in Pakistan is catered by privately owned fleet of buses and minivans which are often despised by the users for their poor quality service and lack of coverage. In view of the scenario, personal automobile based mobility provides an ideal choice for the urban commuters (Haider & Badami, 2004).

The study also revealed that commuters within Enugu urban undergo stress during their trips regardless of the good roads within the metropolis. According to Odofuwa, (2006), the high rate of mobility distress in Enugu metropolis is also complicated by the non-standardized ergonomic design of most intra-city buses and taxis. Their seat sizes, height and spacing results in excessively cramped travel condition responsible for sitting, standing and aisles passing discomfort among commuters. This situation, according to Filani, (2002) is becoming more and more acute in Enugu metropolis. Little wonder, informal transport services (such as the use of tricycles) have become a dominant mode for intra-city travel in Enugu metropolis. Tricycle and mini buses have become the predominate intra-urban travel mode within the neighbourhood (see figure 3) because just like the commercial motorcycles (popular called Okada) that offers comfort and short trip time for commuters, tricycles and minibuses are considered as a replacement and offer almost the same advantages. This view is corroborated by Moeinaddini et al., (2012) who believed that urban public transport usage is under the influence of convenience, safety and security. Subsequently, Kumar (2011) has a different perspective on

the mobility stress in Enugu metropolis and attributes it to deficient infrastructure characterized by insufficient quantity and quality of roads. However, in situations where the roads are sufficient, a part of it is usually taken up by pedestrians, street vendors and parked vehicles. Moreover, facilities for pedestrians and cyclists are becoming extinct, thus forcing them to share crowded rights of way with rapidly moving automobile.

It was also discovered from the study as seen in table 8, that the major impediments to free traffic flow in Enugu urban was traffic congestion during peak hours as well as narrowness of most roads in the city. This finding could be adduced to the issue of near-side parking that is seen on most roads in Enugu urban. This challenge is worsened by the fact that most roads in Enugu are relatively narrow as seen in areas like Ogbete, New layout, Gariki, etc. This finding agrees with that of Adefolalu, (1993) who opined that traffic flow and traffic congestion are the main societal problems related to transportation in developing countries. Furthermore, commuters stated that the major transport challenges that characterizes intra-city mobility in Enugu urban are traffic congestion and few modes of public transport. This is in line with the studies of Okeke et al., (2020) who said that traffic congestion is viewed as the principal urban transportation problem in recent time in Mayor, Amechi, Amuokwe, Gariki and Ogbete market areas and traffic congestion emerged as the foremost justification for large-scale road construction in Enugu urban.

Moreover, the challenge of few modes for public transport could be explained by the fact that the most predominant modes are mini-buses, taxis and tricycles and this agrees with the finding of Solanke, (2013) that majority of the urban populace depend on public transport for their mobility needs dominated by the private sector operating such vehicles as taxi; para-transit mini buses, fare paying passenger carrying private cars (also known as 'kabu kabu'), motorcycles (two wheel) and three-wheeled motorcycles operated in most urban centres. From all indication, these automobiles are designed to convey at least 1–12 commuters. Other mode of non-motorized transport or public transit infrastructure are non-existent putting pressure on the insufficient and unsustainable means of mobility. City Planners are sometimes oblivious of the fact that the development and expansion of roads to reduce congestion and/or increase traffic speeds would promote increased use of automobile (Okeke et al., 2020). This situation could be improved if coal city shuttles are revived for intra-city mobility in Enugu urban. This view is supported by Rahman, (2004) who posited that improvement in public transportation as well as in traffic management is a pivotal way of reducing the effects of traffic congestion in Nigerian cities.

6. Conclusions and recommendation

In line with the aim of this research which is to investigate the challenges in the existing pattern of intra-city traffic in Enugu metropolis, the findings of this research have identified three key issues:

- The major travel mode within Enugu urban is mini buses and tricycles due to the fact that these modes are the most readily available modes for public transportation in Enugu urban. The use of tricycle is traceable to the flexibility that the mode provides when compared to other modes;
- Commuters within Enugu urban undergo stress during their trips regardless of the good condition of roads within the metropolis;
- The challenges to existing pattern of free traffic flow in Enugu urban is traffic congestion during peak hours and narrowness of most roads in within the city.

The implication of these challenges is that it has the tendency to hinder rapid economic growth, urban development and may infuse traits of city fragility if not adequately addressed. The following are recommendation from the study.

- The re-introduction of Non-motorized transport mode of walking and cycling with adequate provision of Pedestrian walkway on streets, in public squares and traffic-free shopping streets be adopted and implemented. This is because walking and cycling is a form a physical exercise that promotes good health while reducing demand for mini buses and tricycles;

- Urban transportation policies, which emphasize accessibility i.e. reducing the need for much travel should be pursued. Such policies relate to land use planning and the decentralization of activity within the metropolis needs to be implemented;
- Coal city public transit shuttles that once existed should be revived to complement the existing public transport system. These would help to ensure that the modes of transportation address the determinants of intra-city mobility such as, affordable transport price, safety of passengers on board, environmental pollution, traffic congestion, time wasting etc.

The study has highlighted the challenges in the existing pattern of intra-city traffic in Enugu metropolis, recommendations have been proposed. However, different aspects of this line of research needs to be investigated. It is suggested that further detailed study on the determinants of intra-urban mobility in Nigeria be conducted.

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IMAGE SOURCES

Fig. 1: Map of Nigeria Showing Enugu State; Map of Enugu State Showing the study area - Authors.

Fig. 2: Map of Enugu Metropolis (Study Area) showing the Neighbourhoods -Google Earth Imaging, 2018

Fig. 3: Map of Enugu Metropolis (Study Area) showing the Neighbourhoods - Authors field survey, 2018

Fig. 4: Respondents' Perception on Major Transport Challenges – Authors field survey, 2018.

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Back from the future. A backcasting on autonomous vehicles in the real city

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Abstract
Backcasting is often mentioned as a scenario-building technique that can help decision-makers facing uncertain and complex dynamics, such as the transition to autonomous driving. This article presents a backcasting carried out in the city of Turin (Italy), aimed at defining a policy pathway to steer the transition to autonomous driving towards objectives of sustainability and liveability of the city and its neighbourhoods. It reflects on this exercise and highlights some critical issues that proved to challenge the effectiveness and the potentialities of backcasting when applied to autonomous vehicles (AVs); these issues are mainly related to: factors and levels of uncertainty, contextualization of the vision, involvement of relevant stakeholders, definition of the policy pathway. Nevertheless, the exercise showed that some solutions can be adopted to deal with these challenges, in terms of: reference to existing background socioeconomic scenarios; combination of a range of participatory techniques to broaden the number and type of involved stakeholders; integration of collaborative and think-tank methodologies to review, enrich and systematize the outputs provided by the stakeholders; reference to mid-term planning tools to organize policy packages that are consistent both internally and with the more general mobility strategies. These solutions can support further backcasting exercises for AVs.

Keywords
Backcasting; Scenario; Planning; Transition; Autonomous vehicles

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1. Introduction

Facing the future and its uncertainty is an intrinsic aspect of planning. Uncertainty can be seen as a challenge, but also as an opportunity to question expected trends and envisage alternative (Lyons & Davidson, 2016). In this respect, much depends on the attitude towards uncertainty: planners and policymakers can address uncertainty as an opportunity rather than a complication, and try to steer urban dynamics towards a desired vision. However, some processes display such high and varied degrees and elements of uncertainty that most planners end up adopting a "watch and wait" approach (Guerra, 2016; Legacy et al., 2019; Milakis, 2019).

The evolution of mobility, and in particular the transition to autonomous driving, is undoubtedly one of those processes that bring with them a very high level of uncertainty (Lyons & Davidson, 2016; Marchau et al., 2018; Walker et al., 2010). Autonomous vehicles (AVs) are expected to disrupt transport systems and mobility (Fagnant & Kockelman, 2015; Faisal et al., 2019), and generate second and third-order effects in several respects, such as congestion, energy consumption, social equity, economy, land use, etc. (Bahamonde-Birke et al., 2018; Milakis, 2019; Smolnicki & Sołtys, 2016). It is generally assumed that AVs can reduce car accidents (Winkle, 2016), increase road capacity and reduce the amount of space for on-road parking (Metz, 2018; Zhang et al., 2015), improve accessibility for some of those who currently cannot drive a car (Milakis et al., 2018; Papa & Ferreira, 2018). Notwithstanding, concerns about the possible negative effects of autonomous driving are growing. As regards their prospected socio-spatial effects, concerns are related to the increase in travel time, vehicle miles travelled and congestion (Childress et al., 2015), the conflict with pedestrians and cyclists (Gavanas, 2019; Millard-Ball, 2018; Parkin et al., 2018), the reduction of public transport patronage and active mobility (Bahamonde-Birke et al., 2018; Botello et al., 2019), and the risk to foster sprawling processes (Zakharenko, 2016).

Public authorities may play a key role in steering the transition to autonomous driving so to limit their potential impacts and exploit their benefits, improving the quality and liveability of urban spaces (Gavanas, 2019; Guerra, 2016; Papa & Ferreira, 2018; Stead & Vaddadi, 2019). Nevertheless, despite the general consensus about the need to govern the diffusion of AVs, public authorities are reluctant to take the lead (Cohen & Cavoli, 2019; Curtis et al., 2019; Fraedrich et al., 2018). In fact, moving from theory to practice is not an easy task, as many uncertainties surround the transition to autonomous driving. Indeed, a factor of uncertainty regards the timing of this transition. There is no consensus in the debate on this issue, and scholars, automotive manufacturers, public administrations and the general public have different predictions (Bazilinskyy et al., 2019). On the scientific research side, estimates of commercial viability and market penetration rates of AVs are rather prudential and have very wide ranges, from 2025 to 2050 (Litman, 2019; Milakis et al., 2017). According to the European Road Transport Research Advisory Council[1], fully AVs[2] will only be available in the decades after 2030 (ETRAC, 2019). Greater optimism is shown by the automotive industry and by the general public, who expect that AVs will flood urban roads by the 2020s-2030s (Bazilinskyy et al., 2019).

While traditional forecasting methods are not deemed to be viable for dealing with high degrees of uncertainty, backcasting is acknowledged as a suitable method for this purpose (Banister & Hickman, 2013; Bibri, 2018; Robinson, 1990; Tuominen et al., 2014; Vergragt & Quist, 2011). Backcasting proceeds in the opposite direction to forecasting, formulating future visions and going backwards to define pathways to achieve them. Although it is more appropriate than other methods for dealing with uncertainty, backcasting is a challenging process in several respects.

This article reflects on a backcasting that was carried out in Turin (Italy), aimed at defining a pathway to steer the transition to autonomous driving towards objectives of sustainability and liveability of the city and its

[1] European Road Transport Research Advisory Council (ETRAC) is the European technology platform which brings together road transport stakeholders to develop a common vision for road transport research in Europe.

[2] According to the taxonomy introduced by the Society of Automotive Engineers (SAE), AVs can be classified into six levels of automation: no automation (level 0), diver assistance (1), partial automation (2), conditional automation (3), high automation (4) and full automation (5).

neighbourhoods. The results of the first two phases of this experience – visioning and policy packaging – were presented in detail respectively in Staricco, Rappazzo, Scudellari and Vitale Brovarone (2019) and Vitale Brovarone, Scudellari and Staricco (2020-forthcoming). The present article reviews the whole process with the aim of highlighting what challenges and critical issues arise for backcasting when applied to AVs. In detail, section 2 frames and describes backcasting, with a focus on its origins and implementations in the field of transport and on the few experiences related to AVs. Section 3 gives a general overview of the whole backcasting process developed in Turin. Section 4 discusses some key questions that challenged this backcasting experience. Finally, section 5 draws some concluding remarks and directions for future research.

2. The backcasting approach

Backcasting is a scenario-building technique that can help decision-makers cope with the uncertainty of the transition to AVs (Li et al., 2018; Marchau & van der Heijden, 2003). Backcasting is an approach used in future studies, which can be classified based on three modes of thinking about the future (Bibri, 2018):

- scenario planning studies, focused on identifying possible futures (*what might happen?*);
- forecasting studies, which try to assess probable futures (*what is most likely to happen?*);
- backcasting studies, focused on preferable futures (*what we would prefer to happen?*).

The main peculiarity of backcasting is a concern with how desirable futures can be attained, rather than with futures that are likely to happen, as in forecasting analyses (Robinson, 1982). Backcasting is a normative approach: it moves step-by-step backwards from a desired future to the present, in order to identify the strategic steps in the policy path that are needed to achieve that specified future (Robinson, 1990).

The backcasting approach has been applied with a wide variety of methodologies, as diverse backcasting traditions and practices have evolved in different countries (Vergragt & Quist, 2011). That being said, backcasting is generally articulated in a sequence of phases, two of which play a key role: *visioning*, aimed at establishing business as usual and alternative visions of desirable futures, and *policy packaging*, to identify pathways and policy measures to pursue the desired vision. Some authors also put an *appraisal* phase at the end of the process, aimed at evaluating the pathways and policy packages (Nogués et al., 2020; Soria-Lara & Banister, 2018b).

The origin of backcasting can be traced back to the 1970s in energy studies, when Lovins (Lovins, 1976, 1977) proposed an approach – which he defined "backwards-looking analysis" – aimed at identifying alternative policy paths to pursue a more efficient use of energy in the long term. The term backcasting was then introduced by (Robinson, 1982), who reflected on the theoretical aspects of this technique. Since the late 1980s, backcasting has been applied to sustainability issues related to geographical contexts – especially cities –, companies and sociotechnical systems (Bibri & Krogstie, 2019; Holmberg & Robert, 2000; Phdungsilp, 2011; Quist, 2007). In particular, in the transport sector "the backcasting approach fundamentally responds to the following question: 'how can a specific transport target be reached (e.g. CO2 reduction, energy efficiency, etc.), when the prevailing structure (e.g. institutional frameworks, legal systems, etc.) blocks necessary changes?'" (Soria-Lara & Banister, 2018, p. 11).

Backcasting has been largely used to address the impacts of transport on the environment (Barrella & Amekudzi, 2011; Dreborg, 1996), and to develop new mobility visions aimed at achieving emission reduction targets and cutting energy consumption (Åkerman & Höjer, 2006; Geurs & Van Wee, 2000; Hickman et al., 2011; Höltl et al., 2018; Mattila & Antikainen, 2011; Olsson et al., 2015; Robèrt, 2017; Robèrt & Jonsson, 2006; Schade & Schade, 2005; Tuominen et al., 2014; Zimmermann et al., 2012).

A recent comprehensive and systematic reflection on transport backcasting scenarios has been developed by Soria-Lara and Banister (2017, 2018a, 2018b), who highlighted a range of methodological issues. In particular, whereas backcasting has traditionally been seen as an expert-led analysis, these authors call for a shift to a more collaborative and participatory approach throughout the whole process (Soria-Lara & Banister, 2018a).

In this sense, they extend to transport a more general recommendation in the literature about backcasting (Carlsson-Kanyama et al., 2008; Quist & Vergragt, 2006), since stakeholder engagement is seen as crucial to bridge the gap between the conceptual elegance of scenario-based research and the practicalities of its actual implementation through policies (Banister & Hickman, 2013).

Backcasting is often mentioned as a suitable method to deal with the transition to autonomous driving (González-González et al., 2019; Li et al., 2018). Indeed, this transition displays the conditions which, according to Dreborg (1996), make backcasting an appropriate method:

- the problem to be studied is complex;
- there is a need for major changes;
- the dominant trends are part of the problem;
- the problem to a great extent is a matter of externalities;
- the time horizon is long to allow considerable scope for deliberate choice.

Moreover, backcasting puts particular emphasis – more than other categories of futures studies – on the definition of the policy pathways to achieve the desired scenario (Robinson, 1990). It can be then considered especially appropriate for the elaboration of policy packages for steering the transition to AVs.

However, most of the studies that dealt with the diffusion of AVs were just focused on the visioning step. Several authors have developed visions and scenarios about AVs, focusing the socio-technical transitions (Fraedrich et al., 2015), expected implications of AVs (Papa & Ferreira, 2018), user friendliness (Smolnicki & Sołtys, 2016), combination of technological innovation and policy support aspects (Milakis et al., 2017), impacts on urban form (Stead & Vaddadi, 2019); yet, most of these studies do not elaborate concrete policy pathways and do not refer to real-world cases. The most advanced exercise of backcasting about AVs was proposed by González-González et al., who first identify some potential measures to steer the transition to AVs toward a range of urban development policy goals (González-González et al., 2019), then focus on parking policies (González-González et al., 2020) and finally present the results of the evaluation of the scenarios and policy packages defined in the previous phases of backcasting (Nogués et al., 2020). Finally, to the authors' knowledge, to date the backcasting process that is discussed in this paper is unique of its kind, as it is applied to a real-world case study (Staricco et al., 2019; Vitale Brovarone et. al., 2020-forthcoming).

3. Backcasting the diffusion of AVs in Turin

This article reflects on a two-step backcasting for the diffusion of AVs in Turin (Italy). The aim was to define a policy pathway toward a future vision (to 2050) in which AVs will be integrated in the mobility system of the city so to preserve the liveability and quality of public spaces. The visioning and the policy packaging phases of this process can be found respectively in Staricco et al. (2019) and Vitale Brovarone et al. (2020-forthcoming), where they have been described in detail. Here a summary overview of the whole process is offered, as a basis for the methodological reflections in section 4 on the application of backcasting to AVs.

3.1 The case study

Turin is the fourth most populated Italian city (around 886,000 inhabitants at the city level and 2.3 million in the metropolitan area); it is located in the north-western part of Italy. The choice of Turin as a case study was due to several reasons.

First of all, Turin is heavily car dependent, so it is particularly exposed to the potential negative impacts of the transition to AVs, if this transition is not properly governed. It has one of the highest car ownership rates in Europe (639 cars/1000 inhabitants), and the modal share of private motorised mobility is nearly 40% (source: EMTA Barometer 2015, Istat). Car traffic is scarcely discouraged; only one restricted traffic zone (covering 2% of the municipal area) and few small 30 km/h zones are active in the city. Public transport (one metro, 8 tram

and about 90 bus lines) and the cycling network are poorly used; their respective modal shares are 24.3% and 3% (source: EMTA Barometer 2015, Agenzia mobilità Piemonte).

In 2018, the city launched a pilot project to test AVs in a real-world environment, on a 35-km route along its road network. In this way, the city aims to position itself at the forefront of the transition to AVs and renew its long-standing economic specialization in the automotive and ICT sectors.

Finally, Turin is now elaborating its new Sustainable Urban Mobility Plan (hereinafter, SUMP), since the previous one, adopted in 2010, is now coming to the end of its 10-year validity period. Therefore, the city is developing the vision of its mobility system for the next decade, and if it wants to govern the transition to AVs, in this moment it has the opportunity to define which short- and medium-term measures for AVs can be integrated into the new SUMP.

3.2 The visioning phase

The visioning phase of the backcasting process was aimed to explore different visions for AVs in Turin, and to select the most advisable one, in terms of sustainability and liveability. Different ways of regulating how AVs can circulate and park in Turin, and of integrating them in the overall mobility system of the city (taking into account the real structure of its road network, its neighbourhoods, etc.) were explored.

In this visioning phase, a combination of the think-tank method and the participatory method was applied. Both are widely used for designing future normative visions (Börjeson et al., 2006; Carlsson-Kanyama et al., 2008; Dreborg, 2004). In the think-tank model, visions are generated back-office by a multidisciplinary research team. In the participatory model, a larger number of (expert and non-expert) stakeholders are involved in developing the visions.

The visioning phase entailed three different steps (the first two based on the think-tank model, the third on the participatory model):

1) development of three possible future visions of Turin, referring to a long-term time horizon (2050) in which all circulating vehicles are expected to be fully connected, autonomous (SAE level 5), and electric. These visions were defined by the research team (composed of urban and transport planners, transport engineers and sociologists) through a brainstorming meeting, grounded on a previous systematic review of the scientific and grey literature about the impacts of AVs on cities. The team identified fourteen key elements to regulate AV circulation and parking and to integrate AVs into the offer of other modes of transport and mobility[3]. These fourteen items were developed and combined differently by the researchers, according to three scenarios that are frequently conjectured for AVs in the literature (Papa & Ferreira, 2018):
   - An optimistic and technology-centred scenario, which assumes that the impacts of AVs on the city will be largely positive. A "Strong deregulation" vision was developed, in which the fourteen items were devised on the assumption that AVs could solve most of the current transport problems in Turin.
   - A pessimistic scenario, which presumes that the negative impacts of AVs on the city will prevail, if not properly managed. A "Strong regulation" vision was elaborated, by implementing the fourteen items according to the general policies that are recommended for AVs in the scientific literature.
   - A neutral scenario, in which the diffusion of AVs will not be explicitly governed, nor their positive or negative impacts. A "Business as Usual" vision was proposed, in which the fourteen items were

[3] The fourteen key elements were: road hierarchy - main roads; road hierarchy - local roads; limitations to vehicle circulation; on-road parking and pick up/drop off areas; multi-storey parking; intermodal parking; main public transport lines (trains, metro, streetcars); feeder capillary network (buses); lanes reserved to public transport; motorized AV sharing; non-motorized AV sharing (bike sharing); pedestrian areas; cycling facilities; modal split.

developed in a sort of inertial prolongation of the current planning conditions of the mobility system in Turin[4].

2) Validation of the three visions, in a focus group which involved seven local experts (ranging from politicians to managers and technicians) of the transport sector. These experts were selected so as to represent the main institutions and companies which are in charge of transport planning, managing, and operating in the area of Turin. They were invited to debate each item of each vision, to confirm it as proposed by the research team or to suggest how (and why) to develop it differently. The recorded results of this discussion were finally analyzed by the research team. The participants did not propose significant changes to any of the three visions; each vision was then considered validated. All the three visions corresponding to the three above-mentioned scenarios could have been built in different versions; however, the participants to the focus group judged that the three visions proposed by the research group (and in particular their articulation according to the fourteen key items) were appropriate developments of the three scenarios to the city of Turin[5].
3) Selection of the most advisable vision. In this third step, the seven experts who participated in the focus group and other 44 local stakeholders[6] filled in a questionnaire to evaluate the advisability of each of the fourteen items of each vision on a scale from 1 ("absolutely not advisable") to 10 ("absolutely advisable"). The stakeholders were chosen so as to represent automotive companies involved in car manufacturing and sales, providers of ICT and mobility services, research centres, public administrations, and environmentalist or professional associations. The "Strong regulation" vision turned out to be considered the most advisable by 45 of the 51 respondents, and recorded the highest values for 13 out of 14 items; only one respondent preferred the "Strong deregulation" vision, and five preferred the "Business as Usual" vision.

3.3 The selected vision

The "Strong regulation" vision is focused on improving quality and liveability of public spaces at the neighbourhood level by reducing the circulation of private AVs and promoting the use of shared AVs, public transport and active mobility (fig. 1 and 2). The vision is inspired by the superblock model (Scudellari et al., 2019), which in turn traces back to the concept of neighbourhood unit launched in the United States after World War I and reinterpreted over time (Brody, 2016; Mehaffy et al., 2015; Patricios, 2002; Perry, 1929; Zali et al., 2016), to reduce the negative impacts of the diffusion of human-driven cars in the urban environment. According to this model, the road network is hierarchized into two levels: a main network of thoroughfares (with a speed limit of 50 km/h) supports cut-through traffic; the meshes of this network are re-thought as superblocks, in which every road is classified as local (with a speed limit of 20 km/h) and reserved to access traffic of shared AVs and AVs belonging to the residents of the superblock. As a result, in a trip from home in neighbourhood A to a destination in neighbourhood B, drivers can run their (private or shared) car in A, then have to run along the main road network, and finally, leave their car (if private) at the border of B or ride just to destination inside B if they are using a shared car. In any case, both private and shared AVs cannot ride through an intermediate neighbourhood between A and B. In this way, volumes of car traffic inside neighbourhoods are reduced.

Parking is completely removed from road and concentrated in multilevel facilities provided around each superblock and at the terminals of each public transport line. The freed-up road space is partly devoted to

4 A fourth "critical" scenario could have been assumed, in which the inevitability of transition to AVs is questioned and a city can actively block the entrance of these vehicles in its roads (see, on this issue, the comments by Legacy et al., 2019). This scenario was not considered, as the city of Turin is already committed in testing and promoting the introduction of AVs in its roads.

5 For more details about the validation process in the focus group, see Staricco et al. (2019).

6 62 stakeholders were interviewed with semi-structured interviews, but 11 of them did not fill in the questionnaire.

platforms for picking-up/dropping-off passengers, partly to favour non-motorised mobility and improve the quality of the public space.

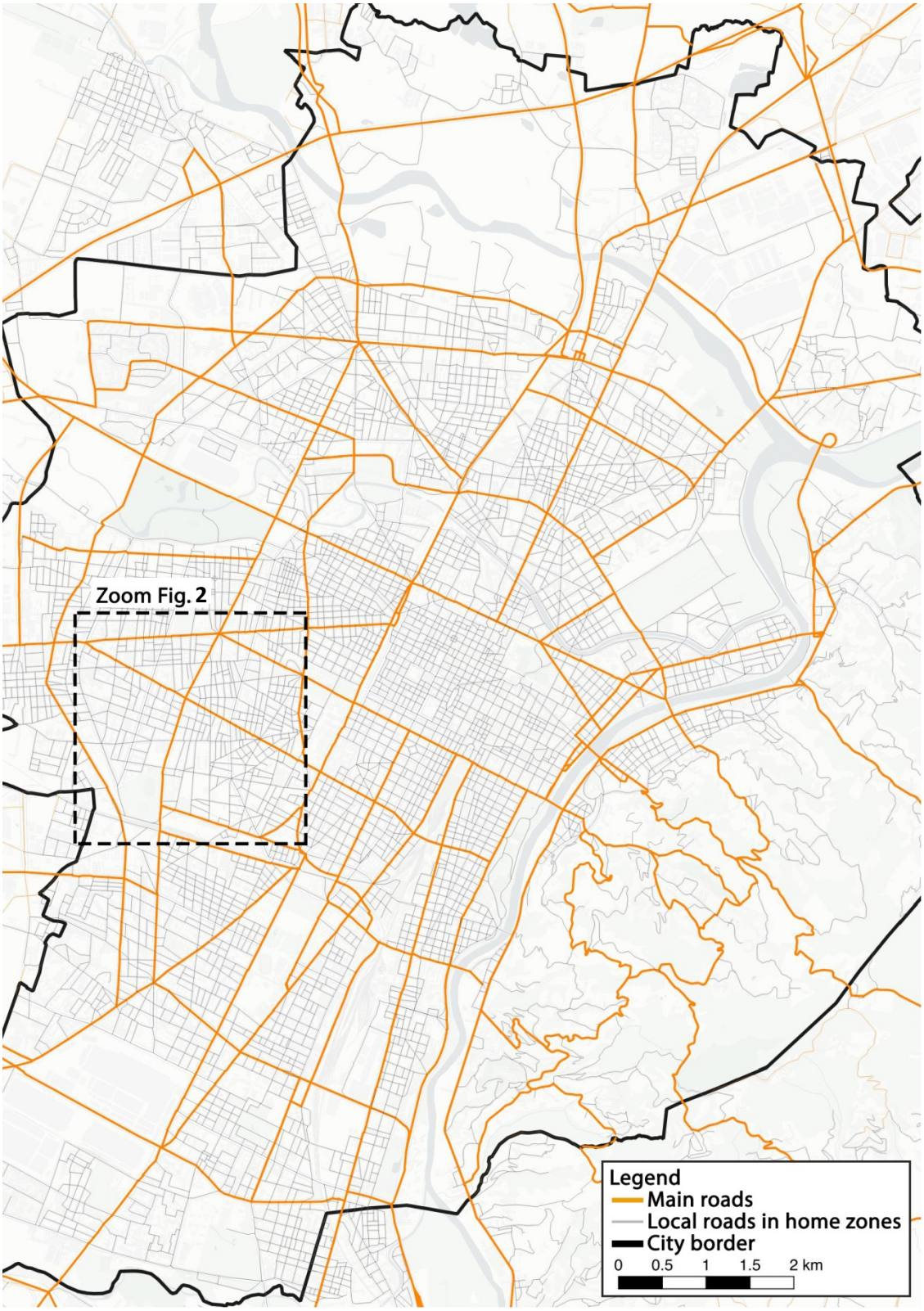

Fig. 1 Road hierarchy in the "Strong regulation" vision

As regards public transport, the service is concentrated on the main network and underground. Trams and streetcars run on reserved lanes on all the thoroughfares of the main network; the metro and the metropolitan

railway service are provided at high frequency. Inside superblocks no public transport service is provided, except in the larger ones, where autonomous shuttles circulate to feed the main lines.
The supply of car and bike-sharing services is spread throughout the city. Cycle paths are provided on the whole main road network, and cyclists are allowed to freely ride on local roads inside superblocks. Within each superblock, the road space is organised as a shared space having walking priority.
As a consequence of these regulations, the modal split is assumed to result in a significant increase in all alternative modes to private AVs; the latter would be strongly hindered, while car sharing services would be boosted. The share of public transport and bikes would slightly increase, and walking would grow thanks to the shared spaces in the home zones.

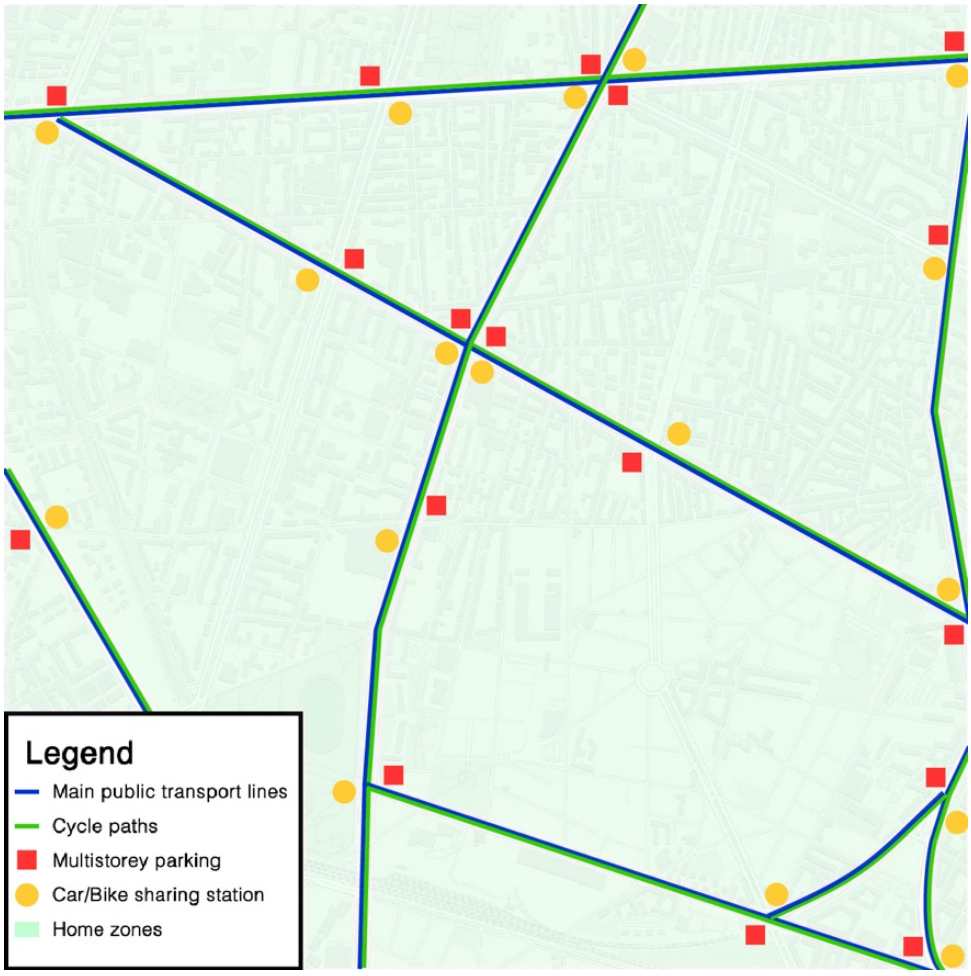

Fig. 2 Public transport, cycling, sharing stations and parking along the network of the main roads in the "Strong regulation" vision (zoomed-in view of figure 1). Each mesh of this network is a superblock

3.4 The definition of the pathway

Once the vision for Turin in 2050 had been chosen, a second phase of the backcasting process was aimed at defining milestones and actions to pursue it along the 30-year timeline. Again, think-tank and participatory methods were combined to frame the actions and organize them in policy packages.
As mentioned in paragraph 3.2 (note 4), in the phase of selection of the vision, 62 stakeholders were interviewed with semi-structured interviews, so to collect their points of view on the diffusion of AVs and the three visions.
During the interviews, participants were asked to identify and suggest possible measures to pursue the most desirable vision. First, a list of 18 measures was set by the research team, combining and clustering the measures emerged during interviews and questionnaires. Thereafter, a workshop was organized, in which 8

stakeholders[7] – split into two groups – were invited to discuss this list, add new actions if needed, and distribute all the measures along the timeline from 2020 to 2050. The two groups were facilitated by members of the research team, who provided support when needed but did not steer the discussion, so to leave the floor to the participants. The mobility and socioeconomic scenarios set at the regional level to 2050 by the Regional Transport Plan of Piedmont Region[8] were assumed as a reference framework. The participants were chosen so to represent different stakeholders' views on AVs (automotive companies, providers of ICT and mobility services, research centres, public administrations, environmentalist, professional or citizens' associations). During the workshop, questions and discussions were raised by the participants, especially about overarching measures and conditions and on the need to further detail some of the 18 actions, splitting them into sub-categories and setting them at different points in the timeline. Overall, around 45 elements were set on the timelines, including overarching measures, actions and sub-actions.

Finally, the research team reviewed the results of the workshop and further integrated them based on inputs from the scientific literature. As a final result, 33 key actions were streamlined and distributed along the timeline[9] (Fig.3). For the sake of clarity, actions were referred to six clusters summarizing the fourteen items that, as mentioned above, were used to frame the vision (Tab.1). Actions were specified in terms of type (articulated in three main categories – policy, technology, physical transformation of the urban space), main public or private actors in charge of implementation, and decade of implementation.

The SUMP was assumed as the key planning tool to pack the main actions towards the vision. As already mentioned, in 2020 the city of Turin will deliver its new SUMP, which will be valid for ten years. Hence, the three SUMPs that the city of Turin will develop in 2020, 2030 and 2040 were set as milestones in the timeline, and all the actions were related to one of these plans.

The SUMP 2020-2030 was envisaged to start setting up the city for the upcoming changes and to test the technology. In this decade, the road network is organized in the two levels – main and local roads, so to delimit the superblocks and set them as 30 km/h zones. Parking space is reduced inside the superblocks, and the space that is freed up is redesigned with light, low-cost temporary interventions, so to reclaim public space for pedestrians. The public transport services and the cycle network are reorganized, the main lines of the public transport and cycling network are concentrated on main roads. Preliminary tests of AVs are conducted in few target areas, and the main road network is provided with technological V2I (Vehicle-to-infrastructure) connection infrastructure. In the following decade (SUMP 2030-2040) autonomous public transport services and shared AVs are allowed to circulate on the main network. On-road parking space is reduced, especially inside the superblocks, and new multi-storey parking facilities are located on the main network. Temporary interventions to reclaim public space for pedestrians are progressively extended and replaced by permanent interventions. The provision of the V2I connection infrastructure is progressively extended also to the inner roads of the superblocks. In the third decade (SUMP 2040-2050) the superblocks are converted in restricted traffic areas. Only shared vehicles and residents' private ones are allowed to circulate and cut-through traffic is completely prohibited. On-road parking is completely removed and public spaces inside the superblocks are structurally redesigned to prioritize active mobility.

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7 The 8 experts who participated to the backcasting focus group were selected among the 69 who were involved in the previous phases, according to their experiences (to have expert representatives from the mentioned categories) and their willingness to be further involved in the project.

8 The main mobility targets to 2050 set by the regional plan are: zero fatalities due to road traffic accidents; public transport offer serving 100 per cent of the potential demand; no consumption of fossil fuels. Regarding the modal split, private motorised transport should decrease from 63% in 2011 to 31% in 2050, whereas public transport, cycling and walking should increase respectively from 20% to 36%, from 3% to 17% and from 14% to 16%. The socioeconomic scenario to 2050 describes a society that is highly differentiated in terms of lifestyles, an economy focused on innovation and in particular on the use of big data, an environment that has overcome the dependence on fossil fuels, a territory whose peculiarities are given value through a place-based policy approach.

9 For more details about the policy packaging process, see Vitale Brovarone et al. (2020-forthcoming).

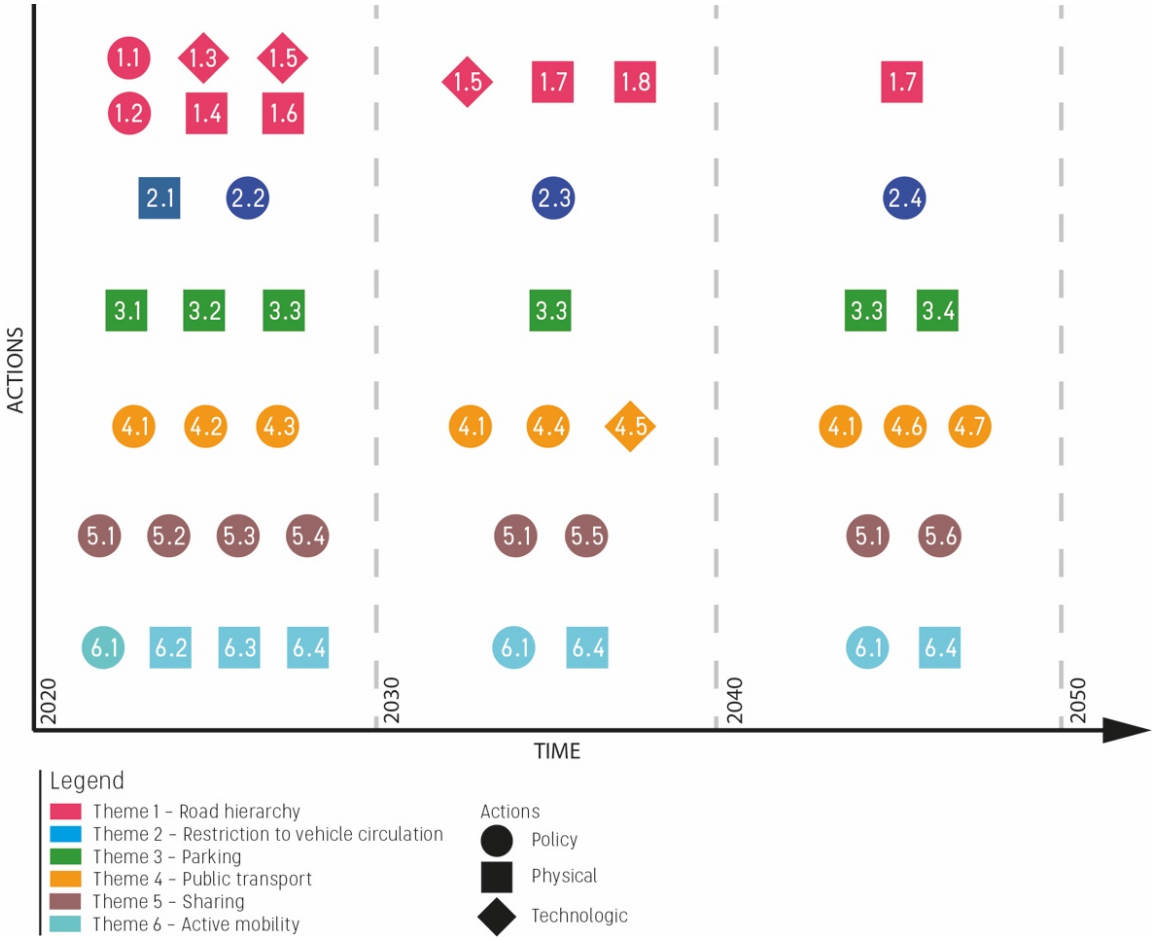

Fig. 3 Distribution of the policy packages on the time-line

	Theme 1 – Road hierarchy
1.1	Classify the roads (main roads, local roads) and identify the main thoroughfare networks and the superblocks
1.2	Identify target areas (including main and local roads) to promote AV tests in real urban environment
1.3	Provide test areas with the technological infrastructure for connection (V2I)
1.4	Ensure road maintenance of test areas to ease the circulation of Avs
1.5	Provide main roads with V2I connection infrastructure
1.6	Ensure maintenance of the main road network to ease the circulation of Avs
1.7	Provide local roads with V2I connection infrastructure
1.8	Ensure maintenance of the local road network to ease the circulation of Avs
	Theme 2 – Restriction to vehicle circulation
2.1	Design superblocks as 30 km/h zones through traffic calming elements
2.2	Enhance limitations to private car traffic in the central restricted traffic zone
2.3	Ban private cars from the central restricted traffic zone
2.4	Transform superblocks in restricted traffic zones where circulation of private cars is prohibited
	Theme 3 – Parking
3.1	Reduce parking space for private cars and increase parking lots for shared vehicles
3.2	Develop new park&ride facilities

3.3	Build multi-storey parking structures along the main road network
3.4	Eliminate everywhere on-street parking
	Theme 4 – Public transport
4.1	Promote the use of public transport (incentives, communication campaigns, etc.)
4.2	Reorganise the public transport network (trams on main roads, buses on local roads)
4.3	Promote automation tests on public transport means along the main road network
4.4	Boost autonomous trams along the main road network
4.5	Integrate local public transport and car sharing in a MaaS system on the main road network
4.6	Remove bus lines inside the superblocks and provide small autonomous shuttles in larger superblocks
4.7	Integrate public transport in a MaaS system on the whole road network
	Theme 5 – Sharing
5.1	Promote the use of sharing services (incentives, communication campaigns, etc.)
5.2	Enhance sharing services (fleet, spatial coverage, etc.)
5.3	Support the renewal of the car sharing fleet with new ADAS
5.4	Promote automation tests on car sharing along the main road network
5.5	Boost shared AVs along the main road network
5.6	Integrate sharing facilities in a MaaS system on the local road network
	Theme 6 – Active mobility
6.1	Promote active mobility (incentives, communication campaigns, etc.)
6.2	Develop a cycling network on the whole main road network
6.3	Expand and improve pedestrian paths and areas
6.4	Improve liveability and quality of public space in local roads

Tab.1 List of the 33 actions subdivided for policy packages

4. Challenges and critical issues of backcasting AVs

This backcasting process is one of the first applications of the backcasting method to the transition to AVs, and to the authors' knowledge the first application in a real-world context. A set of critical questions, challenges and methodological issues emerged. This section aims to reflect on such key issues and on possible ways forward, to support further backcasting studies for planning the transition to autonomous driving.

4.1 Factors and levels of uncertainty

As explained in section 2, backcasting is considered as a suitable tool to deal with problems that display high levels of uncertainty and complexity. Still, in the case of the transition to AVs these levels are so relevant to significantly challenge the effectiveness and implementability of the backcasting approach.

A first factor of uncertainty concerns the technological evolution of AVs. Full automation of driving will be the result of a number of key enabling technologies (radars, sensors, in-vehicle embedded computer units, V2X communication technologies and so on), some of which are currently competing with each other, and it is far from clear how fully autonomous vehicles will actually work (in particular, how much they will depend on communication with other vehicles and the infrastructure) (Medina et al., 2017). This is particularly true for public transport, which could evolve toward more flexible systems completely different from the existing ones (for example, through the connection of individual modules to form platoons on the road; Nguyen et al., 2019).

A second element of uncertainty is the time horizon of the transition to autonomous driving. Indeed, fully autonomous vehicles are the ones that can generate the epoch-making changes in mobility patterns, but as

anticipated in section 1, there is so far little consensus among scholars, automotive manufacturers and public authorities on when they will be ready to circulate on real-world roads (Bazilinskyy et al., 2019). This complicates the definition of the visions and the transition pathways, which depend on when cars with different SAE levels of automation will be introduced in the market. Moreover, the renewal of the vehicle fleet will take several years, and in the transition phase, the co-existence of AVs and human-driven cars would raise some conflicts that are being explored by some scholars but remain to a large extent uncertain and difficult to foresee (Fraedrich et al., 2015; Parkin et al., 2018).

Deep uncertainty also surrounds the effects of other potential innovations in the transport sector. Some of these innovations are already appearing on the market, such as smart micro-mobility solutions that are progressively flooding the roads of many cities (Chang et al., 2019; Maiti et al., 2019; Mathew & Bullock, 2019; McKenzie, 2019). Others, such as urban air mobility, may have a disruptive effect on urban mobility, yet the diffusion of this technology in urban skies is surrounded by several elements of uncertainty (Thipphavong et al., 2018).

Finally, the emergence of new disruptive business models and new mobility paradigms, such as sharing and Maas, may produce massive changes, which are to a large extent uncertain, and could even question the distinction between private and public, collective and individual mobility in the future (Mulley, 2017; Sheller & Urry, 2006, 2016).

During the backcasting exercise, the involved stakeholders often highlighted how all these factors of incertitude make it rather complex to define an acceptable and shared vision, as well as the policy pathway to achieve this vision. In this sense, the combination of the think-tank method and the participatory method proved to be positive: a pre-definition of the visions by the research team reduced the degrees of complexity the stakeholders had to face in the process (albeit at risk of reducing the disruptive potential of these visions).

4.2 The contextualization of the vision

Beyond the above-mentioned factors of uncertainty, other issues make the backcasting process complex. In fact, the vision of AVs circulating in Turin in 2050 is part of a broader framework that comprises further elements, including: the distribution of land uses, hence of generators and attractors of mobility; the availability of vacant spaces, i.e. where to locate parking facilities along the main road network, at the boundaries of the superblocks; the transition to electric mobility, when and how it will occur and how it will reshape the road space (e.g. charging infrastructures); the demographic and societal trends (ageing, depopulation of core cities and growth of metropolitan belts, etc.) [10]; the evolution of the economic structure of the city.

All these factors, and many others, constitute the territorial, environmental and socioeconomic scenario in which the diffusion of AVs will take place. Indeed, these scenarios are in themselves complex to be elaborated over a 30-year time horizon, and even more complex if their interrelations with the evolution of mobility systems due to the transition to AVs are taken into account. In this respect, it is probably appropriate to refer to existing scenarios that have already been elaborated and validated on other occasions. In the present research, the socioeconomic scenario defined at the regional level for the transport plan by Piedmont Region was assumed as the reference framework. This scenario has its limitations but was adopted as-is both for simplifying the backcasting process and for facilitating the development of a policy pathway in Turin which would be consistent with the measures defined in the regional transport plan. This approach was positively assessed by the focus group participants in the second phase of the backcasting process, as it allowed them to integrate the specific measures for AVs into a more general set of measures for governing regional mobility toward 2050.

[10] For a comprehensive review of the public and social attitudes that will influence the transition to AVs, see Cohen et al. (2020).

Therefore, the availability of a socioeconomic reference scenario could be considered a critical pre-condition that should be verified when planning backcasting processes, as it simplifies their development.

4.3 The involvement of relevant stakeholders

As anticipated in section 2, a shift to a more collaborative and participatory approach to backcasting is called for in the scientific literature. This expectation can be extended to the transition to AVs: its inherent high levels of uncertainty and complexity suggest to broaden the range of stakeholders to be involved in the backcasting process. A wide and varied representation of stakeholders would allow to address the different possible respects, and the participatory process facilitates the integration and exchange of knowledge. In addition, the different perspectives and roles in the definition of the vision and of the pathways to pursue it can be put together and possible conflicts or criticalities can be identified.

Willingness to be involved in participatory processes cannot be taken for granted. Not all the cultural contexts show the same enthusiasm in participation processes, due to administrative traditions, institutional factors, national cultures but also subjective factors such as personal perceptions, beliefs, norms and values, or previous experiences in similar processes (Enserink et al., 2007; Huxley et al., 2016; Wassenhoven, 2008). Thus, participation in workshops, focus groups, living labs, etc. can be quite weak in some contexts. As the backcasting experience presented in this article has shown, engaging stakeholders can be very challenging. And in the case of this project, the most reluctant actor to participate turned out to be the public administration, that on the one hand was supposed to be the recipient of policy pathways and the main actor at stake; on the other hand, it proved to conceive the transition to AVs as a problem too far away to deserve real attention at the moment.

Moreover, general knowledge on the topic can be a critical factor for the involvement of stakeholders. The project expressly targeted expert stakeholders in the mobility field, while no in-depth knowledge on AVs was required, in order to avoid narrowing the sample too much. Notwithstanding, scarce knowledge of the subject by some of the participants raised some criticalities. In this respect, the involvement of private citizens turned out to be very difficult, as general knowledge on AVs is very low, and engaging a limited number of private citizens would have raised some issues of representativeness. To address this criticality, citizens' associations involved in the process were considered as representatives of private citizens' views.

Integrating different participatory techniques, as suggested by Soria-Lara & Banister (2018a), proved to be a solution to partially remedy this criticality. In this backcasting process, brainstorming, focus groups, workshops, semi-structured interviews, questionnaires were combined and offered the possibility to deepen, combine and exchange stakeholders' perspectives and knowledge.

4.4 The definition of the policy pathway

Despite a predefined list of actions was proposed to the two groups of participants in the second workshop, the pathways they proposed turned out to be quite different (Fig.4). Two members of the research team moderated the work of each group, but the outcomes differed in terms of rationale, number and priority of the actions, etc.. Hence, concerns arose about the relevance and reliability of the two pathways, and about the significance of the participatory backcasting process in itself.

A remedy could be increasing the number of participants and multiplying the focus and working groups, so to enhance the representativeness, reliability and relevance of the outcomes. Nevertheless, the low attendance rates and difficulties in stakeholder involvement mentioned in the previous paragraph raise some doubts on the feasibility of such a process, and on its cost/benefit ratio.

As a consequence, the definition of the policy pathway was not an easy task. In this sense, the combination of the collaborative approach with the expert-led predefinition of the vision and definition of the policy pathway

seems appropriate. In fact, the integration of elements emerged in the literature review, in the interviews and during the focus groups helped to define the pathway and strengthen its relevance.

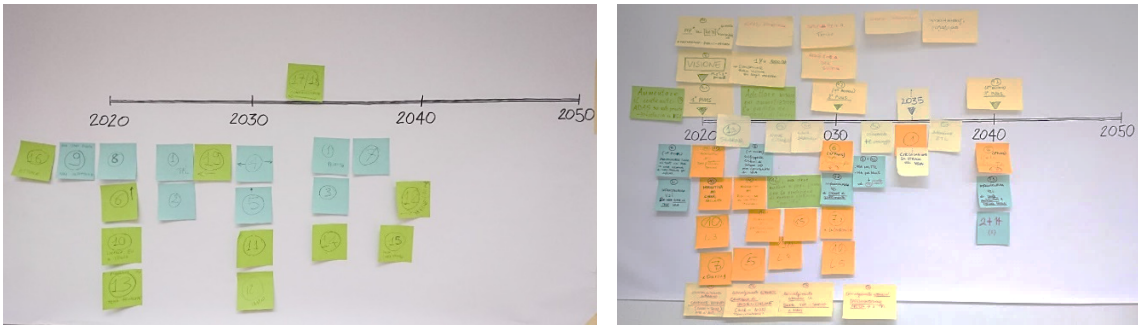

Fig. 4 The pathways proposed by the two groups during the backcasting focus group

The allocation of the proposed measures on the timeline turned out to be quite complex for the workshop participants; familiarity with long-term reasoning through concrete actions cannot be taken for granted, and the high level of uncertainty did not help. Most of the actions were set in the first decade of the timeline; this can be an expression of the difficulty of dealing with long-term horizons, but also of the fact that many actions must be taken now to pave the way for the desired vision. The choice to refer the packages of actions to SUMPs, which is valid for 10 years, can facilitate the scheduling of the actions and allow to verify the internal consistency of the packages of measures, as well as their integration with the other general measures proposed by the SUMPs. Moreover, it allows for a certain degree of time-framing flexibility, as the measures envisaged for the second and third decades in SUMP 20430-2040 and 2040-2050 can be revised on the basis of the results achieved in the first ten years.

As mentioned in Section 2, backcasting sometimes includes a third phase appraisal (after visioning and policy packaging) for assessing the feasibility and barriers of the proposed policy pathway (Soria-Lara & Banister, 2018b). The backcasting process described in this paper involved a wide range of experts, which at least partially allowed to preliminary verify the robustness, consistency and feasibility of the measures included in the pathway. However, a more quantitative appraisal of the pathway could be useful to assess the effectiveness of the measures (for example in terms of modal diversion, multi-storey parking structures that are needed to eliminate on road parking etc.) and their efficiency (with relation to costs of operating the reorganized public transport lines and sharing services, of building the parking structures etc.). In this way, it could help identify if proposed measures (and related scheduling) have to be rethought, or alternative measures are needed.

5. Conclusion

The transition to AVs is expected to have a disruptive impact on the urban environment, and urban planning and policies are increasingly called for addressing this challenge already in the short and medium-term. At the same time, the uncertainty and complexity of this transition make it difficult for public administrations to introduce the issue of AVs in their planning processes. Backcasting is often reported in the scientific literature as an appropriate technique for scenario building on AVs, but very few applications have been implemented so far.

This article discussed a participatory backcasting exercise for defining a vision and a policy pathway to steer the transition to AVs towards the liveability of cities and neighbourhoods. The backcasting was applied to a real-world context, the city of Turin, in Italy. To the authors' knowledge, very few similar researches have been published previously. Hence, this paper aimed to contribute to fill a gap in the literature, and support further research on the subject.

One single exercise is not sufficient to explore all the crucial issues of the application of backcasting to AVs, nor its multifaceted aspects. The backcasting process that was discussed in this paper explored how AVs could be integrated into the mobility system of the city while preserving the liveability and quality of roads and public spaces. The process raised some criticalities and showed solutions to address them were found. While the visioning and the policy-packaging phase of the backcasting were described elsewhere (Staricco et al., 2019; Vitale Brovarone et al., 2020-forthcoming), this article presented the whole process and its criticalities.

The transition to AVs displays very high levels of uncertainty and complexity, which are related, among other factors, to the different possible technological evolutions of AVs, the time horizon of the transition, other potentially disruptive innovations in the transport sector, the emergence of new business models and mobility paradigms. In the case presented in this article, these elements proved to challenge the effectiveness and the potentialities of implementation of the backcasting approach.

In the face of high levels of uncertainty, referring to socioeconomic scenarios that have already been developed for other local plans or policies allowed to simplify the backcasting process, as the elaboration of these scenarios is a further element of complexity. Moreover, it facilitates the integration of the specific policy pathway for AVs into a more general set of measures for the whole mobility system.

The involvement of a wide range of stakeholders in the backcasting process is essential to take full account – through their different perspectives and roles – of the complexity of the transition to AVs in the vision and policy pathways, as well as to reduce the implementation gap. Engaging stakeholders can be difficult: some countries are less keen than others on active involvement in participatory processes; moreover, AVs are often seen – in particular by public administrations – as something that has yet to come, premature to be considered. In our case, the combination of a range of participatory techniques – brainstorming, focus groups, workshops, semi-structured interviews, questionnaires – proved important to broaden the number and type of involved stakeholders.

At the same time, precisely because of the uncertainty and complexity of the problem, the outputs of these participatory phases can be partial, biased, controversial or even contradictory. In the backcasting presented in this paper, the integration of participatory and think-tank techniques allowed to review, enrich and systematize the outputs provided by the stakeholders, particularly in the definition phase of the policy pathway.

Finally, a long time frame makes it difficult for most stakeholders to allocate the proposed actions along the timeline. The reference to mid-term planning tools, such as the 10-year long SUMPs, can be an effective way to organize the pathways into policy packages that are consistent both internally and with the more general mobility strategies.

The application of backcasting on AVs in a real-world case study in Turin and the analysis of its critical issues can support further researches. This research contributed to improve knowledge on the potentialities and constraints of using backcasting to define policy pathways to steer the diffusion of AVs towards a desired vision. Applications in other real-world contexts will confirm to what extent the issues presented in this article can be generalized and provide further insights.

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Image Sources

Fig. 1: authors' own elaboration

Fig. 2: authors' own elaboration

Fig. 3: authors' own elaboration

Fig. 4: authors' own elaboration

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Building strategic scenarios during Covid-19 lockdown

Insights from a university-class remote simulation

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Abstract
Since early spring 2020, the outbreak of the Covid-19 in Italy caused schools and universities to lock and shift from traditional face-to-face classroom education to online education. In the academic field of spatial planning, online education and examples of on-line participatory process (e.g. e-planning, e-governance, etc.) are traditionally not very frequent. Through the application of an on-line participatory process to build a future vision of Bari (Apulia Region), this study explores elements related to the behavior of the knowledge agents involved in the process and compares them with the application of previous face-to-face classroom examples. The results obtained allow to collect some suggestions not only on the performance of the application in two different times, but also on the potential elements of difference to be associated to the temporal and psychological context related to the diffusion of Covid-19. Since these conditions are clearly exceptional and practically (hopefully) unrepeatable, the results seem to show a mixed perspective of effectiveness for the use of online education to build a future vision of a city.

Keywords
Covid-19; Knowledge exchange models; Participatory process; Multiagent visioning; Urban planning

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1. Introduction

Since early spring 2020, the lock down of schools and universities have changed teaching methods in 61 countries around the world, due to the spreading of Covid-19. It has been a shift from traditional face-to-face classroom education to online education (UNESCO, 2020). Suddenly, millions of faculty members on the one hand, and corresponding students on the other, have been using the internet as the only possible tool for teaching interaction (Bao, 2020).

Although teaching interaction is a highly researched approach, whose benefits are increased access to information and improved quality of learning (Subhashni, 2008), the assessment of the adaptability to online education is still poorly researched in extreme events such as a pandemic context.

Also in Italy, according to government decrees (starting from D.P.C.M. dated March 9, 2020), regarding measures to reduce the epidemiological emergency from Covid-19, the universities have started the online education method through different platforms (e.g. MSTeams, Zoom, Classmill, Socloo, Weschool, Webex, GMeet, etc.).

In the study course of Spatial planning and engineering, as a part of the master's degree in civil engineering of the Polytechnic University of Bari, the Microsoft (MS) Teams platform has been used to carry out lessons, exercises and exams. Specifically, simulation exercises were carried out in planning and decision-making fields. The present study aims to explore evidences concerning agents' behaviour starting from an exercise based on a decision-making process simulation to define possible future visions of Bari (Italy). Two different contexts were analysed: simulation performed in presence (face-to-face classroom) and online simulation performed through MS Teams platform. The research question focuses on the analysis of the performance of the methodology through a comparison between two decision making process simulations, i.e., face-to-face and online conditions.

Historically (since the early strategic planning debates, in the days of the Tavistock Institute of Human Relations in the 1960s), the strategy-building process has always played an important and fascinating role. That historical context had already changed the classic command-and-control strategic principle, which was authoritarian, prescriptive, top-down and inspired by millenary and military memory. John Friend (1969) had contributed to replacing it with a constructive, more inclusive and bottom-up perspective, often drawing on grassroots movements, which were lacking in authority and rather inclined to found planning efforts on involvement, collaboration, dialogue, cognitive interaction. The liveliness of the debate then oriented this plurilogic democracy towards pathways of structural knowledge of problems and dynamic construction of strategies, looking at the so-called futures studies (Ringland, 1998). In this context, a recent interest in the cooperative construction of future scenarios has developed, with the aim of grounding the construction of future strategies on the involvement of diffuse (especially non-expert, common, experiential) multi-agent knowledge (Jungk & Mullert, 1996). Yet these experiences, wherever they took place, however they developed, inevitably proved to be linked to the complexity of the organizational and behavioural contexts from which they intended to draw cognitive advantages and strategic efficacy. Situational contingencies have in fact often played a crucial role in these scenario arenas, where the differentiated interest of the participants can become a scarce or inconstant participation in the process, affecting the quantity and quality of the cognitive contents collected and built up. However, information imbalances or distortions of power can still influence these contents and even determine reluctance to participate, in part or in the whole process. Finally, poorly prepared interactive environments can cause difficulties in empathy and expressive creativity on agents, thus misleading interpretations and constructing delegitimized scenarios. Hence, the remote, online technological potentials of scenario-building processes have opened up prospects of almost naturally overcoming these obstacles posed by real participatory arenas.

The exercise is based on the decision-making process building aimed to define future visions for the city, according to the Future Workshop model (Jungk & Mullert, 1996). The Future Workshop model used not only

in spatial planning to involve citizens in the planning process, but also in all sectors where it is needed to address a complex problem through the involvement of stakeholders, rather than simply being subject to the decision of experts. As part of the decision-making process, interests are discussed and developed. Creativity, organization, awareness, imagination and competence of action emerge through the collaboration of stakeholders in two main phases: imagination and action-oriented design (Jungk & Mullert, 1996).
The decision-making process was composed by four phases and five steps of activities. The construction of the simulation of participation in a hypothetical plan refers to the methodology for building future visions developed by Khakee et al. (2000).
The exercise is followed by the support of a knowledge engineer (the lecturer) who plays the role of facilitator in order to support students in a coherent development of the whole process.
The discussion considers the different temporal and 'psychological' context related to the lockdown condition. It highlights some aspects of the same simulation methodology carried out in different ways. Five criteria to highlight the differences were identified, namely (i) contents that emerged, (ii) depth of the arguments that emerged, (iii) different composition of the students' profiles, (iv) the number of students taking part in the simulation; (v) influences of individual contribution related to the context (vi) final discussion - considerations by the knowledge engineer.
Therefore, the results obtained allow to raise some suggestions not only on the performance of the methodology, but also on the potential items of difference to be associated to the temporal and 'psychological' context related to the lockdown.
After this introduction the document outlines the context in which the exercise was carried out (section 2); section three presents the case study and the methodology adopted; section four shows the results; section five illustrates the discussion. Final remarks close the paper.

2. Building a city vision during Covid-19: shifting from face-to-face classes to on-line classes

Visioning or future-vision building process was used in the field of urban planning particularly during the 1980s and 1990s, in order to collect different images of the future of the city according to desires of people involved, and draw out possible strategies (Shipley, 2002).
Therefore, the results of future-vision building process is not a goal but a starting point for a constructive dialogue about the future of the city (Ortegon-Sanchez & Tyler, 2016).
To elicit the rationale or theory behind the building of visions, different approaches exist (see a review by Shipley, 2002). A common consideration in different approaches concerns the reflection phase. The context in which the moment of reflection takes place for the building process becomes therefore fundamental.
For this reason, in the present study, reflections phases will be dealt with in the light of the temporal and emotional context in which the process of building future visions of the city of Bari was carried out.
In fact, in recent months, due to the pandemic declared by OMS on March 11, 2020, there has been a shift from traditional face-to-face classroom education training to online education (UNESCO, 2020). Online teaching is not a new way of teaching. It is an approach tested by many universities that induces benefits and limitations (see e.g. Appanna, 2008). Although there are therefore studies related to online teaching under ordinary conditions, studies in risky (pandemic) conditions are still few and far between. The shift to the online mode in this historical moment has raised several doubts about the ability of lecturers and students about teaching using existing technologies. Doubts are on the actual availability of faculties and students to have the proper tools to carry out teaching, the emotional involvement creating a sense of uncertainty, the anxiety about the future with a consequent stress. Think, for example, of commuting and non-resident students concerned not only about their health, safety and education, but also about the welfare of their families (Basilaia & Kvavadze, 2020; Bao, 2020, Sahu, 2020).

The quality of online education is a critical issue that requires adequate discussion and is far from the objectives of this paper. Rather, this study aims to highlight evidences emerging through the comparison of a methodology applied in two different contexts, in the definition of a decision-making process for the construction of future scenarios of the city of Bari. Although the effects of Covid-19 in spatial planning are beginning to be studied (Honey-Rosés et al. 2020; Lee et al., 2020), examples of remote participation (e.g., e-planning, e-governance etc.)[1] are traditionally not very frequent and their slow experimentation can benefit from situations carried out in unforeseen or extreme conditions.

3. Case study and methodology applied

The present section discusses an experimental methodology applied in the case study of Bari. The methodology applied follows an approach largely put down by Kahkee (2000). It can be subdivided into four phases and six steps of activities (Fig.1).

During the first phase the framework of the process is shared with students, whereas in the second phase, identification and clarification of the issues are defined. The third phase is composed by two activity steps: (i) free idea generation, desires, dreams, fantasies regarding the vision of the future and (ii) the potential limitations to developing the vision of future. Finally, the implementation phases allow to develop the potential ways and resources to overcome previous limitations. The methodology was applied in face-to-face classroom context and online context.

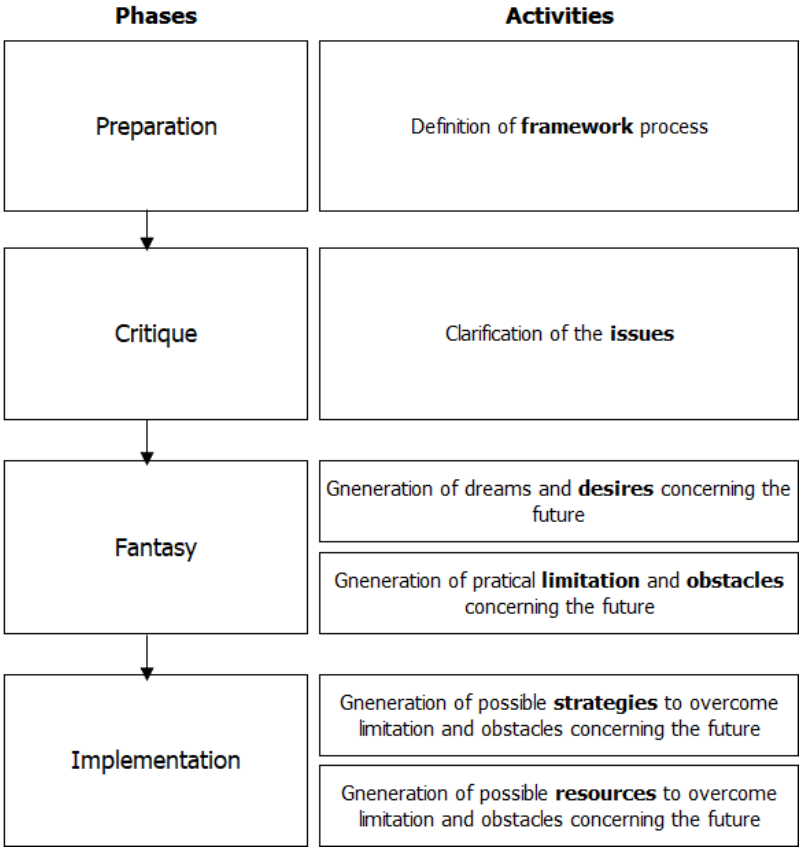

Fig.1 Framework of decision-making process applied during face-to-face, in-class simulation and online, remote simulation (adapted by Kahkee, 2000)

[1] https://www.opengovpartnership.org/collecting-open-government-approaches-to-covid-19/; https://ec.europa.eu/digital-single-market/en/news/covid-19-how-egovernment-and-trust-services-can-help-citizens-and-businesses; https://www.un.org/development/desa/dpad/publication/un-desa-policy-brief-61-covid-19-embracing-digital-government-during-the-pandemic-and-beyond/

3.1 Face-to-face, in-class condition

This type of exercise took place over several subsequent years among the activities scheduled for the Spatial planning and engineering course at the Polytechnic university of Bari, each year involving about 100 students, aged about 25-30. As said, the context is the definition of a decision-making process for the construction of future scenarios of the city of Bari. The exercise was always carried out 'in presence', in the classroom, during the laboratory hours of the course. The simulation model of participation in a planning process is the Visioning model described in the previous section.

The practical development of the exercise has been held in the classroom, with the presence of the lecturer (in a role changing over time, from knowledge engineer, to moderator, to lecturer), the collaborators with a role of functional support for the performance of the exercise itself, and the group of students who were present during the lab hours. These participants have never been the totality of students enrolled in the course, often absent for various contingent reasons - as also occurring in the operational reality of these social-based processes.

A first phase has been the description of the participation model of the exercise to students (preparation). This was followed by the actual exercise phase in the distinct phases of critique, fantasy, implementation (Fig.1). The materials used to carry out the participatory process simulation were mainly sheets of white cardboard in UNI A1 format, coloured marking-pens and sticky notes.

The sheets of white cardboard have been used as posters with the relative titles and were prepared to identify (spatially) ideal message boards (and moments) related to each phase of the simulated participatory process.

The coloured marking-pens have identified with different colours the different phases of the knowledge-exchanging process: they were used to write the title of each message board and to trace the ideal connections and unions between the contributions left on every message board for each phase by every single student.

The sticky notes have been used to put down the contributions offered individually by each student.

Each message board received the corresponding phase "crowding" of sticky notes.

Once the theme concerning the simulation of the participation process was made known - over the years, a simulated process supporting a planning (also strategic) activity concerning the city of Bari has always been chosen - the students expressed themselves in alternative steps on critique, fantasy, implementation. For an accurate description of the methodological aspects of the model, numerous case studies can be examined in literature (e.g. Khakee et al., 2000, 2002; Celino & Concilio, 2010).

In this case study, the description of the process is reported only in a concise way, strictly oriented to the research purposes of this work.

The individual writing phases (organized with precise strict timing for each phase) were alternated by collective reading and discussion phases. During these phases, the sticky notes previously attached in random order on the cardboards/message board after the collective and shared reading were repositioned into homogeneous groups to elicit the recurring families of critical issues written by the students. After the fantasy phase, an attempt was made to elicit fantasy visions (i.e. free from the limits imposed by the awareness of possible critical issues) by organizing them in family groups. The discussion phase was crucial in this step to highlight which visions to pursue leading to the contribution phase of implementation. The sticky notes written for the last phase were collected by content, including planning strategies aimed at achieving the recognized visions achievable in a predetermined time horizon.

In the multi-year history of these classroom exercises, however, the process has typically stopped at the generation of visions or, more rarely, when singling out obstacles to visions themselves. The identification and implementation phases of the strategies (policy making and resource-finding) never appeared, due to the limited number of lab hours available. This limiting circumstance, however, even for different reasons, is typically also present in the operational reality of these processes, often contrasted by the extreme volatility of the time available to the participating agents in their multifaceted daily struggle for time. For this reason,

even the forcibly interrupted process in the classroom was always considered as a didactically valid reason for reflection.

3.2 Online condition

The exercise involved 130 students enrolled in the course study of Spatial planning and engineering of the Polytechnic University of Bari. The students aged 24 to 29 and most of them came from Bari metropolitan region as a whole - only a small part residing in Bari city or in other Apulian cities.
The analysed sample is characterized by 30 resident students of the city of Bari and 100 commuters, resident of neighbouring areas. The exercise was carried out through MS Teams online platform during the first week of April 2020, in the midst of the Italian lockdown period.
For each phase an online document was created through Google Modules, structured in (i) user profile, in which students were asked to indicate gender, age, city of origin, and a nickname for technical reasons, and (ii) the subject matter referred to the five steps of activities (Fig.1). For each phase, students were asked to express up to three concepts related to the topic, either in the form of a sentence or by synthesizing the concept using three words. Because of time constraints, each student had 30 minutes to fill in each form.
The phase in which the students filled in each form was introduced by an initial narration by the lecturer, as facilitator, in order to explain the purpose of each phase. There were moments of discussion to verify the elements that emerged between the different phases and a final moment of discussion to validate the elements globally emerged.

4. Results

This section describes the results deriving from the simulation of the construction of a decision-making process aimed at envisaging possible scenarios of intervention in the city of Bari, in the two ways described above.

4.1 Face to face classroom simulation

The exercise has been developed over the years with a didactic purpose that involved students in a sort of role-playing (participating in a participatory planning process), so that they could experience the participation as a support to a planning process, according to the model (previously described) proposed in theoretical form during the course.
The annual repetition of this exercise suggested implementing its description and the results obtained for research reflections to identify recurrences in the contents produced by students as agents, and in the general development of the exercise itself. This posed minimal re-organizations of the exercise for an experimental form and the problem of collecting and managing the contents that emerged. The results obtained have been not easy to manage as data, because of their difficult examination, and of the need to transcribe what emerged from the simulation into a digital supporting report.
The analogical support combined with the flow movement of an always crowded group of students merged with a passionate debate concerning the themes involved in the exercise itself has created an interesting phenomenon of sharing/exchanging ideas. It is useful to report here that during the exercise students could influence each other even in the individual stages of development of the contribution or when some participants left the arena before the conclusion of the works, causing variations in the outcome of the simulation.
Rather unexpectedly, as a consequence of an inscrutable event, the classic "black swan" emerged from the "deep unknown" (Rabino & Stufano Melone, 2020), so leading to the sudden closing of the universities. All interactions suddenly moved onto digital platforms for remote meetings from home. Lecture and lab materials

remained locked and physically inaccessible at University, and faculty and staff remained strangely detached from papers kept in university workrooms.
We can qualitatively describe results that emerged during the last face-to-face exercise, that we had last year, writing without the support of any of the materials produced during that previous simulation. Being a normally recurrent simulation, each year, texts, pictures and graphs belong to the volatile outcome of a didactical activity, carried out without thinking of improbable future research uses. So, we can describe briefly what we witnessed by heart, as Stefan Zweig did after he escaped in Brazil from the war and the Nazi dominion (Zweig, 1942). This difficulty is an integral part of the research reflection that we propose in this paper, in the comparison between the different methods of carrying out the exercises in face-to-face classroom simulation and online classroom simulation.
As can be read in the following section reporting the results emerged during the exercise developed via MS Teams platform, the topic discussed during the exercise has been the same (simulation of a planning process for Bari city), and some emerging issues are recurring, particularly concerning criticalities. This seems to show that in a biennial cycle, the perception of the city by a group homogeneous in age and interest has not changed much.
The critical issues in the case of the last face-to-face exercise focused on the difficulties in public transport, the ease of accessibility, street cleaning, sense of safety, lack of greenery.
The visions that emerged focused on a city completely connected by sustainable, reliable and widely distributed pedestrian and bicycle networks, a green city in which 'the gardens could sing' together with the sea, and people could move through the streets in complete safety.
The subsequent discussion phase identified the strategic lines to be implemented and the critical issues and obstacles that the realization of these visions would encounter in the impact with the obstacles of a possible reality. The principal obstacle was recognized as been mainly the lack of funds to enhance public transport, to set up and manage the gardens, to allow social peace that would mitigate certain widespread micro-crime, as well as to an effective reduction of the criminal phenomenon in the city.
The strategies that have been defined have focused on identifying possible urban plans that would be able to attract the funds necessary to initiate actions aimed at challenging critical issues and setting actions for policies that lead to the implementation of implementable visions.

4.2 Online simulation

As described in the previous section, each student had the possibility to define the topic through two ways: a sentence and a synthesis into three words. In order to reduce the analyst's margin of interpretation and to obtain a result in real time during the process, an analysis of the frequency of the words referred to each phase was carried out. The frequency of the words was used to identify the recurring issues that emerged from the students. It is evident that this operation is extremely reductive in real situations and therefore unrecommended, but it was considered acceptable in the didactic perspective in which the process itself took place.
In phase one, criticity, the most recurrent themes identified through the most frequent words refer to (i) mobility (traffic, lack of transport and lack of parking) and to (ii) the concept of usability of space (pollution, degradation, incivility, inefficiency of transport, lack of sense of security). In phase two, images of the future, the themes that emerged are linked to the concept of sustainability declined on (i) mobility and (ii) green spaces. The students expressed the desire to increase green areas in order to reduce environmental and social degradation and to reduce pollution together with the adoption of sustainable mobility.
At the end of these two phases, the analysis resulting from the frequency of the words was shared with the students. This participated moment allowed the shift from more frequent words to recurring themes. This phase allowed the construction of visions of the future for the city of Bari. Tab.1 shows the visions emerged:

Future visions
Bari, green and environmental sustainability city
Bari, city of efficient and reliable mobility
Bari, safe city
Bari, city that valorises the suburbs
Bari, city integrated with the sea
Bari, city of culture, research and university
Bari, city of socialization and public spaces

Tab.1 Future vision of the city able description

Based on the shared visions, students were asked to lead the next three steps of the process (Fig. 1).
The visions analysed by most of the students are: (i) Bari, green and environmental sustainability city, (ii) Bari, city of efficient and reliable mobility, (iii) Bari, safe city.
For a matter of simplicity, syntheses among *obstacles*, *strategies* and *resources* were made for each vision.

Bari, green and environmental sustainability city

Obstacles	Strategies	Resources
Citizenship attitude	Communication strategies to raise awareness of more sustainable actions	Human
Failure to manage green spaces strategies	Collaboration strategies between different types of stakeholders converging in common actions to regenerate existing green spaces	Human/financial
Lack of funding	Project writing to get funding	Human/financial

Tab.2 Obstacles, strategies and resources for Bari, green and environmental sustainability city vision

Bari, city of efficient and reliable mobility

Obstacles	Strategies	Resources
Citizenship attitude	Communication strategies to raise awareness of more sustainable actions	Human
Lack of funding	Increase funding to boost public transport and build more cycle paths by promoting sustainable mobility	Human/financial

Tab. 3 Obstacles, strategies and resources for *Bari, city of efficient and reliable mobility* vision

Bari, safe city

Obstacles	Strategies	Resources
Presence of criminality	Intensify supervision and narrow the cultural gap between citizenship	Human
Lack of public lighting	Increasing areas of the city without lighting that are gathering points for crime	Human/financial
Presence of degraded areas	Upgrading areas of the city with physical and social interventions	Human/financial

Tab. 4 Obstacles, strategies and resources for *Bari, safe city* vision

As shown in Tables 2, 3 and 4, for both visions, the main obstacles are related to human and financial resource management. Specifically, with reference to the vision *Bari green city and environmental sustainability*, the lack of human resources management refers to the lack of communication that makes citizens aware of the adoption of sustainable actions, to the lack of collaboration between institutions that favours strategies for the redevelopment of existing green areas and that allows the implementation of projects for the acquisition of funds. With reference to the vision *Bari city of efficient and reliable mobility,* the concept of lack of communication to raise awareness of sustainable mobility actions is repeated. The lack of funds also appears crucial in this vision. Increasing funding to boost public transport and building more cycle paths by promoting

sustainable mobility becomes the most cited policy by students. With reference to the latest vision, *Bari safe city.* the obstacles identified are related to the presence of crime, lack of lighting and the presence of degraded areas. In order to reduce these obstacles, students have proposed, on the one hand, policies of social transformation linked to the reduction of the cultural gap between citizens in order to reduce the percentage of young people who find refuge in crime and, on the other hand, policies of physical transformation of some areas of the city in order to increase its liveability and make it safer.

5. Discussion

The application of the methodology in two different contexts allows us to make some observations. On the one hand, there are suggestions strictly intrinsic to the nature of the two approaches, as also highlighted by the literature (Subhashni, 2008). On the other hand, they are suggestions related to the specific application.
The online simulation approach, compared to face-to-face classroom approach, shows several advantages. Concerning the analyst, they are related to the easiness of managing the information deriving from the construction of the process through a digital platform, the possibility of obtaining immediate and organized results, and of validating them in real time in a participatory way, as well as the creation of a secure database. Digitally collected data are less likely to be lost than sticky notes or billboards used in face-to-face classroom approach.
Moreover, this approach also shows suggestions for users, in this case for students. The associated advantage or disadvantage value cannot be attributed a priori because it is strictly dependent on the context and circumstances. For example, the little interaction between the different students could lead to a greater focusing for moments of reflection, but it could also represent a space without feedback, which limits reflection. The house, a place of constraint during lockdown, may not have represented a comfortable environment for everyone. The current contingency, moreover, may have generated an emotional peculiarity, not quantifiable and strictly subjective.
The contribution given by the two methodologies to the criteria defined above is summarized in Table 5.

	Contents	**Depth of the arguments**	**Students' profile**	**Students' involvement**	**Influences of individual contribution**	**Discussion**
Face to face classroom simulation	=	-	-	-	unknown	+
On line simulation	=	+	+	+	unknown	-

Tab. 5 Summary of results deriving from methodologies comparison

In terms of contents, the results from the two methodologies did not produce many differences. In fact, the issues that emerged in the online education can also be found in the face-to-face approach used during the past years. The possibility to write in a less limited space compared to post-it has left a greater freedom of expression that is reflected in long and argued contents. In the face to face classroom approach, for each student it is not possible to know the hometown but, considering the number of students involved, it is possible to assume that most of them come from Bari or from cities nearby. Instead, in the online approach is possible to track the hometown. The results show that a fair percentage of students is not residing in Bari. The easiness of interaction in the online approach may have helped to facilitate their participation.
Having produced concepts in a context without interaction has certainly reduced the contamination in the reflection. Therefore, every thought expressed is associated to the subjective sphere of the student. It was impossible to define whether this element may have enhanced or limited reflection. Furthermore, it is also

possible that the students may have had a parallel communication with the analyst. In this case, the contamination in the reflection occurred, and the thinking is the result of this exchange of information.
The validation of the phases and the concluding debate found greater participation in the face-to-face classroom simulation.
During the face-to-face sessions, there was always the chance to perceive the level of involvement that students were living right at that moment. Surely, the moments when every student had to put their sticky notes on the different billboards have been crowded, noisy, but the experience of a collective simulation has been something of plenty lived by participants and something not far away from similar real-world arenas (at least as they usually had taken place). The debate has been always passionate, and the attention has been high, probably the curiosity about the carrying out of the process and about the outcomes that would be reached, a subtle line of thrilling about this was palpable. The debate phases were discussed as if the participatory process could have been an effective result.
Previously it has been explained how issues and topics during online and face-to-face sessions were basically the same. Concerning the contents, it could be useful to highlight here that students reacted to questions with a mind still focused on issues and topics concerning a pre-Covid city. Probably, when the exercise was held, the consciousness of a different future asset for social practices was still not perceived (or refused). The pandemic has been a too rapid event to be immediately elaborated not only as an episode but as something that potentially was going to change many assets.

6. Conclusion

The relevance of the present research stems from a rather unique, although socially terrible, opportunity of comparing two interactive knowledge-building approaches in planning-oriented decision-support processes. The lockdown period induced in Italy by the virus emergency allowed the setting up of IT-based remote experimentations suitable to be compared with similar non-remote experimentations previously held. In particular, the previous traditional face-to-face experimentation carried out within the mentioned university course of Spatial planning and engineering largely showed the typical outcomes, potentials and limitations of such kinds of processes in other real or simulated planning contexts (Shipley, 2002; Khakee et al., 2002). In order to enhance the reliability and significance of the knowledge-building process, it has been said (Khakee et al., 2002) that interacting from a remote platform could minimize the constraints opposed by normal organizational rules, decrease controllability, stimulate creativity without risks of social condemnation. Cognitive contents could be managed massively but also selectively, taking advantage of the real-time support of IT architectures. In general, we know the greatly significant stimulus given to decision-support knowledge-exchange processes by IT-based architectures in this sense (Borri et al., 2013, 2014; Shipley, 2002). Yet to date, we know that at least a couple of negative elements resist in comparison with face-to-face processes. A first, traditional problem is the so-called 'coldness' of remote interaction, carried out in an expressive solitude that wears out the exchanged cognitive content, due to lack of participation. The second problem, however, is the persistence of an intermittent, inconstant availability of the cognitive agent who thus risks giving quantitatively but especially qualitatively limited contents - moreover without a social, contextual stimulus and / or control, being physically isolated. Well, the lockdown status caused by the Covid-19 emergency has allowed in our recent experiment to partially remedy these negative aspects. The captivity and computer-dependence regime ensured a continuity of remote multi-agent interaction and favoured the conclusion of a scenario-building process - which normally proves to be difficult to be achieved both in presence and even much more in a remote mode (Khakee et al., 2002). Also, a hidden sense of solidarity induced by the common fate seems to have partially offset the sense of coldness of the remote interaction, as can be seen from the quantity but also from the expressive quality of the contributions. This last result, although strictly dependent on the very peculiar context, can be interesting in the perspective of a process in extreme risky conditions.

Admittedly, the relevance of this online simulation experiment is undoubtedly depending on its didactical substance, being limitedly legitimated only within this methodological context. The control of the quality of interactions and data, as well as of the interactive 'loyalty' of the agents, was low as it was of little interest for teaching purposes. In addition to the problems mentioned, however, the experiment poses another dilemma, which is the by-product of the results of participatory continuity achieved. In fact, in another remote exercise also carried out this year, on another subject, the students showed and argued their great suffering for a harrowing absence of socialization and of frequenting the normal environments of individual and collective life (Mastrodonato & Camarda, 2020). These are therefore the particular conditions that have guaranteed and accompanied their continuous availability for interaction in our case. Being clearly exceptional and virtually unrepeatable conditions, it seems difficult to imagine a favourable perspective regarding the use of these strategic construction processes of the future, in a remote way.

Advantages and disadvantages of both approaches cannot be entirely worked out when trying to extend such case-based findings to a real planning process. For example, one typical drawback induced by the forcedly remote interaction during the lockdown period is generally claimed to be the economic and/or digital divide - as community's accessibility to high technologies is notoriously variable. On the contrary, such difficulties are not widespread in a university (particularly engineering) environment, where technological equipment and literacy are nowadays essential parts of students' toolbox. In this vein, an online knowledge management process applied in the local or macro governmental units in times of stress/pandemic/natural disaster is an intriguing perspective - which nonetheless requires more extended studies. Such online discussion platform certainly inspires future applications among real decision-making stakeholders.

Currently, online processes seem not much preferable to the more traditional face-to-face path, which instead seems to remain generally preferable since digital familiarity is commonly still not pervasive at least in terms of age.

Hence, the debate certainly remains interestingly open and able to spur the future subject of adequate analytical development in subsequent research activities.

Author Contributions

Author Contributions: Stefania Santoro: abstract, introduction, section 2, methodology and results of on-line education sections, discussion; Maria Rosaria Stufano Melone: methodology and results of face to face education sections, discussion; Domenico Camarda: conclusion, review, project framework and supervision. All authors have read and agreed to the published version of the manuscript.

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Pedestrian routes and accessibility to urban services: An urban rhythmic analysis on people's behaviour during the Covid-19

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Abstract
The Covid-19 emergency has changed the face of our cities, preventing most urban activities, limiting travel over large, medium and short distances and drastically reducing the number and intensity of social relationships. The restrictive measures imposed on the entire population have significantly influenced the experience of our built environment, as well as the assets of pedestrian and bicycle network to access essential urban services. On the one hand, these limitations have drastically imposed a change in the habits of people who now spend more time walking and cycling in the absence of other activities; on the other, they have revealed the need of a reorganization of pedestrians and cycle paths, as well as open spaces. The morphology of these urban spaces is unable to cope with the current situation of social distancing and to adapt to a new normality. Local decision makers face a new demand for urban space for pedestrian and cycle access that has not yet been explored. In order to contribute to future planning decisions, this paper proposes a comparison between pedestrian flows and accessibility of essential services before and during the lockdown, taking a decentralised area in the city of Aberdeen as a case study. As a conclusion, the paper proposes specific recommendations for urban planning in order to deal with emergency situations, such as mobility limitations due to an outbreak.

Keywords
People's behaviors; Pedestrian networks; urban accessibility; rhythmic analysis; GIS

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1. Introduction

On 30th January 2020 the World Health Organisation (WHO) declared an emergency due to Covid-19. This put in crisis not only the health system of European realities, but at the same time, it required an immediate response from administrators in promoting a different organisation of the built environment.
The first outbreak was found in Wuhan in China and subsequently in over hundreds of countries, but the WHO declared the global pandemic just on the 11th March (Allam & Jones, 2020).
Italy was the first nation in Europe to have a high spread of the virus followed by France, Spain and the United Kingdom. The daily records of the infections varied in different countries. This was due to different ways of dealing with the emergency.
Italy was the first country to implement restrictive measures. Many others followed it, such as Spain, France, Germany and later the United Kingdom. The latest report, issued by the British National Government (7/05/2020), outlined a 15.8% higher ratio between deaths and positive cases than other European countries, due to a delay in the development of provisions provided to the population.
The outbreak required not only a rapid response to the forms of organisation of health systems but also a new urban spatial structure (Soharabi et al., 2020). Social distancing, movement restrictions, travels allowed almost exclusively for the access to the services identified as essential, forced the local authorities to face and deal with a different demand of movement and accessibility to urban services (Papa et al.,2017).
The European countries and the whole world find themselves experiencing a real emergency that has overturned the indisputable role of our cities.

1.1 Scientific framework

The emergency produced significant impacts on all components of the economic-productive, socio-cultural urban system including the change in social relations (Sturzenegger, 2020; Gargiulo et al.,2020; Gargiulo & Russo, 2018) and effects on long-term use and organization of cities (Pirlone & Spadaro, 2020).
The effects inevitably led to an urban asset change and, as a consequence, to the need of new configurations for the cities. The idea of defining an appropriate safe distance is a point from which to start to adapt our cities to different layouts in the near future.
Adapting our behaviours certainly implies a different regulation of the use of public spaces and a redefinition of our priorities and greater reflexivity in acting individually and collectively within the community. Squares, open spaces and meeting places lose their meaning without the users living in the city.
The organisation of our urban spaces and pedestrian network for accessing essential urban services that must remain open for citizen's subsistence, is unable to respond to an emergency and to the needs of a population.
The characteristics of the built environment combined with users' behaviour, expectations and aspirations affect spatial and urban accessibility to places and activities (Gaglione et al., 2019; Meshur, 2016). Accessibility is a fundamental element to understand the interactions between the activities and the ways of users' moving for reaching them (bicycle, on foot) (Bonotti et al., 2015). In this regard, the scientific community continues to question the issue of neighbourhood and urban spaces walkability.
Rodriguez et al., 2015; Cerin et al. , 2006, Gharaveis, 2020; Loo et al., 2012 investigated the identification of the physical characteristics of pedestrian routes (width, state of the pavement, etc.), the environmental density of lighting and functional characteristics that affect the walkability and safety of users (Gargiulo et al. ,2018; Rossetti et al 2014). The purpose of this investigation was to improve accessibility to urban areas on a neighbourhood scale in terms of usability, safety and attractiveness of the pedestrian paths.
Another line of research has developed qualitative and quantitative indicators of walkability in order to define the areas where the priority should be given to the improvement of pedestrian accessibility to neighbourhood services and liveability (Brainard et al., 1997). The studies examined the factors that influenced the perception

of safety, usability and the level of cognitive familiarity of the built environment (Arellana et al., 2020; Arshad et al., 2016; Carnegie et al., 2007).

The ability to freely walk to enjoy urban places and essential services has positive effects in terms of health conditions of a population (D'Orso & Migliore, 2020; Ribeiro et al., 2018).

Today, the rules to avoid the spread of Covid-19, imposed by governments in most of the countries in the world, led to more sustainable modes of movement. The high risk of spread the virus, in the public transportations, posed a further research question related to the cities' walkability. Particularly, it focuses on new possible adaptations of pedestrian network to reach, to queue and to access commercial services (Aghaabbasi et al., 2018; Blečić et al., 2014). Furthermore, we can argue that pandemic fear led users to prefer walking and cycling short distance but also to use private cars for longer distance. This raises further the question related to the theme of urban dimensions and liveable distances to access places and services.

1.2 The role of commercial services within the city

In most of the European cities, the distribution of commercial services is based on a model of centralisation over large areas (Wang et al., 2006) compared to their spread over small areas. In other words, the commercial activities are structured on a shopping centre layout which today cannot host the public due to the pandemic. Particularly in the UK various essential services are located together with other non-essential service in the same centre or even directly within the same shop module. This overlap of functions, during Coivid-19 time, generated further issues related to the accessibility. The closure of centre malls led to long queues and waiting times along the pedestrian walkways in order to access single essential retails (Fig. 1). Furthermore, in some countries, such as the UK, access to single urban health and essential commercial services is timed due to the different types of users (children, elderly, travelled with disabilities).

Fig.1 Thursday's scene outside Asda in the Kings Heath area of Birmingham

The mall by nature is a highly organized complex consisting of a variety of retail stores and service facilities concentrated in one building in order to provide a complete customers service (Shi et al., 2015). A large scientific study was produced on the identification of the best position of large shopping centres through spatial analyses in GIS (Erdin & Akbaş, 2019; Shi et al., 2015); furthermore, the study investigated what the effects generated by the presence of shopping centres were within urban areas (Lens & Meltzer, 2016).

Moreover, Pope & Pope's studies (2015) and Nega & Timm (2015) examined how the presence of a shopping centre can affect the real estate values of a neighbourhood. and the relative impact they produce in the urban areas adjacent to them with the aim of estimating the impacts that these large centres produce in the urban areas adjacent to them.

Other studies examined what the effects of shopping centre are in terms of increasing or decreasing the attractiveness of a neighbourhood. The results showed that the presence of these large commercial centres induced negative effects such as an increase in air pollution, crime, noise and traffic congestion (Ihlanfeldt & Mayock, 2010; Koster & Rouwendal, 2012; Kuang, 2017). Effects that will now be questioned again in order to deal with the emergency of Covid-19 and the associated reorganisation of commercial services.
In light of these brief considerations where pedestrian routes and essential services accessibility are clearly intertwined, the need of implementing urban planning actions and strategies to respect social distancing in the short and medium term, is clearly emerging.
The new strategies should respond to the emergency with flexible and interchangeable solutions in order to restore a new normality. In doing so, the current and shared aims of more versatile design principles would be met, and public and private spaces would be accessible to every category of people, regardless of the age, cultural, social, physical and cognitive conditions. (Bianconi et al., 2018; Türk, 2014).
In this perspective and in order to support local authorities to improve liveability and urban organisation in terms of pedestrian mobility and accessibility to primary services, even in emergency conditions, the paper examines the pedestrian accessibility of large shops before and during Covid-19 within Aberdeen urban context; on the other hand it proposes how to adapt the pedestrian paths and spaces to reach larger retails such as supermarkets, pharmacies in compliance with social distancing and with the aim of providing useful suggestions to decision-makers.

2. Methodology

This paper discusses how urban spaces, services and mobility changed since the Covid-19 pandemic emerged, taking Aberdeen, Scotland, as a case study. The proposed methodology aims to define the pedestrian accessibility of essential commercial services in two different scenarios before and during Covid-19.
The proposed methodology combines two different approaches adopted in urban planning and on the topic. In the first part of the research, a qualitative approach, aimed to monitor, through a direct survey on sites, the urban flows for access services, routes and roads. Data were expressed in terms of number of users during certain scheduled times every day. In the second part, a quantitative approach, starting from the number of users, aimed to define pedestrian accessibility through the use of a network analysis tool in the GIS environment. More in detail, this method is divided into four phases. The mixed methodology, qualitative and quantitative, is illustrated in the following paragraph.

2.1 Rhythm-analysis

The complexity of contemporary urban spaces is remarked by relations and conflict between different mobilities and interactions. Their configurations generate urban rhythm (Smith et al., 2013).
In this regard, the study of spatio-temporal phenomena enabled to individuate possible inefficiencies of the spaces and infrastructures but also provided the basis for design improvements.
Urban rhythms, in this paragraph, are defined to outline the uses of urban spaces and essential services in relation to how users move in two different scenarios. In this sense, the choice to consider the rhythmic analysis of urban flows was useful to understand how during the lockdown the behaviour of users living in the city changed. Urban spaces are experienced with the body and perceived with different levels of engagement (Vergunst, 2010), and this implies an analysis of both presences in the urban space and functions offered in that particular space. Functions are mainly related with the services that follow particular timetable during the day. In this sense, it is possible to perceive the movements and presences as data depending on the functions and so the services opening times. According to Mareggi (2017) the time can be understood in different ways, however for this research, the time was conceived as opening time of the activities and the

rhythm was perceived as the intensity of users flows. This to understand how the users' habits and lifestyles varied, especially during the pandemic, where temporality took on an important role.
The first phases of the research took rhythmic urban analysis in order to identify the users' flows on the streets, pedestrian paths and access to services around the main retails in Garthdee, Aberdeen, before and during the lockdown. The areas were monitored through site surveys carried out during two working days and one day along the weekend. In this sense, the intensity of users has to be considered as an overage number of users during three scheduled times each day (10am; 15pm; 17pm). According to Lefebvre (2004), this analysis also shows the complexity of the urban spaces and their use in relation to the flow and the opening times of the services present there.

2.2 Pedestrian accessibility analysis in GIS environment

The second phase involved the creation of data model of the rhythmic analysis of urban flows expressed in terms of number of users through the ArcGis software in two different scenarios before and during Covid-19. The data have been spatially referenced with the aim of having a framework on the urban phenomenon before and during Covid-19 (Grekousis, 2020; Stillwell & Clarke, 2004). The data collected were associated in GIS environment with the graph of the pedestrian in the network before and during Covid-19 by implementing the pedestrian graph starting database. For each scenario, the average daily flow was calculated in order to better understand the intensity and trajectory of the attendance at different times (Mareggi, 2017). These data were translated into rhythmic maps with the aim of understanding the relationships between the characteristics of the built environment and the pedestrian behavioural variation of the users along the walkways. In addition, rhythmic maps aimed to classify pedestrian flows using the natural breaks method. These maps were also useful for obtaining potential insights on where and how to adapt urban space in an emergency situation.
Due to the pedestrian flows defined on each arch of the pedestrian network, the third phases aimed to define pedestrian accessibility to essential urban services before and during the pandemic through the use of a network analysis tool in environment GIS. Pedestrian accessibility is defined, on the pedestrian graph, by relating the ability of users to travel on a pedestrian network with the speed of walking.
To define the walking speed of users, the study of the scientific literature made possible to consider as useful, for the purposes of this work, the research carried out by Colclough (2009) which determined such values based on different groups age of the population combined with the topological characteristics of the network, such as slope and connectivity of the pedestrian network. More in detail, an identified average value of walking speed 1.33 m/s was defined. This value defines the walking speed of a user on each pedestrian network in relation to his ability to walk a pedestrian path. Particularly, on the pedestrian graph, the accessibility was defined by the length of the route based on the users walking time; the average daily pedestrian flows, over each arch, was considered before and during the Covid-19, generating the function attributed to the pedestrian graph with the implementation of the Network analysis tool.
Due to pedestrian accessibility on the network and the location of urban services, in phase four, urban areas were classified in terms of pedestrian accessibility to urban services, using a network analysis tool in the GIS environment. The classes were defined in relation to the restrictive distances imposed to access the commercial services during the pandemic. This enabled to understand whether the organisation and distribution of the urban service offered responds to the emergency at a neighbourhood scale. The classification of urban areas, in relation to pedestrian accessibility to urban services, is an indispensable premise for the construction of a tool to support the public decision-makers and for the implementation of interventions on the territory.
The aim is to identify pedestrian routes which need interventions to respond to the new needs of the population. Interventions that require further and stronger relation to the characteristics of the built environment. The combination of these two methods enables to better understand how to rethink the reorganisation and distribution of essential urban services.

3. Case Study

During the lockdown several changes in the use of urban spaces happened and this inevitably affected the servient and ancillary spaces of urban services.

The paper specifically focuses on Aberdeen city which has a particular reality. It is the third city in Scotland and its city centre is mainly developed along a spine, Union Street. The city is characterised by three main centre malls while supermarket chains are located out of the city centre. Local commercial activities, despite the country is reach of farms and agriculture sites, are not present within the city. This is due to its economy developed only around the oil and gas sector and to its urban improvements and masterplan which are proposed mainly by developers from private sector, aiming to appealing investments. Furthermore, the peripheries and neighbours, including those ones designed for elderlies, are not served by various retails and consist just of residential buildings. During the lockdown, farms located in the countryside started to offer at home-delivery of goods and this had a good success around the population (Foodiequine, 2020). In view of the above considerations, the study focuses on Garthdee area in Aberdeen, which is served by supermarkets, a pharmacy, petrol stations and a DIY, and shows the data collected on week and weekend days at different times during each day. Particularly, excluding the early opening time specifically dedicated to key workers and vulnerable people, the survey took place in the morning, afternoon and evening. Every monitoring lasted around one hour and half.

The area is characterised by various residential areas, two main British supermarkets with adjacent petrol stations, one of the main pharmacy stores of the city and a multination DIY (do it yourself) and home improvement retail. All services have wide carparks which were used, during the lockdown, as queueing and waiting area to control and limit the access to the stores. Two main infrastructures, serving the area and services, were monitored, in the first phases, as a result of a rhythmic urban study on users' flow: 1. Holburn Street which is one of the major spines of the city connecting the North and the South parts of Aberdeen. It is intensively used by private vehicles, public transportations and goods transportations; 2. The Deeside path which is a cycle and pedestrian route along the river Dee, and which connects the Duthie Park and the retailing area. For both infrastructures, only the pedestrian and cycling flows were considered for this study. The following tables show the data obtained during a week between April and May 2020.

Retail	**Opening time**	**Key workers / dedicated time**	**Flow overage 10am**	**Flow overage 15pm**	**Flow overage 17pm**
Sh 1	9am – 10pm	9-10am NHS & elderly (Mon-Wed-Fri-Sun)	79 pep. in queue	83 pep. in queue	50 pep. in queue
Sh 2	8am – 9pm	7.30-8am NHS (all days) 8-9am elderly & disable (Mon-Wed-Fri)	32 pep. in queue	40 pep. in queue	31 pep. in queue
DIY	8.30am – 5pm	N/A	40 pep. in queue	65 pep. in queue	closed
PH	8.30am – 8pm	N/A	5 free entrance	5 free entrance	4 free entrance
Petrol stations		N/A	3 cars	10 cars	16 cars
	Pedestrian/cycle paths				
	Deeside path		35 people	64 people	42 people
	Holburn Street		6 people	2 people	36 people

Tab.1 Aberdeen Site survey carried during a weekday Wednesday 29/04/20

Retail	Opening time	Key workers / dedicated time	Flow overage 10am	Flow overage 15pm	Flow overage 17pm
Sh 1	9am – 10pm	9-10am NHS & elderly (Mon-Wed-Fri-Sun)	45 pep. in queue	74 pep. in queue	60 pep. in queue
Sh 2	8am – 9pm	7.30-8am NHS (all days) 8-9am elderly & disable (Mon-Wed-Fri)	32 pep. in queue	34 pep. in queue	35 pep. in queue
DIY	8.30am – 5pm	N/A	40 pep. in queue	52 pep. in queue	closed
PH	8.30am – 8pm	N/A	5 free entrance	4 free entrance	2 free entrance
Petrol stations		N/A	4 cars	7 cars	7 cars
	Pedestrian/cycle paths				
	Deeside path		55 people	59 people	36 people
	Holburn Street		6 people	14 people	5 people

Tab.2 Aberdeen Site survey carried during a weekday Friday 01/05/20

Retail	Opening time	Key workers / dedicated time	Flow overage 10am	Flow overage 15pm	Flow overage 17pm
Sh 1	9am – 10pm	9-10am NHS & elderly (Mon-Wed-Fri-Sun)	19 pep. in queue	18 pep. in queue	18 pep. free entrance
Sh 2	8am – 9pm	7.30-8am NHS (all days) 8-9am elderly & disable (Mon-Wed-Fri)	0 pep. in queue	15 pep. in queue	16 pep. in queue
DIY	8.30am – 5pm	N/A	57 pep. in queue	50 pep. in queue	closed
PH	8.30am – 8pm	N/A	0 pep. in queue	0 pep. in queue	0 pep. in queue
Petrol stations		N/A	3 cars	2 cars	0 cars
	Pedestrian/cycle paths				
	Deeside path		23 people	25 people	36 people
	Holburn Street		0 people	0 people	4 people

Tab.3 Aberdeen Site survey carried during a weekend day Saturday 02/05/20

The analysis suggests that retails, despite the wide spread furloughing condition of the country and so more spare time during the week, continued to maintain regular pace with an increased flow during the weekend. Interestingly, the most popular retail, according to the monitoring, was the DIY which had long queue outside the store all days. Particularly, the DIY was the only shop with outside queuing lanes erected on the parking spaces in front of the shop.

The other supermarkets instead, used marking lines on the pavement to take customers 2 meters apart from each other and distributed in a linear shape.Certainly, the intensity of the flow was slowed down by precautions taken by the retails in order to maintain social distancing inside. This generated longer lines and waiting times.

Fig.2 Aberdeen shop 1. Site survey carried during both week and weekend days

Fig.3 Aberdeen shop 2. Site survey carried during both week and weekend days

Fig.4 Aberdeen DIY. Site survey carried during both week and weekend day

Differently from the shops, the Deeside path was more populated than usual with a continuous flow of visitors who used the path to reach the shops and for leisure purposes. The width of the path cannot provide the minimum social distancing required and so users spread out around the park, creating new alternative routes.
In the second phase, pedestrian flows were associated in the GIS environment with the graph of the pedestrian network and its average was defined before and during Covid-19.
The results, gained from the comparison of the maps, show that before the Covid-19, in the residential areas of Garthdee, the pedestrian flows were very low and had a value of 5 due to the use of other forms of movement such as private cars and public transports to access urban services. Pedestrian flows were higher in Garthdee Crescent area due to a greater concentration of urban services adjacent to residential areas.
In Ferryhill and Ruthrieston's neighbourhoods the pedestrian flows were greater than the Garthdee area due to the presence of Duthie Park and the area adjacent to Aberdeen harbour, redeveloped in the 70s through a high concentration of urban services.

Fig.5 Aberdeen Deeside path. Site survey carried during both week and weekend day

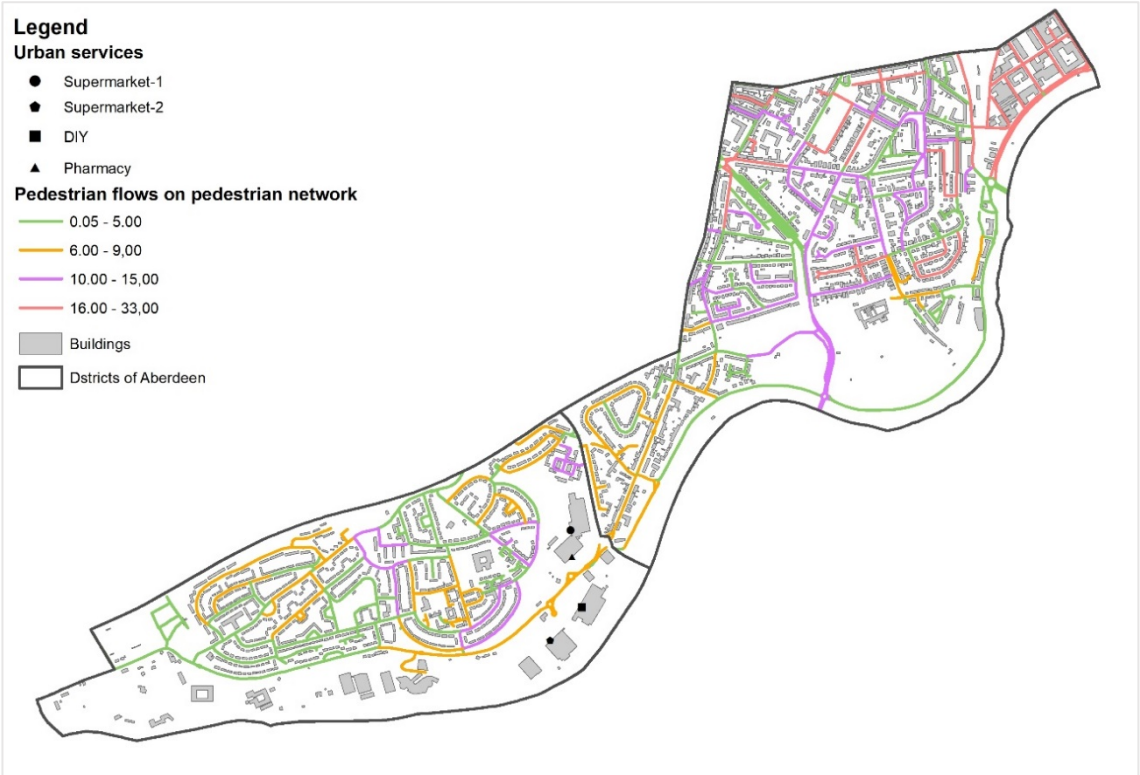

Fig.6 Pedestrian flows of the districts of Garthdee, Ferryhill and Ruthrieston before Covid-19

During the Covid-19 period, it is clear how the fear of infection changed the habits and lifestyles of users who live in the city. More in detail, it can be noted that in the residential areas of Ferryhill and Ruthrieston the pedestrian flows were almost completely zeroed while in the residential areas of Garthdee the pedestrian flows were almost completely unchanged before and during Covid-19. On the contrary, in the proximity of essential services, within the area of Garthdee road and Garthdee Crescent, pedestrian intensity increased considerably. The high pedestrian intensity was due to both the new ways of access the urban service and to the new social distancing in place. Both of them imposed a review and new organisation of the urban system particularly in terms of spaces and pedestrian networks.

Moreover, the Scottish government restricting measures imposed a limiting travel of 5 miles. This, together with the increased and forced spare time, led to more sustainable travel modes, encouraging the use of pedestrian and cycle path. In this regard, Holbourn Street pavement and the Deeside Path had a considerable increase in pedestrian flows compared to period pre Covid-19. As a result of this shift, more places and leisure areas in the city were more experienced than before by the users, even if the spaces were still not organised to maintain a safe distance (Figs. 6 and 7).

In this regard, it seems important to highlight how the continuity of the pedestrian and cycle network in the area, apereas fragmented and moreover its width does not allow safe journeys particularly in relation to the surrounding built environment and roads. The vehicles infrastructure continuity and the effective connections have been so far prioritised, reducing the possibility to positively influence the users to consider other types of mobility. Furthermore, what emerged from the survey and as highlighted by an ongoing research at Robert Gordon University (Civitas Portis, 2020), the fragmented walkability of Aberdeen, together with the limited possibilities of having cycling continuity within the centre, are still an important issue in terms of safety.

Fig.7 Pedestrian flows of the districts of Garthdee, Ferryhill and Ruthrieston during Covid-19

In the third phase, the pedestrian accessibility was defined on the network considering both the pedestrian flows defined along the pedestrian network graph and the actual users' ability to travel through each pedestrian network. In phase four, because of the measure of pedestrian accessibility on the network and the location of urban services, urban areas were classified into three pedestrian access levels. The pedestrian accessibility

levels have been defined on the basis of the restrictive measures that the Covid-19 imposed in terms of pedestrian distances to reach essential services (Figs. 8 and 9).

Fig.8 Pedestrian flows of the districts of Garthdee, Ferryhill and Ruthrieston before Covid-19

Fig.9 Pedestrian flows of the districts of Garthdee, Ferryhill and Ruthrieston during Covid-19

The western area of Garthdee, again, is predominantly residential while the eastern one offers a high range of urban services. This disconnection increases the needs of alternative ways of travel to the pedestrian one.

In light of these brief considerations, the necessity to rethink the general organisation and distribution of urban services appears fundamental especially within the residential areas. This implies a switch towards a smaller-scale of retails scattered around and about the neighbourhoods against the centralised model of bigger centre malls concentrated in dedicated areas within the city as, at the present, shown on an urban scale.
The distances were defined because of the particular restrictive measures during the pandemic. More specifically, the results, obtained for the urban spaces considered, show how pedestrian access to urban services increased during the pandemic. Furthermore, the restrictive measures of moving demonstrate that the urban services' distribution in clusters around the city is not suitable during emergency periods.
In this sense, it is possible to notice that Ferryhill and Ruthrieston's neighbourhoods are totally absent on the maps and therefore unable to reach certain essential services on foot.

4. Conclusions

The fragility of the urban system has been revealed by a pandemic. The virus generated a structural damage for cities requiring more flexibility of the spaces, especially those ones commonly used just as carparks serving supermarkets and other services. In this sense, it is important to rethink and reorganise the spaces in order to host different functions and in order to transform them in more porous places.
Accessibility, routes and waiting spaces imply a spatiotemporal experience which can be effectively and critically analysed through the rhythmic analysis. The sequence of the spaces, along with the experience of passing thought, walking, cycling, resting, is intrinsically related to the temporality.
Space and temporality are then key aspects to consider in re-designing the city and which can be clearly understood through their rhythm analysis. In this sense, it seems pertinent to recall the recent idea of Anne Hildalgo (The alternative UK, 2020), the mayor of Paris, on the *15-minutes city* and clearly inspired by Jacobs' proximity concept (1961). The 15-minutes city addresses both aspects related to the urban dimensions and time by offering all essential and non-essential services within a radius of kilometres walkable in 15 minutes. The factor 'space' would be addressed through the introduction of micro-local green cities within neighbours; and the factor 'time' would be addressed through the reduction of time lost for transportation from one side of the city to the other.
Using the 15-minutes city as a theoretical reference, this research proposes conceptual guidelines for the two main categories of spaces analysed here and different in their morphology: the infrastructure with a linear configuration and the ancillary spaces of activities with a more areal layout but still re-proposing a linear configuration for the waiting queues. Through the analysis and graphical elaborations, it is possible then to draw some conclusions as guidelines for the improvement of both spaces.

4.1 Pedestrian path

In the case study the rhythm was constant and the linear morphological configurations in place did not enable any rhythmical variations. A linear configuration reminds to the concept of boundary, but the challenge proposed is to perceive that boundary as Heidegger (2001) suggested:
"A boundary is not that at which something stops, but, as the Greeks recognised, the boundary is that from which something begins its presencing."
What is proposed here is a form of de-linearization together with a reinforced continuity of the routes which may combine both dimensional and functional solutions.
If the city is going to change its dimensions in terms of carbon reductions (Civitas Portis, 2020), then parts of the space could be re-thought in order to implement the width and the continuity of pedestrian and cycle routes while offering more multifunctional services both essential and non-essential.

Fig.10 Conceptual diagram wider and multipurpose pedestrian paths. 1 current configuration; 2 "pockets of multiple activities"

Public mobility infrastructure should be more capillary, multifunctional and reversable, particularly in terms of width. This dimension is crucial to maintain effectively the minimum social distancing and can be achieved with the introduction of green areas and relaxing pocket areas along the paths. It appears important to re-think the infrastructure as a sustainable and more green catalyst able to connect, to serve and to host various physical activities from running, cycling and walking, to the leisure ones such as sunbathing, sitting areas and green spaces (Gargiulo et al., 2018).
In terms of morphology, this implies a radical shift from a thin, linear and monofunctional spaces to a more elaborated and thicker sign within the territory with fragmented borders able to generate "pockets of multiple activities".

4.2 Ancillary Spaces

During the pandemic, car parks serving shops, were used to moderate the flow of users while maintaining the social distancing. In view of a more sustainable city and referring to the specific case of Aberdeen, which lost its micro-localism due to an economy heavily focused on the oil and gas sector and on a globalised market, we argue that large areal spaces can be an occasion to reinforce the local sense of identity.
These spaces are extremely wide and sometimes distributed on two floors. The areal dimensions suggest that there is enough space to host car parks and pedestrian paths along with the possibility to reintroduce some localisms against the more globalised and standardised function of the big chains. Particularly, the covered car parks can be transformed as space for pedestrian use to access the shops but also as multipurpose space able to host temporary market and small activities to complement the main shop.

4.3 General considerations

The new meaning of distance, as a safe measure for any relation, overturns the idea of urban space and reveals the importance of slowing down its physical growth, and of rethinking its relations with the surrounding areas and nature. Social distancing should be read as an opportunity rather than a limitation in order to re-imagine the relation between linear infrastructure paths, ancillary spaces and nature (Gargiulo et al, 2016). Nature may help to guarantee the distances and the social sharing of the space at the same time.
Furthermore, the relation with nature rises another important aspect that deserves attention in the near future. It can help to slow down the mobility, making the movements more enjoyable and help to reflect on the possibility to psychologically reduce the distances between areas by providing more services and attractiveness accessible by pedestrian and cycle flows.
The importance of reactivating micro-localism, private and small local activities together with a hyper-proximity of various services, may provide more cultural identity and easy accessibilities to different services especially in the peripherical areas of the city.

Author Contributions

Although this paper should be considered a result of the common work of the authors, C. Zecca and R. Laing for the section 1, 1.1 and 1.2; F. Gaglione and C. Gargiulo for the section 2 and 2.2; F. Gaglione for the section 3; C. Zecca for the section 2.1, 4, 4.1, 4.2 and 4.3.

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The Times They Are a-Changin' and cities have to face challenges which may not be further postponed. In particular, six of these challenges to modify and/or adapt cities physical shape, facilities distribution and their organization as complex systems: climate changes effects, population aging, reduction of fossil-fuel energy consumptions, immigration flows from disadvantaged regions, technological innovation and optimization of land use.

The three issues of the 13th volume will collect articles concerning the challenges that cities are going to face in the immediate future, providing readings and interpretations of these phenomena and, mostly, methods, tools, technics and innovative practices (defined as Climate proof cities, Zero consumption cities, Car Free cities, ..) oriented to gain and keep a new equilibrium between cities and new external agents.

Publishing frequency is four-monthly. For this reason, authors interested in submitting manuscripts addressing the issues may consider the following deadlines:

• First issue: 10th January 2020;

• Second issue: 10th April 2020;

• Third issue: 10th September 2020.

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REVIEW NOTES

The quality of the offer that the magazine has set as a priority since its foundation has given increasingly encouraging results, first with the recognition by readers and, subsequently, by the institutional bodies responsible for the quality of research in Italy. The recent inclusion of TeMA in the list of reviews of A class represents a milestone to start from. The Review Pages section, since the first issue of TeMA in 2007, has played a substantial role in the general balance of the review, both as an expression of constant updating and as a permanent observatory on emerging issues relating to the relationships between urban planning, mobility and the environment. Starting from the issue of August 2020, the Review Pages will have the new form of Review Notes. They will become short scientific articles, which, while maintaining the function of a reasoned review, will deepen relevant issues in the context of the scientific debate on the recent challenges of the cities, territories and environment. The Review Notes will contain critical thoughts congruent with the topic of the review. The guidelines for these considerations will be: centrality and interest in the scientific debate; advancements and innovativeness of topics; significant gaps resulting from the analysis of the state of the art; recent evidence stemming from the scientific debate; perspectives and potential developments. The Review Notes will consist of four sections, edited by the following researchers:

- Carmen Guida for the section Urban Planning Literature Review;
- Federica Gaglione for the section Town Planning International Rules and Legislation Overview;
- Gennaro Angiello for the section Projects and Innovative Approach;
- Stefano Franco for the section Economy, Business and Land Use.

Researchers can identify a specific and personal topic to deepen in more than one issue, becoming self-contained scientific articles. Articles are subjected to the usual submission process required by the statement of TeMA journal. The Editorial Staff provides a specific quality control of the articles.

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REVIEW NOTES – Urban planning literature review

After recovery: towards resilience

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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 sections 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 aims at discussing the main impacts and consequences of the Covid-19 pandemic on our lives and urban systems. While for the last issue of TeMA, this section of the journal was dedicated to the emergency phase, according to the new policy and strategic actions aimed at improving the coexistence of the new coronavirus within urban environments, this contribution is focused on how policy makers can enhance urban resilience, in sight of potential new health crisis.

Keywords
Resilience; Emergency; Covid-19.

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1. Introduction

The 1(2020) TeMA Issue was published during the lockdown, while policy makers at every level were working on limiting people's movements and activities, in order to avoid an irreversible collapse of healthcare provision system. The global lockdown imposed by the health emergency has highlighted the extreme fragility of contemporary social and economic systems. The crisis we are experiencing demonstrates the unequivocal interrelation between human health and the ecosystem conditions of the planet. The global scale and the rapid spread of the epidemic have shown this reality in all its drama, but also its potential. Nowadays, we are living a second phase, even more challenging than the first one, since local and regional authorities are working on new practices in order to limit socio-economic consequences, guarantying a certain level of service for almost every activity and service. Since TeMA 1(2020), a Special Issue titles Covid-19 vs City-20 was published. It 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. It is the proof of a wider interest from academia, as well as from technicians and policy makers, in finding new and innovative solutions to improve urban resilience towards the spread of new infections and diseases. Although researchers and scientists are still questioning about the main relationships between territorial and urban issues and the dynamics of Sars-Cov-2 virus it is clear how it impacts of people's behaviors, changing ordinary daily lives and attitudes, especially in urban areas. In fact, the spread of the new coronavirus and the consequent Covid-19 disease showed significant vulnerabilities for cities all over the worlds due to high density of people and activities, which may not guarantee appropriate social distances. Furthermore, according to scientists, this pandemic is unlikely to be the last. As the World Bank and the Intergovernmental Panel on Climate Change (IPCC, 2019) have been saying for years, global warming could lead to the multiplication of tropical pandemics in the future. This could make public health interventions more problematic and, therefore, our ability to control the spread of epidemics less effective. The extraordinary scale of the Covid-19 crisis is evident in the growing deaths and economic losses the pandemic has wrought in every country of the world. Bearing that in mind, the concept of urban resilience will have new rise, taking into account new and complex challenges. This contribution is divided in two parts: the first one aims at summarizing the notion of resilience and its application to urban planning polices and practices; the second part presents some interesting scientific products, two books and a journal's special issue, concerning urban resilience in emergency outbreak. The first book, "The City in Need. Urban Resilience and City Management in Disruptive Disease Outbreak Events" from Cheshmehzangi (2020), falls a literature gap, through the overarching concept of 'resilience thinking', addressing critical issues of preparedness, responsiveness and reflectiveness during emergencies, focusing on cities and how they should prepare to avoid a variety of adversities and uncertainties caused by their outbreaks. The second book, "The Routledge Handbook of Urban Resilience", by Burayidi et al. (2020), provides a comprehensive discussion and overview of urban resilience, including socio-ecological and economic hazard and disaster resilience, and important direction to practitioners and civic leaders who are engaged in supporting cities and regions to position themselves for resilience in the face of climate change, unpredictable socio-environmental shocks and incremental risk accumulation. The third scientific product is a special issue from the Journal Sustainability, "Resilience Engineering for Sustainability: Methodological Approaches and Practical Experience". The aim of this collection of papers is to gather state-of-the-art knowledge on resilience and sustainability, and to discuss innovative and long-term research paths.

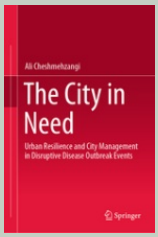
2. Urban Resilience in Planning practices

Resilience and resilience thinking have become important concepts in both scientific research and in policy discourse (Gargiulo & Lombardi, 2016); they represent advanced concepts, in a wider scientific and technical

frame related to sustainability (Mazzeo, 2017). Resilience is interpreted as an approach, or family of approaches, that can cope with the high levels of uncertainty present in complex urban challenges (Errigo, 2018; Zucaro & Morosini, 2018). Resilience gained interest particularly in urban studies mostly due to its potential applicability to a wide range of urban risks and problems (O'Hare & White, 2013; Stumpp, 2013; Meerow et al., 2016). Its positive connotations may also have contributed: 'strengthening resilience' provides a distinctly more positive policy framing than 'reducing vulnerability' (McEvoy, et al., 2013). In practice, the concept has been taken up by cities and network organizations of cities worldwide. For example, the ICLEI - Local Governments for Sustainability network, a global network of more than 1,750 local and regional governments committed to sustainable urban development, active in 100+ countries, has been promoting resilience and organizing 'Resilient Cities' congresses since 2010 (Otto-Zimmermann, 2011). Furthermore, '100 Resilient Cities' project has been "helping cities around the world become more resilient to the physical, social, and economic challenges that are a growing part of the 21st century" (Rockefeller Foundation, 2019), for instance by stimulating the appointment of Chief Resilience Officers in cities and by providing tools and support. Similarly, resilience gained traction in recent intergovernmental frameworks, including the EU's Urban Agenda, and the UN's UNFCCC COP21 Paris Agreement, the Sendai Framework for Disaster Risk Reduction, the Sustainable Development Goals, and the Habitat III New Urban Agenda. The resilience concept has much of its origins in ecology and complex adaptive systems research (Folke, 2006; Holling, 1973), where it is used in relation to the stability of ecosystems and the capacity of a system to recover following some shock or disturbance. It has since been applied in a wide range of scientific fields (Brand & Jax, 2007; Matyas & Pelling, 2015). From the socio-ecological perspective, the urban resilience concept has been defined as the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks (Walker et al., 2004). Since it was introduced in scientific literature, definitions have varied from generic to specific and even more elaborate: "the ability of a city or urban system to withstand a wide array of shocks and stresses", "the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience" (Rockefeller Foundation, 2019), or "the ability of an urban system - and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales - to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity" (Meerow et al., 2016). Turning resilience from a scientific concept into practical urban interventions is challenging, as resilience is a fairly intangible and malleable concept, leaving much room for interpretation. For practitioners, the flexibility of the resilience concept may help its function as a 'boundary object', connecting the many fields, sectors and stakeholders involved in the urban system (Brand & Jax, 2007). However, it can also hinder practice, through lack of clarity and footholds to make resilience manageable and implement it in local plans. Indeed, critical literature argues that, in practice, resilience is often used as catchall term for futureproofing, without clear-cut interpretation of what it means or how specific interventions or system characteristics might improve it. This can lead to ad-hoc policymaking, where choices taken in translating resilience to the local context remain non-deliberate, implicit, and possibly unfitting to local goals and needs. Within the scientific panorama of urban resilience definitions, it is worth noting that, considering the Covid-19 pandemic emergency, the relationship between urban resilience and anthropic risk, especially health risk, has inevitably distorted the "normality" to which we were used to (Pirlone & Spadaro, 2020). In fact, the Vovid-19 emergency has had and still will have significant long-term effects on the times, uses and organization of cities, and their adaptability to this novel challenge requires the synergic work of all actors who live or work in a city. From healthcare to high street retail, transport to food and medical supply chains, the coronavirus outbreak, has exposed the limited resilience of our cities to a terrifying tragedy that was not and is not inevitable (Rockefeller Foundation, 2020). The immediate priority of those who govern the territory was obviously aimed at health and solving the critical

issues connected to the pandemic, but now many other challenges must be considered in urban and territorial planning, concerning mobility and public transport facilities, public spaces and offices, essential activities (schools, hospitals, healthcare centers, etc.) and their resources. The following books aims at explaining and applying the concept of urban resilience to planning practices, in order to prepare cities and urban environments to external and impactful agents and to rapidly adapt, limiting irreversible and dangerous consequences.

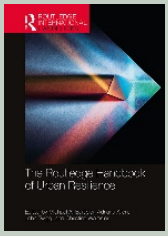
The City in Need. Urban Resilience and City Management in Disruptive Disease Outbreak Events



Author/Editor: Ali Cheshmehzangi
Publisher: Springer
Publication year: 2020
ISBN code: 978-981-15-5487-2

This book fills a major gap in academic research, by exploring 'urban resilience measures' and 'city management issues' during disruptive disease outbreak events. Based on the overarching concept of 'resilience thinking', it addresses critical issues of preparedness, responsiveness and reflectiveness in the event of outbreak, focusing on cities and how they should prepare to combat a variety of adversities and uncertainties caused by outbreaks. This comprehensive book is an essential guide for decision-makers, city authorities, planners, healthcare and public health authorities, and those communities and businesses that face disease outbreak events. It also offers a set of practical measures to support the development of tailor-made strategies in the form of an action plan. These strategies should address outbreak control and containment measures, institutional rearrangements, management of urban systems, and healthiness of the society. Divided into six chapters, this book explores important topics of 'urban resilience' and 'city management' for preparedness action plans and responsiveness planning. Further, it presents a comprehensive urban resilience approach used to support city management in the recent outbreaks in Chinese cities, which can be applied in cities around the globe to strengthen their resilience and maximize the practicality of urban resilience and minimise urban vulnerabilities during disease outbreaks. Highlighting topics such as maintaining societal well-being, community engagement, and multi-sectoral city management enhancement, this book offers a unique combination of research, practices and lessons learned to aid cities in need. It is made of six chapters which cover the topic of urban resilience in outbreak events for the first time, helping readers gain a holistic understanding of urban resilience and city management measures in disease outbreak events. Furthermore, each chapter addresses key outbreak issues from city preparedness, city responsiveness and city management perspectives.

The Routledge Handbook of Urban Resilience



Authors/Editors: Michael A. Burayidi, Adriana Allen, John Twigg, Christine Wamsler
Publisher: Routledge
Publication year: 2019
ISBN code: 978-113-858-359-7

This volume provides a comprehensive discussion and overview of urban resilience, including socio-ecological and economic hazard and disaster resilience. It provides a summary of state-of-the-art thinking on resilience, the different approaches, tools and methodologies for understanding the subject in urban contexts and brings together related reflections and initiatives. Throughout the different chapters, the handbook critically examines and reviews the resilience concept from various disciplinary and professional perspectives. It also discusses major urban crises, past and recent, and the generic lessons they provide for resilience. In this context, the authors provide case studies from different places and times, including historical material and contemporary examples, and studies that offer concrete guidance on how to approach urban resilience. Other chapters focus on how current understanding of urban systems – such as shrinking cities, green infrastructure, disaster volunteerism, and urban energy systems – are affecting the capacity of urban citizens, settlements and nation-states to respond to different forms and levels of stressors and shocks. The handbook concludes with a synthesis of the state-of-the-art knowledge on resilience and points the way forward in refining the

conceptualization and application of urban resilience. The book is intended for scholars and graduate students in urban studies, environmental and sustainability studies, geography, planning, architecture, urban design, political science and sociology, for whom it will provide an invaluable and up-to-date guide to current approaches across these disciplines that converge in the study of urban resilience. The book also provides important direction to practitioners and civic leaders who are engaged in supporting cities and regions to position themselves for resilience in the face of climate change, unpredictable socioenvironmental shocks and incremental risk accumulation.

Special Issue "Resilience Engineering for Sustainability: Methodological Approaches and Practical Experience"

Authors/Editors: Giulio Di Gravio, Riccardo Patriarca, Francesco Costantino
Publisher: MDPI
Publication year: 2020
ISSN code: 2071-1050

This is a Special Issue of Sustainability, an international, cross-disciplinary, scholarly, peer-reviewed and open access journal of environmental, cultural, economic, and social sustainability of human beings. It provides an advanced forum for studies related to sustainability and sustainable development. The purpose of this Special Issue is to gather state-of-the-art knowledge on resilience and sustainability, and to discuss innovative and long-term research paths. Such perspectives are expected to be of interest for both researchers and practitioners, in order to delve into the complexity of current and future socio-technical environments. The Special Issue contains interesting contributions which refer to conceptual and theoretical discourses, exploring the concepts of resilience and sustainability for the analysis of socio-technical systems. Furthermore, relevant contributions may explore the usage of systemic methods and models typical of resilience engineering (e.g., functional resonance analysis method, resilience analysis grid, resilience early warning indicators) in socio-technical work environments, and in urban management, disaster response, and crisis management. The Special Issue was published in March 2020 and contains seven papers from researchers and scientists from the whole world. The key words of the contributions are: resilience management, resilience engineering, safety management, sustainability, environmental governance, management of ecological systems, complexity management, socio-technical systems, adaptive capacities, crisis management, transportation, industrial plants, urban resilience, ecological resilience, multi-disciplinary resilience, quantitative and qualitative methods.

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Author's profile

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REVIEW NOTES – Town planning international rules and legislation

Strategies and guidelines for urban sustainability: the Covid-19 effects on the mobility system in Italy

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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 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 Town planning international rules and legislation overview section aims at presenting the latest updates in the territorial and urban legislative sphere.
Urban patterns and their intrinsic relationships have completely changed since Covid-19. In particular, the mobility subsystem experienced a strong setback. Local public transport recorded a significant reduction in regional rail services compared to the period prior to the emergency and an equally substantial cut in urban and suburban road transport. This section examines the legislative decrees issued by the Italian government to restart local public transport after the lockdown.

Keywords
Urban sustainability; Urban mobility; Covid-19; Local public transport.

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1. Introduction

The spread of coronavirus disease (Covid-19) has radically altered urban life, reducing population mobility at both local and country scales and dramatically affecting social relationships. The emergency led to significant impacts on all components of the socio-economic, physical and functional urban systems while generating a high economic crisis (Gargiulo et al., 2020). Italy was the first nation to register a high spread of the virus within Europe. The contagion index has changed from day to day also due to the different restrictive measures implemented by regional authorities. Furthermore, the irregular geographic distribution of the virus in Italy is still an enigma today given the intense movement between regions before the lockdown measures (Becchetti et al., 2020). The effect of Coronavirus on urban mobility has long lasting consequences. In more detail, the focus of this section is to examine how Covid-19 containment measures changed people's habits in reaching urban places and services, thus influencing the mobility subsystem. Urban system mobility is very complex and depends on several factors, primarily on the ways users move around the cities (walking, cycling, by buses or underground), on the level of accessibility to a place and the organization and structure of the public transport supply. A recent report conducted by the Ipsos Group highlights variations in travel preferences during the Covid-19 period. In more detail, Ipsos Group conducted the first research on the subject by examining travel preferences before and after the blockade on Chinese territory, where the first outbreak of Covid-19 occurred. The results obtained from this research show that in China, the fear of contagion has discouraged users from moving from public transport to using a private vehicle. Specifically, users tended to use private cars in a percentage of 34%; after the emergency phase this value raised up to 66%. On the other hand, the percentages are reversed when users are asked about the use of public transport, with numbers more than halved (from 56% to 24%) due to the perception of being at higher risk of infection in the Chinese territory (Ipsos, 2020). In Italy, a similar model is highlighted, according to research conducted by Isfort, the perception of unsafe use of public transport is greater than travel by car and on foot. The comfort during the pandemic period has carried out research aimed at defining the levels of perception of safety of the different ways of moving users on a scale from 1 to 10. The results obtained highlight how traveling by foot or by private vehicle are perceived as safer with an average rating ranging between 7.3 and 8.7, while the values obtained for public transport do not exceed the score of 3.5, highlighting the lack of perceived safety. Confined spaces, crowds and proximity to strangers, the need to cling to the supports touched by many people are, in fact, all reasons that encourage users to avoid public-transport usage, in favour of the private vehicle. The increase in private mobility in the short term also occurred due to an immediate inability by local public transport to cope with an imminent emergency and to be able to keep the metro interpersonal distance between travellers on board buses, trains and subways. The idea that travel takes place with a private vehicle generates serious urban concerns, given the limited unused capacity of roads and parking in Europe within city centres. In addition, the increase in car travel leads to a high level of congestion with serious consequences on the environment and on the quality of life of people and the air. It is important to rethink how to plan the reopening of local public transport by ensuring adequate levels of safety based on the needs and requirements of travellers. The first objective to encourage the reopening of public transport and the increase in passenger flows to relieve the pressure that gravitates around public transport avoiding its overload, to limit the increase in the traffic of private cars and to prevent the increase in emissions pollutants that would be one of the key factors in the spread of the virus as some studies claim (Otmani et al., 2020; Zoran et al., 2020).

With this in mind, governments, local public administrations and the scientific community are under due to answer to new research questions, in relation to the forms of organization of the mobility system, still moving in unexplored waters. Mobility networks and the offer of local public transport, combined with the distribution of activities in the area, affect the lifestyles of users who live in the city.

The scientific community has always questioned about the offer of public transport in terms of accessibility to services with the aim of identifying the critical areas in which potential actions should be priorities to improve

access and the quality of the service offered (Langford et al., 2012; Morency et al., 2011; Luo & Wang, 2003) This research segment has conducted investigations through the processing of questionnaires to collect information relating to users' habits and preferences, the use of multivariate statistical techniques for the assignment of weights and the relative identification of significant variables and the application of accessibility models in order to understand the availability of in reaching a specific transport service and to identify the areas where priority should be given. The processing of questionnaires to collect information on the lifestyles of the elderly population combined with the use of multivariate statistical techniques for the assignment of weights and the relative identification of significant variables was also developed within a other lines of research aimed at identifying what are the key factors (waiting times, frequency of the service, travel costs) that influence users' travel decisions due to the space-time constraints present in the territory (Tseng & Wu, 2018; Szeto et al., 2017; Spinney et al., 2009).

Today Covid-19 poses new questions to the scientific community, thus leading scientists from many fields to consider new variables and indicators to measure the transport supply. In this perspective, in the reopening phase, albeit in a still precarious condition, it will be necessary to take into account how to restore the transport sector and the safety measures for travelers also by using technology solutions (Coppola & De Fabiis, 2020).

We need to rethink the forms of reorganization of urban mobility that are combined within a new system of urban life rules that includes new timetables for economic activities and differentiated timetables for school and education. The challenge is by no means trivial, it requires a radical change in people's lifestyles and family habits, but at the same time also an opportunity to restart a series of mobility reforms.

In this direction, the content of this review aims to examine, through the revision of Italian legislative documents, the measures to relaunch public transport and sustainable mobility after Covid-19 in Italy.

Law Dl Rilancio, legge 17 luglio 2020

The Legislative Decree May 19, 2020, no. 34, containing *"Urgent measures on health, support for work and the economy, as well as social policies related to the epidemiological emergency from Covid-19"* (the so-called "Decreto Rilancio") was published in the Official Gazette no. 128 dated 19 May 2020 (Ordinary Supplement no. 21). Recently converted into law L. 17/07/2020, n. 77 with amendments, of the decree-law of 19 May 2020 and published on the official gazette n.180 of 18-07-2020 - Suppl. Ordinary no. 25. The text contains hundreds of heterogeneous provisions that range, among others, from construction to culture, from taxation to school, from healthcare to mobility, businesses etc. In this review, the emphasis is on the mobility system and the measures implemented to restart the local public transport system.

More specifically, among the 260 articles of the provision there are several measures aimed at the economic recovery from the Covid-19 crisis. In the matter of urban mobility and local public transport, the decree provides in art. 200 a fund of 500 million euros established by the Ministry of Infrastructure and Transport, aimed at compensating companies (local public transport, regional and national rail transport) in view of the reduction in tariff revenues deriving from the epidemiological emergency. The same article regulates that long-distance rail transport and inter-regional services relating to containment measures do not entail any reduction in the fees provided for in the service contracts even if there is a reduction in the service offered, in favor of LPT companies. The decree also establishes to anticipate the disbursement of 80% of the National LPT Fund (by 30 June) and to disburse, by 31 July, 80% of the fees provided for in the service contracts until August 31, 2020.

Furthermore, the decree provides for the suspension of co-financing for the renewal of the bus fleet for Regions, local authorities and managers of local and regional public transport services and, until 30 June 2021, the same subjects benefit from the suspension of the provisions aimed at implementing the renewal of the rolling stock with alternative fuel vehicles. Finally, until December 31, 2021, a share, up to a maximum of 5% of the resources allocated for the renewal of local and regional LPT bus and rail parks, can be used to adapt vehicles with suitable equipment to reduce epidemiological risks for passengers and staff.

Article 229 regulates incentives for measures that promote sustainable mobility by encouraging the purchase of bicycles, including pedal-assisted e-bikes, as well as vehicles for personal mobility with mainly electric propulsion. The "mobility bonus" can be requested only once and exclusively for one of the intended uses. By decree of the Minister of the Environment, the methods and terms for obtaining and disbursing the benefit will be defined, also for the purpose of respecting the spending limit. Furthermore, the Ministry of the Environment has recently reiterated that the bonus can

be requested by adult citizens residing in the regional capitals, in the metropolitan cities, in the provincial capitals or in the municipalities with over 50,000 residents and will have retroactive effect. To obtain the contribution, it is necessary to keep the expense receipt (invoice) and, as soon as it is online, access via SPID (Public Digital Identity System) credentials on the web application that is being prepared by the Ministry of the Environment and also accessible from its institutional website.
From the application start day (within 60 days from the publication of the provision in the Official Gazette), the mobility bonus can only be used through a digital shopping voucher that the beneficiaries can generate on the web application. In practice, the interested parties will have to indicate on the platform the vehicle or service they intend to purchase and the platform will generate the electronic shopping voucher to be delivered to authorized suppliers, together with the balance at their expense, to collect the goods or enjoy the service identified. In 2021, the provisions of the Climate Decree, which provides for a fund to be paid by the Ministry of the Environment, will be effective again.
Paragraph 4 of article 229 invites transport companies and public administrations to adopt, by December 31 of each year, a plan for the home-work commute of their employees aimed at reducing the use of private means of transport by appointing, for this purpose, a mobility manager able to provide continuous professional support to the strategic development, implementation and promotion of optimal sustainable mobility solutions. The mobility manager is responsible for a demand-oriented approach to passenger transport that involves the promotion of more sustainable transport modes to reduce dependency on private cars and the consequent environmental impact deriving from vehicular traffic in urban and metropolitan areas. For public administrations, this figure must be chosen from the permanent staff (a non-regulatory decree and implementation of these provisions is envisaged by the Ministry of the Environment-Ministry of Transport). To summarize, the Relaunch decree pursues a twofold objective in the matter of mobility: to restore the structure of local public transport on rail and road so that the transport system recovers from the pandemic crisis, promoting incentives to reduce tariffs and compensate for revenue losses; to encourage a sustainable mobility development model (micro-mobility) to replace the use of private vehicles that can affect the urban system in terms of congestion of vehicular traffic and noise pollution.

MIT guidelines

After the enactment of the Relaunch decree and with the end of the lockdown, the Ministry of Infrastructure and Transport (MIT) has issued guidelines to protect transport workers and passengers. The sections of the "Guidelines for information to users and organizational measures to contain the spread of Covid-19" adopted by the Ministry of Infrastructure and Transport also include the organizational and informative indications for local public road, lake and rail transport sectors. With the publication of the Prime Ministerial Decree April 26, 2020, the Italian government has launched the so-called "Phase 2" of the measures for the containment and management of the epidemiological emergency of Covid-19. In more detail, article 7 of the Decree provides the measures to be adopted for local public transport and goods according to the provisions contained in the aforementioned guidelines, which take into account what MIT itself shared with the trade associations on the occasion of the signing of the Common regulatory protocol for containing the spread of Covid-19 in the transport and logistics industry, which took place on March 20, 2020 (attachment 8 to the Prime Ministerial Decree).
The MIT guidelines are divided into: (i) systemic measures (ii) general measures (iii) recommendations for all users of public transport services. The systemic measures directly link to the use of transport services to modulate the mobility of workers and consequently prevent the aggregation risks connected to the mobility of citizens. The extension of opening hours of offices, shops, public services and schools of all levels is also a useful preventive approach, while encouraging alternative forms of sustainable mobility. The individual responsibility of all users of public transport services is essential to guarantee social distancing and hygiene measures. In addition, mobile information panels are provided to communicate the behavioral rules in the use of means of transport.
The general measures are provided with the following indications: (i) sanitization and sanitation of premises, means of transport and means of work must concern all parts occupied by travelers and/or workers (ii) installation of dispensers in airports, ports and on long-distance means of transport (iii) sale of tickets with telematic systems and differentiated costs according to the hours of the day. Tickets must be sold observing the interpersonal distance of at least one meter between passengers. In cases where it is not possible to respect the aforementioned distance, passengers should necessarily be provided with specific individual protections (iv) installation of points of sale, also by means of security device distributors in stations or ticket sales offices.
The recommendations for users are intended both to provide indications on the signs and routes indicated inside the stations and advise to purchase tickets electronically or via app.
In addition, the specific indications for each transport sector are contained in the technical annex of the guidelines dedicated to the individual modes of transport, including local public road, lake and rail transport sector. The ministerial recommendations contain, inter alia, measures aimed at pursuing the following objectives: (i) suspension of the sale and control of travel tickets on board; (ii) increased frequency of vehicles during peak hours; (iii) management of passenger flows by separating entry and exit doors; (iv) application of markers on non-usable seats; (v) reduction of the number of passengers to ensure interpersonal distancing; (vi) video-surveillance systems to avoid crowding.

Due to the indications provided by the Ministry of Infrastructure regarding the introduction of different tariffs per hour of the day, every passenger should reserve a seat and book for the travel time slot to access the stations/vehicles. In addition, the physical distancing measures on board of public vehicles and their effective sanitization entail additional staff and operating costs for public transport companies which have already suffered a major loss of revenues. The reading of this document also raises new questions within the scientific debate about the key factors influencing travel mode choices of city users and how to improve accessibility to the local public transport supply after the pandemic.

A plan for post-lockdown

In the light of what is regulated under the legislative decrees analyzed above, public transport companies, especially the Italian ASSTRA, outline through *a position paper* the operational measures that companies and public bodies must implement to safely manage the emergency phases. In more detail, the document aims to define the interventions required in the short to medium-term compatibly with the economic, regulatory and organizational constraints, with the primary objective of ensuring health security and avoiding as much as possible the unsustainable increasing use of private cars. The measures proposed in the short term aim to give a positive structural impact on the mobility systems and on the integration between the world of transport and the production sector, while the measures in the medium to long-term are aimed at promoting investments in sustainable mobility and quality of life, which must be the cornerstone of any mobility policy in relation to the current mobility flow demand. According to the recent ISFORT report, Italy before Covid-19 recorded movements of more than 14 million people per day at national level by public transport. In the first months of the emergency, almost 400 million travels per month were lost. During Phase 2 (starting from May 4, with limited reopening of trade and production activities and gradual resumption of local public transport), the use of public transport was limited to work reasons or cases of real necessity. It is estimated that the modal share of motorized private mobility is growing significantly at the expense of public transport services, which could be reduced by 50%.

In light of these data, the operational measures adopted for Phase 2 and Phase 3 (the latter starting in September with the reopening of educational activities and massive recovery of the entire production sector) are based on the following six pillars: (i) institution of a national "control room", which provides general guidelines to be adapted at regional and local level according to an analysis of the demographic, socio-economic and, therefore, transport characteristics of the territory; (ii) coordination between competent public bodies (Regions, local authorities, agencies) and public transport companies through territorial control rooms that guarantee the implementation of national guidelines; (iii) definition of the use of public transport by citizens; (iv) definition of precise parameters to implement the principle of physical distancing taking into account the differences in the mode of transport; (v) greater flexibility in the production of services (e.g. on call and dedicated); (vi) correct attribution of control activities.

In turn, the operational measures are divided into four macro categories. The first one is about the institution of coordinating bodies between public authorities and companies: for their organization and data flows, the urban and suburban transport companies are able to offer services in line with the needs deriving from the emergency management. Therefore, they represent the subjects that, in coordination with the reference body and in compliance with roles and responsibilities, are able to effectively guarantee immediate full coordination of the collective mobility offer in the catchment area, ensuring uniform reporting and above all homogeneity in the application of sanitary rules to protect public health. The second category of measures (to be implemented in the short term) is about the overall mobility flows: in addition to the indications provided for in the decrees, it also provides for possible staggered start times of schools, university, work and production activities, so as to distribute people flows throughout the day and avoid the typical LPT curves characterized by peak times and soft hours, and for an increase in preferential lanes and intelligent traffic lights, which would guarantee an increase in commercial speed and, consequently, reduce the risk of contagion. The third one is about the recovery of public transport: the measures aim at creating dedicated point-to-point services and executive services (such as the skip-stop service) to be carried out only on specific transport lines and with different price levels. The fourth one is about the safety of local public transport. In addition to the safety measures outlined in the decrees, ASSTRA proposes the use of technologies capable of providing indications on the concentration of passengers on vehicles or at stops (e.g. data deriving from geolocation through telephone cells) and technologies accessible by users to check the influx of passengers at stops, waiting times and punctual information through company channels (website, apps, ticket offices, communication campaigns, etc.) on the conditions of access to services, on the mandatory requirements imposed on travelers and on the consequences of violations.

The examination of these documents shows that to face the epidemiological emergency technology will certainly contribute to the new organization of urban mobility systems. Moreover, the policies and interventions that transport associations are trying to pursue for economic and social sustainability should be deployed as quickly as possible to reorganize the services and manage the mobility demand. Hence, it is necessary to support the public transport system, not only to preserve a strategic urban mobility sector (the collapse of which would lead to a failure of the entire urban transport system), but also because an increase in the use of private vehicles could lead to a high level of road congestion with serious consequences on the environment and people's quality of life.

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REVIEW NOTES – Urban practices

Toward greener and pandemic-proof cities: Italian cities policy responses to Covid-19 outbreak

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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 by major Italian cities in response to the Covid-19 outbreak.

Keywords
Covid-19; Italy; Urban policies.

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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 July 2020, more than 200 Countries around the world have reported 16,997,821 confirmed cases and a death toll of 665,562 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 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 (Naglaa and 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 and 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). In particular, 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 cleaner 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 (Duarte Pinheiro and Cardoso Luís, 2020; Garcia, 2020). Decentralization of 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 (Pisani, 2020).

Recent analysis of policy measures implemented in major European cities after the Covid outbreak provide early evidence of this integrated approach. Cities like Paris, Berlin, Athens and Dublin are been being radically reshaped, as empty streets have given public authorities the opportunity to implement and accelerate large-scale urban projects finalized providing the ground for a green post-Covid city recovery (The Guardian, 2020a; WHO 2020; UCCN,2020). Although Italy has been one the most affected countries in the world, Italian cities policy response to the Covid-19 has been only partially covered by research and media. Furthermore, it is not clear whether and to what extent such response is contributing to build back more sustainable and pandemic-proof urban settings. Within this context, the present short paper provides a first overview of policies and initiatives undertaken by major Italian cities in response to the Covid outbreak. To this aim, paragraph 3 of the present contribution presents an overview of the measures implemented in the four largest Italian cities. This is followed, in paragraph 4, by a discussion on whether these measures are (or will) promote a sustainable recovery.

3. The Italian case study

Italy has been the first country outside Asia to bear the brunt of the Coronavirus and one of the most affected countries in the world. At the time of writing, 35,000 lost their lives, half of them in the Northern region of Lombardy. Why Italy has been so severely affected by the virus outbreak is currently under debate. Murgante et al., 2020, for instance, found that climate and weather conditions, air quality and urban form played a major role in the development of the virus in Northern Italy and on its diffusion in other parts of the country. On the contrary, Gargiulo et al., 2020 found a weak connection between urban form and the spread of the virus, identifying in the demographic characteristics and economic performances of cities under investigation the main drivers of the virus outbreak.

While the causes of the virus outbreak in Italy are still under investigation, the Italian response to the Covid crises has been timely and comprehensive: Italy has moved in few months from being a global pariah to a model — however imperfect — of viral containment (The Guardian, 2020b). Italy response has been articulated along three main levels of governance: i) the state level, determining general response principles; ii) the regional level adopting detailed rules and iii) the local level issuing regulatory and other administrative acts (Vedaschi, 2020). Municipalities, in particular, have provided a valuable contribution in the implementation of national and regional measures and, some of them, have further developed operational proposals to complement the broader national and regional agenda, with interventions specific to the context in which they operate.

The four sub-paragraphs below provide a summary of the measures undertaken by the four largest Italian cities in response to Covid-19 outbreak. Administrative acts, plans and regulatory frameworks issued by each city have been retrieved from cities' institutional websites, as reported in the bibliographical references at the end of the contribution. Description of impacts on economic sectors - providing background information for the four case studies - are based on CERVID (2020). The small-size pictures accompanying each subparagraph provides an intuitive visualization of the infection rate in each city by proportionally displaying on a map the number of confirmed cases per 10,000 inhabitants.

3.1 Rome

Rome is the capital city of Italy as well as the capital of the Lazio Region. With 2,9 million residents in 1,285 km2, it is also the country's most populated urban area and the third largest city in the European Union. Serving as the center of administration for Italy, Rome hosts national, EU and international organizations headquarters and, as such, its urban economy is largely service-oriented. Furthermore, being appreciated for its large historic heritage, Rome is one of the most visited city in the world. For this reason, Rome's economy strongly relies on the tourist industry. While its historic center is listed by UNESCO as a World Heritage, the recent expansion of its outskirt areas has been characterized by a poorly regulated development, coupled with inadequate infrastructure provision and consequent urban sprawl.

The city economy has been severely hit by the pandemic crisis with tourism, leisure and mobility being the economic sectors suffering the most. Measures in response to the Covid-19 in the Italian capital have been mainly target at containing the virus outbreaks by limiting social contacts and mass gatherings. For instance, the well-known cultural event 'Estate Romana', animating the city' summer nights since 1979 has been strongly downsized, with major events moved to open-air locations. Whit a drop of tourism - one of the main source of income for the city - of approx. 44%, the Municipality of Rome has devoted a large part of the Covid response to recover this sector. Financial support has been provided to tourism and leisure activities through the 'RomeSafeTourism' initiative. Within this context, the city has also approved stringent health-safety measures aimed at increase the confidence in the tourist market by promoting the city as a safe and attractive place to visit and discover. Another big part of the post-Covid response has been devoted to provide economic support to low-income and marginalized communities. The pandemic indeed has further exacerbated the already existent social inequalities and the longstanding rent crises, putting at high risk of social exclusion a big portion of the urban population. Measures finalized at safeguarding the fragile socio-economic households situation included economic support to pay the rent, food aids, facilitated access to credit, improved family and child protective services, and temporary shelters for needy persons and street sleepers.

Only few initiatives implemented by the municipal administration, mainly in the mobility sector, can be considered as structural and not contingent to the pandemic crises. These include the expansion of the city's bike lane infrastructure as well as investments in the city logistics. In this respect, on May 2nd 2020, Rome's city Council approved the construction of 150 kilometers of temporary and permanent cycle routes on the city's main streets and along other key transportation routes. Some of these routes were already foreseen within the city's Sustainable Urban Mobility Plan (SUMP) that has been updated to meet the new demand of cycling mobility, promoted by the Council as a safe mobility option. SUMP updates also included an expanded role for cargo-bikes in the city's logistics system as a safer and more sustainable logistic mode to serve the densely populated city center. Some interventions have also been target toward multimodality: Rome has allocated a dedicated budget to invest in intermodal actions such as multimodal hubs at main train/metro stations, as well as new parking facilities at public schools and offices. Finally, on the May 11th 2020, the Council approved new guidelines for shared electric mobility service provision to allow for the introduction of several thousand scooters via private service providers. Initiatives aimed at promoting sustainable mobility have been coupled with measures aimed at managing mobility demand trough time planning. In this respect, the city Council updated the 'Times and Hours Territorial Plan'. Plan updates are aimed at reducing congestion and mass gathering by rescheduling services opening hours for public facilities such as school, markets, municipal offices, cultural and leisure activities.

3.2 Milan

With 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. The city has experience a sustained urban growth over the past few decades, characterized by the implementation of large-scale urban renovation projects and the development of an efficient and modern public transportation network, coupled with a well-developed shared-mobility eco-system.

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. 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 2020', 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 five 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 (LTZ) 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-min 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.

3.3 Naples

Naples is the regional capital of the Campania Region, the third-largest city of Italy and the largest city in the South, with a population of 967,069 within the city's administrative limits. As one of the oldest continuously inhabited urban areas in the world, Naples' historic city center is the largest in Europe and has been designated as a UNESCO World Heritage Site. City's economy has fast transitioned from industry-based to cultural, tourism and creative economy. However, despite recent economic progress and ambitious land-use and transportation redevelopment plans, the city still faces social and territorial imbalances, especially in peripheral urban areas where social-disadvantages conditions are coupled with persistent degradation of the built environment.

As for other southern Italian cities, the spread of the virus has been relatively contained. However, stringent lockdown measures imposed by the national government – in some cases further reinforced by the regional administration – have caused severe disruption to the city's fragile economy and social tissue. In contrast with the city of Milan that has articulated an organic city adaptation response, Naples response to the Covid-19 has been relatively fragmented and characterized by a number of sectoral policies regulating different aspects of the urban life. These policies have been issued by the city Council between March and July 2020, targeting specific domains such as mobility, social welfare, land uses and public services. In particular, measures in the social welfare domain have been the focus of the public administration. Unemployment rates indeed are relatively high in the city, and there are large numbers of households living below the poverty line. Covid-19 has further compounded this situation, disproportionately affecting low-income and marginalized communities. To tackle this issue the city administration has created a dedicate budget, financed by both public funds (national, regional and municipal resources) as well as private donations. These resources have been devoted to provide households aids in the form of direct economic support (based on family's income), rent relief support, food aids, municipal taxes relief programs and discounts on the purchase of public transport subscriptions.

Important measures have been taken also in the mobility sector, to alleviate congestion and reduce risk of virus transmission on the public transportation network. Lack of a well-functioning transportation network is indeed a longstanding problem in the city and risk of virus transmission have been identified as very high in Naples, since transit commuters are often packed into busy trains or buses at peak times. For this reason, the city is ensuring suitable preventive measures to protect employees and transit users, by cleaning and disinfecting passenger compartments of trains and buses and visibly displaying to the user the appropriate disinfection certification. Furthermore, the city is promoting the use of municipal taxis as alternative mode of transportation by introducing a flat rate of six euros for intra-neighborhood trips starting or ending in 24 established stops.

Main structural measures have been issued in the soft mobility domain, and are finalized at recovering and expanding the city's cycling networks and promote the use of shared bicycles as a safe transportation mode. In this respect, the city launched in April 2020 a participatory process aimed at identified the most suitable locations for the construction of new bike lanes. Based on this, on May 8th 2020, the City Council approved the expansion of the city's infrastructure, with 16 km of new cycle lanes and the implementation of small-scale interventions aimed at increase the comfort and safety of cyclists on already-existent routes. In the same date, the Council also approved guidelines for introducing electric shared mobility services in the city. These guidelines provide the legal and administrative base for the introduction of micro-mobility services, the development of the electric vehicles charging infrastructures and the activation of a line of financial support for the acquisition of electronic bikes. Mobility-related measures have been coupled with public spaces allocation measures. These measures have been mainly target at supporting the recovery of leisure and touristic activity. Tourism indeed has flourished in the city in the past few years and many activities have been reconverted to accommodate the growing demand of touristic services. With a step-down in the arrival of foreigner city visitors and strong lock-down measures, these activities, mainly concentrated in the historic city center, have suffered significant economic lost. To support their recovery, the LTZ zone of the city center have been further expanded. Furthermore, bars, restaurant and café have been allowed to expand their terraces onto sidewalks and even close roads in some areas. Finally, as for other Italian cities, the city Council has re-designed the 'Territorial Times and Hours Plan' that reschedules the opening hours of public services in order to reduce congestion and mass gathering.

3.4 Turin

Turin is the regional capital of Piedmont and the fourth largest city in Italy with an urban population of 875,698 inhabitants. Turin economy has been traditionally associated with the automotive and aerospace industry that since the seventies has been - and still is - the largest employer in the city. Starting from the early 2000s, the city has diversified its economy and is shifting back towards a service-oriented one. Due to consistent infrastructural investments and a smart place-branding strategy, the city has successfully promoted a new urban representation at an international level as a cultural and innovation hub.

Turin sustained economy has been hit hard by the virus outbreak. In particular, Turin and its metropolitan area ae the most affected area in the country in terms of economic dropdown, with an estimated reduction in revenues for business and companies operating in the city of approx. -15% for the current year, with manufacturing

and commerce being the most damaged sectors. Despite large economic impacts, signs of a coordinated municipal response are hard to find. On the contrary, a myriad of small-scale initiatives provide interesting examples of the growing role of technologies in the city recovery response. These initiatives are finalized at fostering city's sustainability, both on the social and environmental fronts. A notable example in this direction is the 'Torino solidale' project, a dedicated solidarity fund, aimed at supporting families and persons in needs by providing food aids and other form of welfare checks. Technologies here have been employed to drastically reduce the time needed to provide food to people in economic difficulties and to identify priorities in the distribution of food parcels in a more precise manner. Another interesting initiative is the 'Torino City Love' campaign which, through digital solidarity, has developed about hundred small-scale projects to 'freely provide 'resources, actions and skills to citizens and businesses affected by the Covid crises', often in partnership with private companies and stakeholders. For instance, in partnership with internet providers, the city is providing free home connectivity, free laptops and collaboration tools in support of teleworking and long-distance learning. Another initiative, in partnership with automotive companies, is dedicated at improving the city mobility: the initiative, named 'Turin Geofencing Lab', is currently experimenting the introduction of electrical cars in the city as well as the introduction of intelligent transportation system solutions finalized at monitoring the correct implementation of traffic limitations in the city's central areas. The city is also paying a great attention to skills re-development as a tool to promote economic and social recovery and increase citizen's resilience to future threats. In this respect, a growing network of private partners, coordinated by the public administration, is providing free programs and e-learning courses for Turin citizens, with particular emphasis on the development of in-demand skills such as coding, translation, media production and sales. Finally, the city has recently started a general reorganization of its administrative apparatus, finalized at improving administrative procedures while promoting safety and security on workplaces. This reorganization is expected to provide the conditions for fostering teleworking among the municipal workforce with an estimation of 1,600 working units to be able to telework from home. The same initiative also includes financial incentives for municipal workers that will shift work-commuting from private cars to active modes of transportation.

4. 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 Italy and examined policy response to the Covid-19 epidemic in its four largest cities.

A cross-city analysis of measures implemented in Italian cities 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:

- *Expansion of cycling infrastructures.* In line with major European cities, the cities of Milan, Rome and Naples have devoted a significant part of their recovery budget in the expansion of their 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, 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 and Shaw, 2012).
- *Improvement of walking paths/ expansion of pedestrian areas*. Measure aimed at fostering pedestrian mobility by improving walking paths (e.g. widening the width of sidewalks or improving pedestrian safety) and expanding pedestrian areas have been introduced in the cities of Milan and Naples. 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.* The city of Milan has strongly promoted the extension of urban green spaces and the development of open spaces functions. To a less extend, these measures have been also promoted in the city of Naples. 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 and 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.
- *Decentralization of public* facilities. The adaptation strategy of the city of Milan includes measures finalized at relocating public functions within the cities in order to balance the differences between districts. 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 (Manual, 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.
- *City time planning*. All cities under analysis have put in place some form of regulation aimed at a general reorganization of the times of the city to redraw city's work, school, and daily lifetime patterns. These measures might provide a valuable contribution in limiting social contacts and mass gatherings at facility sites as well as through the journey to reach such facilities. Furthermore, if coupled with opportune mobility and land use interventions these measure can also provide value in reducing traffic congestions during peak hours. However, the possibility to extend these measures in the long term might result problematic.
- *Household / small business economic support.* All cities under investigation provided some forms of economic support to households and business. The pandemic crises indeed has exacerbated the existing social inequalities while severely affecting cities economy. Measure aimed at provide households economic, social or rental support have been more intense in cities characterized by pre-existent social inequalities (e.g. Naples and Rome). Measures in support of city business have been target to the most affected sectors (e.g. tourism in Rome) but also strategically to sectors identified as key players in the post-Covid recovery scenario (e.g. the construction industry in Milan). 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.
- *Improvement of IT infrastructures and digital services*. The city of Turin and Milan have dedicated significant efforts in the improvement of IT infrastructures and digitalization of public 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. As showed by the good practices implemented in the city of Turing, IT technologies can also provide a fast and concrete response to citizen's needs. Investments in this domain should be thus certainly encouraged.

- *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. Within this context, the city of Turin has invested a consistent effort in human capital re-development as a measure to recover from the virus pandemic. These measures are highly recommended by international organizations as they provide the ground for fostering citizens' resilience to current and future disruptive events.

Table 1 provides an overview of the measures discussed above and their implementation in the four cities under analysis. It suggests that urban policies in the Italian cities has been mainly target at ensuring financial support to households and business and regulating the opening hours of public services. While undoubtedly necessary, these measures are temporary and contingent to the ongoing crisis.

	Rome	Milan	Naples	Turin
Cycling infrastructures expansion	✔	✔	✔	✗
Pedestrian areas/walking paths recovery	✗	✔	~	✗
Green and open-space functions expansion	✗	✔	✗	✗
Decentralization of public facilities	✗	✔	✗	✗
City time planning	✔	✔	✔	✔
Households/business economic support	✔	✔	✔	✔
IT infrastructures and services improvement	✗	✔	✗	✔
Human capital development	✗	~	✗	✔

Tab.1 Overview of measures implemented in the four largest Italian cities.

✔ Consistent policy making in this area. ✗ No intervention in this area. ~ Limited policymaking in this area.

Although more structural interventions to promote soft mobility and digitalize public services have been put in place, in most cases, measures have been uncoordinated, favoring a sectoral rather than a systemic approach. The city of Milan represents the only notable exception. The capital city of Lombardy has put in place a long-term adaptation strategy, addressing different policy domains in a coordinated fashion, and aimed at making Milan a pandemic-proof city, while, at the same time, improving city sustainability and quality of life of its citizens.

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Image Sources

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REVIEW NOTES – Economy, business and land use

Entrepreneurship in the city: the digitalization

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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 underlines the benefits that entrepreneurship exerts on the city, with a specific focus on the digitalization.

Keywords
Digitalization; Entrepreneurship; City.

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1. Introduction

Entrepreneurship is among the economic measures that determines the growth and wellbeing of a city (Glaeser & Kerr, 2010). Cities that offer the best conditions for firms to grow up or that ease the birth of new entrepreneurial activities, increase the number of jobs they offer, in turn enhancing citizens' wellbeing and budget (Lee & Rodríguez-Pose, 2020; Lee, 2017). With a study based on US cities, Lee (2017) recently found that a 10% increase in new birth of small businesses increases urban employment by 1.3-2.2% and wages by 1.2-2.0%. In addition, such virtuous path increases the attractiveness of the city for talents and new investments. In other words, creating the best conditions for entrepreneurs to invest and implement their business ideas, is an important mean for cities to grow up from an economic and a social perspective (Fritsch & Noseleit, 2013). A recent example of the importance that entrepreneurship has for cities is provided by the Brexit. Several start-ups are planning to leave UK – one of the most attractive countries for new ventures - if Brexit conditions will penalize them. Accordingly, many European cities like Berlin, Lisbon, Amsterdam and Dublin are designing strategies to host such a plethora of businesses (The Guardian, 2017).

At the same time, the entrepreneurial commitment of a city also depends on the implementation of activities aimed at transforming the systems that control government efficiency and effectiveness (Bernier & Hafsi, 2007). For example, transparent administration or Open Data strategies can be considered as forms of public entrepreneurship (Bernier & Hafsi, 2007).

Established literature on the topic argues that the entrepreneurial vocation of a territory may depend on market or institutional factors. As far as market is concerned, small independent firms enhance the entrepreneurial capability of a city or a region by lowering the costs of entry through the development of independent suppliers and by creating an entrepreneurial culture (Glaeser & Kerr, 2010; Saxenian, 1990). In an institutional perspective, the entrepreneurial activity may be influenced by the level of education, cost advantages, infrastructures, climate and accessibility (Glaeser & Kerr, 2010). These factors largely depend on the intervention of governs and policymakers. Recently, Lee & Rodríguez-Pose (2020) also found that entrepreneurship – in firms belonging to tradeable sectors - is a mean to reduce poverty in cities, increasing incomes for non-entrepreneurs. However, this positive effect depends on the productivity and innovation levels reached by the businesses (Baumol & Strom, 2007) that are also affected by territorial capital (Castelnovo et al., 2020; Geissinger et al., 2019), and on companies' ability to correctly embrace technological challenges. Among these, the digitalization is one of the most relevant issues that companies and societies need to face, and providing successful digital services may help business to grow and cities to develop new competences while benefiting citizens' life. That said, this review note, aims at describing what are the possible advantages for cities in favoring the spread of digital services both attracting digital companies and implementing e-governance strategies. In the next pages of this short article, I will briefly underline the relevance of the digital entrepreneurship in the city and different possibilities that cities have in order to implement a digital strategy. Finally, I will draft concluding considerations about Italian digital strategies and how are Italian cities responding to the challenge of the digital transformation.

1.2 Digital entrepreneurship in the city

Entrepreneurship represents a way through which cities can increase their resilience to economic and natural shocks (Errigo, 2018; Molavi, 2018; Williams & Vorley, 2014). This aspect assumed great relevance in recent years, since economy has been affected by two enormous shocks in the last 15 years with the 2008 financial crisis and the recent Covid-19 pandemic. In particular, firms characterized by flexibility, that are able to adapt to changing contexts, are the ones that are more prepared to external shocks, in turn enhancing the capability of the city to respond to economic downturns. Small and flexible firms such as startups, are also the ones that typically implement technological and organizational innovations, developing competences that trigger adaptive behaviors (Pinelli et al., 2020). The recent Covid-19 pandemic, for example, has shown that digital

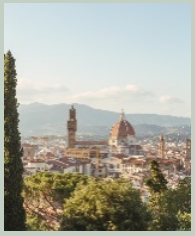
skills are fundamental to maintain high levels of productivity allowing people to work even far from their usual offices and job places. In addition, digital industries are characterized by strong interconnections between businesses that favor the growth of the entire system exploiting a network effect (Losurdo et al., 2019). This aspect is particularly relevant, for example, in the service industries that traditionally determines the economic systems in large urban centers. Thus, given the aforementioned importance that digital firms may have in the economic, cities that promote digital entrepreneurial strategies can exploit the relative benefits (Komninos et al., 2019): increase employment, productivity, wellbeing, resilience and technological readiness to future challenges. Cities can enhance their digital capabilities in two ways that are not mutually exclusive. Rather, they should both be implemented to develop a proper digital strategy: from one side cities can develop strategies to attract and maintain digital companies, from the other they can embed digital facilities in the public administration, offering digital services to citizens. In the latter case, research has extensively argued about the advantages of implementing digital technologies in public administrations, that enhance transparency and engagement while reducing administrative costs (Young, 2020). Cities promote the diffusion of digital technologies also for mitigating climate risks, for example through the implementation of shared mobility measures aimed at improving air quality and reduce congestion (Bai et al., 2018; Creutzig et al., 2019; Rolnick et al., 2019).

On the other side, cities may increase their attractiveness towards digital firms by attracting venture capital and skilled labor that find the best conditions to grow in a dense and interconnected urban context (Geissinger et al., 2019). In addition to the several advantages previously discussed, such a context also offers to the city the possibility to positively react to new technological shocks by easily internalizing new developments in digital technologies.

2. Digitalization in Italy

With particular reference to Italy, the national strategy aimed at implementing the digital transformation is based on two pillars: transparent administration and diffusion of digital technologies in firms. In practical terms, the aim is to promote the diffusion of robotics, artificial intelligence, cyber security systems – and other industry 4.0 technologies - in companies, and to implement e-governance strategies. Going in depth in the analysis of the most digitalized Italian cities it is possible to state that their main commitment regards e-governance measures. In their plans, indeed, Italian cities hardly mention actions aimed at attracting new digital firms. According to the recent I-City Rank 2019 (ForumPA, 2019), Florence, Bologna and Milan are the most performing cities in terms of digitalization. In the following boxes we will deepen the main activities implemented by these three cities that represent the more advanced cases of digitalization of Italian cities. In details, Italian cities appear to push a lot on e-governance and social inclusion, with measures aimed at involving local stakeholders in decision-making processes. Another very sensible aspect for Italian cities is that of open data and transparent administration that eases the relationship between citizens and firms and the public administration. On the other side, Italian cities show a lack of strategies aimed at attracting digital entrepreneurs. Such a weak commitment is limiting for Italian territories that can hardly exploit benefits coming from the diffusion of digital firms in their urban centers. To this end, Italian policymakers should be aware of the fact that, while they appear to be moving in the right way in terms of public entrepreneurship and e-governance measures, urban digital strategies should still do a lot more in terms of creating conditions for digital companies to born and prosper.

Digitalization in Florence



Florence is one of the Italian cities that supports firms towards the digital transformation through education and consultancy activities. The aim of such program is to bring local businesses closer to the industry 4.0 paradigm. In addition, the local chamber of commerce provides financial supports to local firms through the grant of vouchers. The city of Florence also supports local businesses with lectures and seminars about digital marketing provided in partnership with Google. Such partnership also has the ambitious goal of educating the so-called NEET (Not-engaged in Education, Employment or Training), in turn performing a social utility function. Florence also offers to local entrepreneurs the access to the Fintech Digital Index – a database that provides information about the most advanced digital companies in the country on topics like blockchain, big data and analytics.

Digitalization in Bologna

Bologna is among the Italian cities that adopted a digital agenda planning their digital transformation since 2011. In the 2016-2020 digital plan, the city of Bologna mainly prioritizes interventions aimed at improving services to citizens: enhancing free wireless, spreading the broadband, improving digital communication with firms and citizens that allow them to participate to decisions, simplifying online services, implementing data-driven decision-making. So, Bologna is giving priority to the participative administration and to its relationship with local stakeholders. This aspect is also remarked by the fact that the Digital Agenda has been developed through the involvement of several stakeholders.

Digitalization in Milan

Milan is among the few cities in Italy that has established a department for the digital transformation. The main commitment of Milan towards the digital transformation refers to the Open Data strategy. For example, Milan administration provides an open access platform that allows to manage and share in an integrated way, through technical maps, all the geographic data held by the Municipality of Milan, allowing an agile and streamlined publication of spatial data in an open format. In addition, Milan has improved some functions offered through online channels to ease citizens' access to specific services such as building and events.

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