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Article

Walkable City and Military Enclaves. Analysis and decision-making approach to support the proximity connection in urban regeneration

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Abstract: The concepts of accessibility and urban walkability are the cornerstones of urban policies for the contemporary city, called upon to adopt sustainable development models in line with the objectives of the 2030 Agenda and the ambitious objectives of the 'European Green Deal'. These concepts are closely linked to the paradigm of a sustainable city (livable, healthy and inclusive), founded on a system of quality public spaces and on a network of services and infrastructures, both tangible and intangible, capable of strengthening or building new relationships: social, economic and environmental. It is therefore necessary to recognize potential opportunities for connection and permeability in consolidated urban environments, very often fragmented and characterized by enclaves. Within this framework, the city of Cagliari represents an interesting case study as it is characterized by the presence of a series of military complexes, real 'enclaves' which condition the proximity connections and, more generally, the walkability. In this sense, building on previous research and analysis of policies and projects aimed at reintroducing, even partially, this military asset into civilian life (Green Barracks Project - GBP - 2019), this study proposes and applies a methodology to improve urban accessibility in a flexible network logic, where 'walkability' can become not only a moment of possible "choice" but the basis for planning oriented to the '15 min city' model or, more generally, to the renewed, inclusive, safe, resilient and sustainable "City of proximity".

Keywords: City of Proximity; Walkability; 15 Minute City; Urban Regeneration; Urban Enclaves; Green Military Barracks

1. Introduction

The process of economic transition from the old to the new economy produces its effects on cities and territories. The modification of the production structure has, in fact, led to a substantial urban change with numerous phenomena of decommissioning of buildings and latent abandonment. In particular, starting from the 1980s, the decommissioning of industrial areas and large public infrastructures and / or factories, which characterized the nineteenth-century city and the first half of the twentieth century, inaugurated the conversion phase, where institutions and investors have developed enhancement proposals [1, 2, 3, 4].

Furthermore, the need to adopt sustainable urban development models [5, 6, 7] to favor the much-desired ecological transition based on the protection of the environment [8, 9] and more generally of the protection of natural resources also with the contrast to the indiscriminate consumption of land [10,11] confirms that the topic of reuse and the circular economy [12, 13, 14] in the management of public assets is a relevant issue to be

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discussed: civil and military disused facilities play a central role in political debate, as well as in urban planning and governance.

The disposal of public real estate mainly affects the historic city and this highlights the determining role of this asset for the definition of urban regeneration strategies of the compact city model [15], guaranteeing health -well-being [16, 17].

The Covid-19 epidemic has in fact highlighted important critical issues in both domestic and urban spaces, which can in part be overcome through the implementation of strategies for the use of disused buildings: civil and military with potential and multiple tangible values and intangibles which are also based on slow mobility [3, 6 , 18, 19]. In this sense, the city of 15 minutes or city of proximity [20, 21, 22], as a derivation from the concept of "neighborhood unit" (1923), aims to ensure sustainable accessibility to central services and / or places, helping to reduce commuting phenomena and therefore to reduce negative externalities such as air pollution. The city of 15 minutes, however, also clashes with the consolidated urban layout of the cities, including the enclave effect caused by disused buildings.

Big 'enclaves' are, among others, often formerly military building-area, whose reconversion assumes a strategic role both in terms of re-functionalization but also of urban connections capable of attenuating the sense of anticommons in semicommons or commons [23, 24, 25].

Military areas, in fact, have the characteristics of 'anticommons', a concept first introduced by Michelman in 1982, and then taken up and further developed by Heller (1997) and Eisenberg (1998) through the theory relating to the under - use or exclusion of a resource or context.

In this sense, the reconversion policies based on the principles of environmental, economic and social sustainability, combined with the Walkable City approach - from land use mix to tactical urbanism [26-30], help to overcome the anti common condition that weighs on military buildings in urban areas.

In this framework, the main scope of this work is to evaluate the potential offered by an even partial conversion of military complexes towards urban, civil uses, in particular in terms of permeability and capacity of enhancing walkability in an urban environment. To do so, a composite Walkability in Big Building Index (WBBI), already implemented and applied by authors to other cases, will be hereby used and applied to military complex facilities in the city of Cagliari (Sardinia, Italy), comparing ante and post operam (ex-ante evaluation).

The rest of the paper is organized as follows:

- section 2, Literature review;
- section 3, which describes the new approaches to the regeneration of the military heritage aimed at favoring the transition from anticommons to semicommons;
- section 4, which deals with the case study of military areas in the city of Cagliari, Sardinia, Italy;
- section 5, which describes the proposed methodology and application to the case study;
- section 6, discussion;
- section 7, conclusions and future development.

2. Materials and Methods

This section reports the literature review on the two main themes addressed by this paper, i.e. the post-Covid-19 city and the regeneration of public-owned assets, specifically military sites in Italy.

The 2020 pandemic outbreak has apparently accelerated innovative measures to deal with the side effects of the city-making process under neoliberal urbanism dynamics [31]. Despite being introduced in the pre-pandemic period, solutions such as the 15-minute city[32], Superblocks [33] and Tactical urbanism [34] are being growingly applied across

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the world [35]. They are claimed to provide the 'right to the city' [36], deal with environmental issues and address the impacts of climate change by providing a healthier and human-centered environment. Their increasing application since 2020 [37] seemingly relies on the findings of epidemiologists regarding the causes of COVID-19-related rate of infections. People living in areas having a high air pollution index and extreme meteorological conditions have higher risk of mortality [38, 39, 40] and COVID-19 particularly hits deprived neighborhoods [41, 42] and exacerbates urban issues such as socio-spatial segregation [43]. In particular, the application of the 15-minute city approach [44] may match the European-fostered programme "European Green Deal" [45] launched in December 2019 [46], whose implementation is being delivered by the so-called New European Bauhaus [47]. A relevant aspect of the application of the 15-minute city can be the development of a local- and territorial-scaled urban planning strategy that may give life back to the myriad of urban voids located within cities [48], even though the analysis of this aspect is still at its beginning in the current literature [49]. If we take into consideration the case of Italy and specifically a branch of the unused public-owned assets [50, 51], military sites stand out for their character of high-consuming pieces of land that may boost large urban regeneration processes and consequently deal with the urgency to provide a healthy and safe life for the citizenship [52]. After more than 30 years of failing public policies to reuse these assets [53] and increasing research at international and national level [54, 55, 56, 57], the recovery of former military sites may take advantage of the human-centered approaches of the post-COVID-19 city.

3. Approaches to the regeneration of military buildings in Italy: from anticommons to semicommons

The redevelopment of the Italian military asset and, in particular, the recovery of the unused barracks complexes, pursue the twofold objective: improve the architectural quality of the existing building stock and encourage urban regeneration processes of wider contexts, also through coordinated actions between urban planning and public–private partnerships [24]. Based on this assumption, in 2019 the Italian Army presented the "Large Infrastructures - Green Barracks Proiect (GBP)" project (Ministry of Defense, 2019) [58]. It is dedicated to the study and the future construction of a new generation of military infrastructures, energy efficient and functional for mainly military needs, but without excluding some of the civil types such as training and sport. Among the infrastructures of the Armed Forces contained in the document "Global Plan for Rationalization of the Army Infrastructure" (PGRIE) [59], 26 sites located throughout the national territory have been considered strategic (Figure 1): 6 areas in the north-west, as many in central Italy, 5 in the north-east, 9 in southern Italy - including the islands -. Among those falling in the islands, two are located in the Sardinia Region: the "Mereu-Riva di Villasanta-Monfenera" barracks, in the Municipality of Cagliari; the "Pisano" Barracks and Capo Teulada shooting range, in the Municipality of Teulada.

The redevelopment of the Italian military asset and in particular, the recovery of the unused barracks complexes The GBP provides for a total investment of 1.5 billion over 20 years. Inspired by innovative construction criteria, the project is primarily geared toward modernization and renewal of the military asset with the intention of achieving high quality standards of the working environments of staff and their families and the containment of environmental impacts, as well as of activating - strengthening the interaction between the barracks and the local context.

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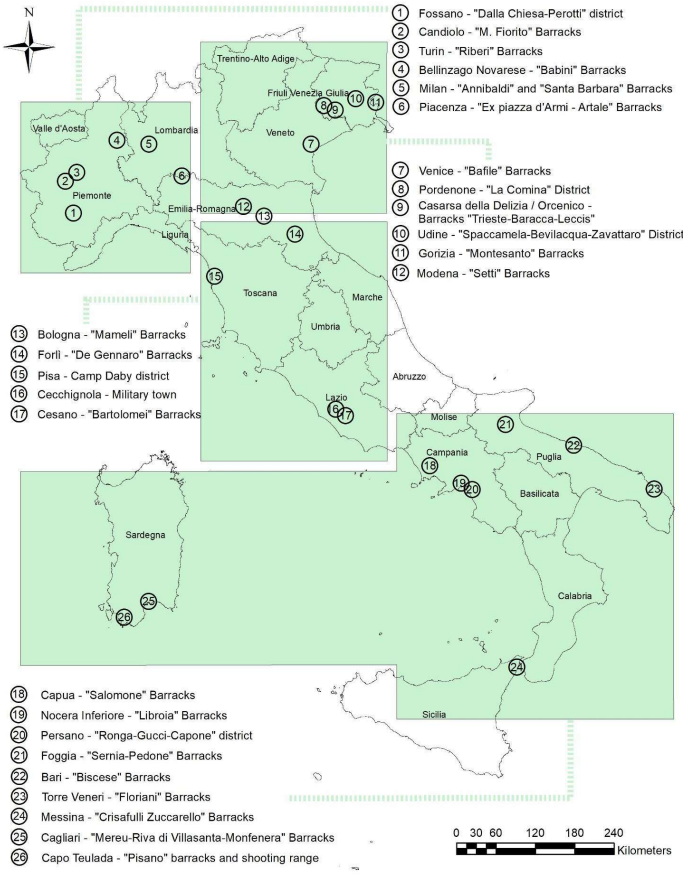

Figure 1. Location of the 26 military sites included in the GBP. Source: Ministry of Defense (2019). Authors: Milesi A. and Ladu M. (2021).

As a matter of fact, the new military bases have a functional organization aimed at promoting greater social inclusion. In this sense, the 'dual use' approach to structures allows sharing of sports and recreational services with citizens by specific agreements.

As part of a future standardization of interventions, each of the 26 sites should have the necessary structures to carry out five priority functional areas: command, training, logistics, sports / recreation and accommodation. Among these, the sports / recreational one, intended to accommodate the spaces for carrying out sports activities, constitutes an element of union between the army and the local population. For this reason, the GBP can be understood as an important sign of the opening of military 'enclaves' towards the city, as well as a first step in favor of the hoped-for transition from anticommons to semicommons-commons [60, 61, 6].

However, we emphasize that the success of the GBP will also depend on the ability to integrate this renewed strategy within a comprehensive urban regeneration project aimed at improving the conditions of the surrounding built environment [62, 63], especially of its open space and in terms of accessibility and connectivity, in line with the principles of the Walkable City [64].

4. The case study of the military barracks in the city of Cagliari (Sardinia)

The city of Cagliari, capital of the Sardinia Region and Metropolitan City since 2016, with over 150,000 inhabitants, is the most important cultural, economic, political and administrative center of Sardinia.

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However, in analogy with the current national and international trend, the Cagliari is affected by phenomena of decommissioning and potential abandonment of public and private buildings, evidence of the evolution of central places. These are buildings and areas characterized by historical-architectural values that are devastating for urban regeneration [63]. The Strategic Plan of the Metropolitan City of Cagliari is based on these assumptions (SPMCC, 2021) [65, 9].

Some military buildings have already been transferred from the Military Property to the Autonomous Region of Sardinia [66] becoming an integral part of the city and a resource for the community [67]. This is a process started in the early 2000s for the redevelopment of the barracks to meet the needs of the community in the broader framework of the 2030 agenda and climate neutrality [68], also through the models of: Walkable City, 15 minutes City, Safe and Healthy City and Sport City. The military barracks are characterized by large areas with respect to the surrounding urban fabric, exceeding 10,000 square meters. The inhibition of the crossing therefore determines the circumnavigation, also highlighted by the tracks recorded by the smart community of the Strava digital platform (Figure 2), which highlights the geo-referenced digital traces of slow mobility (walking, running and cycling).

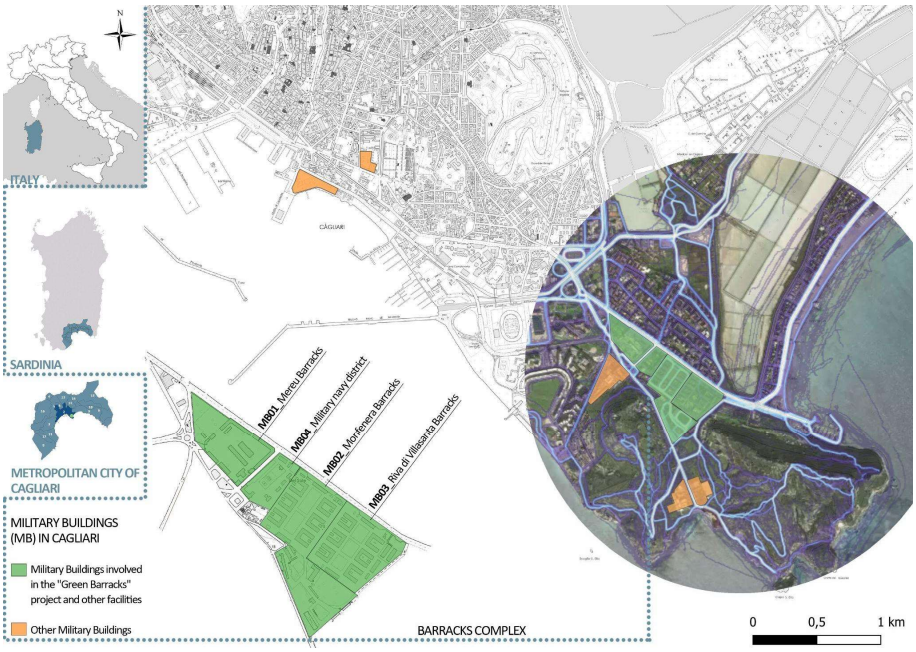

Figure 2. Geospatial location of the military barracks in the city of Cagliari. Below, detection of the tracks recorded by the smart community through the Strava digital platform (30.09.2021). Authors: Milesi A. and Ladu M. (2021).

The heat map portion Figure 2 (Strava digital platform) highlights the propensity of road networks to slow mobility. It is starting from the observation (direct in the field and indirect of the digital traces) of the enclave phenomenon that the authors have developed a research methodology with the aim of defining an index of representativeness of Walkable Big Buildings Index (WBBI), which is a function of three main factors: porosity (PI), crossing (CI) and attractiveness (AI).

5. Methodology and data

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5.1 Methodology: Porosity (PI), Crossing (CI) and Attractiveness (AI) Indices and Composite Index - Walkability in Big Building Index (WBBI)

From the above considerations, the present study proposes a methodology for evaluating urban accessibility 'before and after construction', where 'walkability' can become not only a moment of possible 'choice', but significant mobility in the urban environment with multiple benefits (environmental, health and well-being) individual and collective [69, 70].

In particular, the method is based on the combination of the following factors: building area, number of crossings, number and variety of the main urban proximity functions (15 min) ante and post operam of actions proposed in the Strategic urban planning of the metropolitan city of Cagliari (Concurrent planning, 2019).

This method, already developed and applied in the main public enclaves of the historic center of Cagliari, consists in the definition of the Walkable Big Buildings Index (WBBI). In particular, WBBI (synthetic index) is a function of 'porosity', 'crossing' and 'attractiveness', three factors that the present study recognizes as determining for the reduction of the enclave effect [49]:

1) Porosity index (PI): the weighted coverage ratio, between the building area and the pertinent free land area. The PI was calculated as in the formula: [70].

$$PI = Rc * p_p$$

where R_c = the ratio, in percentage, between covered area referred to the building, built or buildable, and the land area of reference, and p_P is a weight to be attributed to the ratio R_c, so that:

$$0 \leq p_p \leq n$$

In particular, if $R_c \Rightarrow 0$ then the weight $p_p \Rightarrow$ n (linear decreasing function) according to an inverse relationship is closely related to the conditions of the reference context, but if R_c=0 then PI=1.

In other words, as Rc decreases, the weight pp increases in order to appreciate the empty area included in the building areas functional to walkability (see case study, Paragraph 5.2).

2) Crossing index (CI): The crossing index specifies the level of crossability that characterizes each barracks and depends on the architectural morphology of the building, in particular on the number of paths that connect the sides of the building area. The CI was calculated as in the formula:

$$CI = Nc * p_c$$

where N_c = number of crossings that unfold between two accesses and that allows us to relate more urban portions and pc is a weight to be attributed to the N_c, so that:

$$0 \leq p_c \leq 1$$

In particular, if $N_c \Rightarrow$n then the weight $p_c \Rightarrow 1$ (linear increasing function) according to a direct relationship and is closely related to the conditions of the reference context. In other words, as N_c increases, the pc weight increases in order to appreciate the crossings included in the functional areas for walkability (see case study, Paragraph 5.2).

3) Attractiveness index (AI) refers to both the number and the variety of central places found within a 15-minute travel range from the analyzed barracks. For this index, the Simpson diversity index was used, which makes it possible to give weight to the diversity of urban facilities. The Simpson diversity index, used in statistics in the case of populations with a finite number (in the case of index D) of elements:

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$$AI = D = 1 - log \sum_j \frac{Nj(Nj-1)}{N(N-1)} = -log\lambda \frac{\sum_j Nj(Nj-1)}{N(N-1)} = -log\lambda$$

where Nj indicates the number of j-th "species"

$$N = \sum_j Nj$$

where λ corresponds to the Simpson concentration index in the case of a finite population.

$$\lambda = \frac{\sum_j Nj(Nj-1)}{N(N-1)}$$

The Simpson index finds a wide application in ecology to represent environmental ecological diversity and by analogy it has been transposed to the urban context [71, 72, 73], or to the diversity of urban services. Specifically, it refers to the diversity of central locations. These indexes constitute the first set proposed by the authors of a big data set under development, representative in quantitative terms of the intrinsic and extrinsic walkability of large-scale disused public assets, such as barracks.

4) Walkable Big Buildings Index (WBBI). The indexes PI, CI and AI were integrated by the authors into a composite index Walkable Big Buildings Index (WBBI) experienced in the historic center of the city of Cagliari. In particular, the WBBI is the sum of the weighted (pk) indexes (PI, CI, AI), where the sum of weights is 1. To distinguish this index from the others, a one hundred basis was used. The WBBI was calculated as in the formula:

$$\text{WBBI} = \sum_{i=1}^{n} (I_i * p_k) * 100 \quad \text{where} \quad \sum_{k=1}^{n} p_k = 1 \quad \textit{and} \quad I_i = \textit{PI, CI, AI, … where i=1, 2,3,..n}$$

where p_k represents the weight attributed to each index in relation of the urban form of the military enclave and its proximity contexts, extrapolated empirical evaluation of the Municipal Urban Plan [74] and the Strategic Plan of the Cagliari city [75].

5.2 Study Area and Data

The peculiarity of the Cagliari case study lies in the location of the military areas to be redeveloped, concentrated between the district of San Bartolomeo and the promontory of Sant'Elia, in a landscape context characterized by significant environmental components and territorial invariants [9], mixed with historical military settlement processes [76, 77].

In particular, the case study consists of a barracks complex with a total area equal to 279.981,325 sqm (MB01 = 36.764,967 sqm; MB02 = 129.806,581 sqm; MB03 = 84.081,493 sqm; MB04 = 29.328,315 sqm), which is part of the GBP. As shown in Figure 3, the barracks complex can currently be crossed in the northern portion, in correspondence with a street indicated with a light blue line (ante operam). In line with the GBP objectives, which ask for a mixed civil - military use of some portions, we propose a new network to cross the complex, indicated with a red line (post operam) (Figure 3).

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Figure 3. Representation of the barracks complex ante (light blue line) and post operam (red line). Authors: Milesi A. and Ladu M. (2021).

We then proceeded to evaluate the indices (PI, CI, AI and composite index WBBI) of ante and post operam from GBP. In particular, the following is obtained from the spatial distribution of urban buildings and from the relative urban design of the city of Cagliari. It should be noted that the calculation is empirical and derives from the relationship of urban saturation and from the transport infrastructures and allows to represent the urban contextualization [78] (Figure 4).

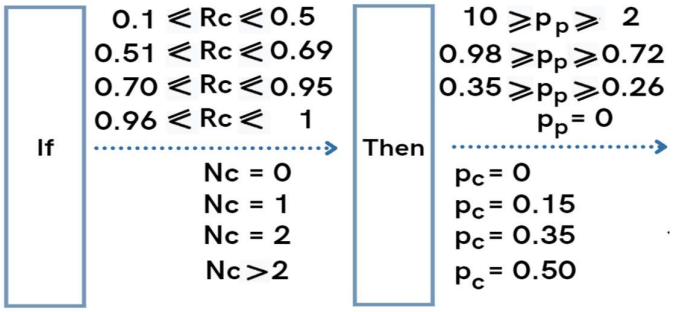

Figure 4. PI and CI of the barracks system (MB01, MB02, MB03 and MB04).

The assessment of the attractiveness index (AI) to the case study was developed through the geospatial localization of urban proximity services using the Walk Score application [79], with an area of about 1200 meters from the centroid (barracks) or an urban space of about 15 min, ante and post operam (Figure 5).

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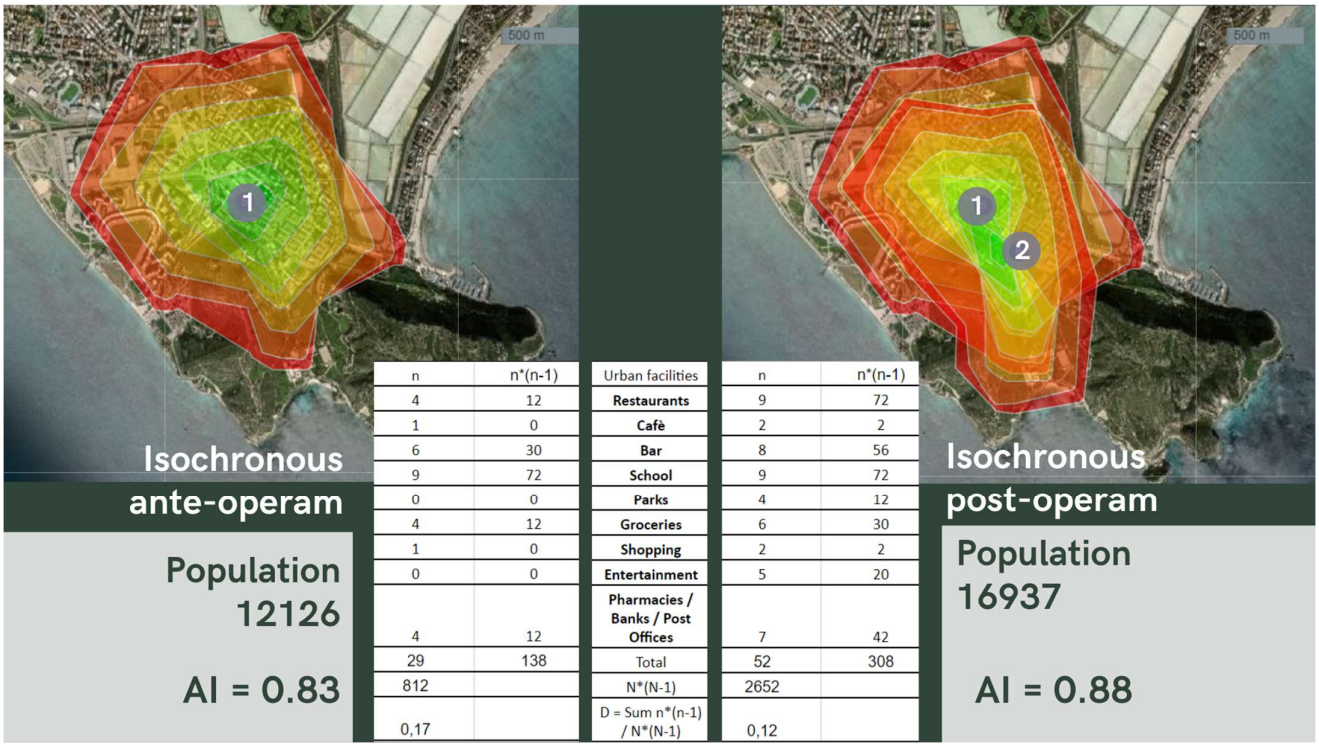

n	n*(n-1)	Urban facilities	n	n*(n-1)
4	12	Restaurants	9	72
1	0	Cafè	2	2
6	30	Bar	8	56
9	72	School	9	72
0	0	Parks	4	12
4	12	Groceries	6	30
1	0	Shopping	2	2
0	0	Entertainment	5	20
4	12	Pharmacies / Banks / Post Offices	7	42
29	138	Total	52	308
812		N*(N-1)	2652	
0,17		D = Sum n*(n-1) / N*(N-1)	0,12	

Figure 5. Isochrone 15 min by foot (ante and post operam) and relative AI (Attractiveness Index). Author: Balletto G. and Milesi A. (2021). Source: https://maps.openrouteservice.org and https://www.walkscore.com

By the observation of Figure 5 with the two simulations - ante and post operam - it is possible to highlight how in the post operam case, there is an important increase of the urban facilities and population reachable, by means of the increase of the walkability. Figure 5 ante operam is in fact showing an AI of 0.83, that increases to a value of 0.88 in the post operam case. The picture portrays the overlapping of the ante operam catchment area - centred on point 1, from which isochrone lines are computed - and post operam one - as a combination of the point 1 isochrone lines and point 2 ones.

Figure 6 below shows a summary table of the calculation of the four indices, starting from the input data referring to the barracks complex (ante and post operam) in the urban context of the city of Cagliari.

In particular, for the evaluation of the WBBI, we considered pk = 0.33 for PI, pk = 0.33 for CI and pk = 0.33 for AI, because no particular urban context conditions were found that would justify a differentiation of weights.

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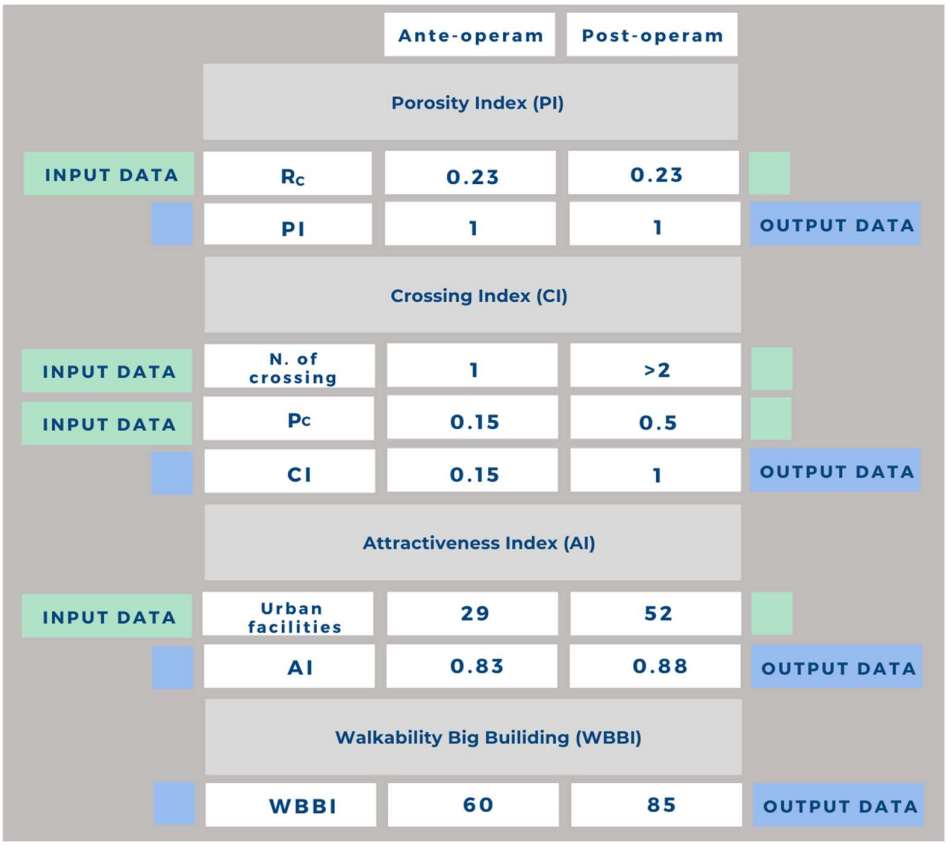

Figure 6. Input and output data referred to the index calculation PI, CI, AI and WBBI for ante and post operam. Authors: Balletto G. and Milesi A. (2021).

The results of the proposed method are presented and discussed in section 6.

6. Discussion

In this work we wanted to propose and apply a methodological approach already developed by the authors, to evaluate indices for analysis and decision support in the context of the 15-minute city hopes. In particular, through PI (Porosity Index), CI (Crossing Index) and AI (Attractiveness Index), a combined WBBI index (Walkability Big Building Index) applied to the case study of the barracks complex (total area 279.981,325 sqm) it was possible to compare the effects of walkability deriving from the urban regeneration project of the Green Barracks Project (GBP).

This research work through the use of the diversity index (Simpson) has also made it possible to experiment with the role of diversity of urban services for pedestrian attractiveness. According to the authors, this constitutes the original contribution of the proposed method, as well as its exportable application in other similar national and international contexts, in line with the European Green deal which recalls the importance of acting in favor of an agile and healthy city.

In summary, through these indices it is possible to relate intrinsic elements (PI and CI) with extrinsic elements (AI) of a certain large building that constitutes an urban enclave (barracks) to evaluate the current pedestrians and the future, knowing that the ideal point of reference is given by squares and urban parks. The WBBI makes it possible to relate intrinsic elements (PI and CI) with extrinsic elements (AI) by means of specific weights. The ideal WBBI benchmark is equal to 1 which occurs in a free area, therefore it can be crossed in multiple directions and with a diversified relative attractiveness. The evaluation of the pre-operam indices (PI = 1; CI = 0.15; AI = 0.83; WBBI = 60) and post-

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operam (PI = 1; CI = 1; AI = 0.88; WBBI = 85) highlighted the performance of the GBP both in terms of WBBI and AI. In other words, the crossing action of the current military enclave determines an improvement both in the indices and a potential increase in the population that can enjoy the proximity services (increase of 40%). In particular, with the same IP, the WBBI (ante operam) = 60 is determined by the low value of accessibility and attractiveness. The WBBI (post operam) = 85 is determined by a significant increase in crossability and attractiveness closely related to the proposed crossing in the military enclave as part of the GBP, aimed at urban regeneration as semi-commons (between military uses and uses for the community).

The recent and radical socio-urban changes induced by the health emergency have prompted the authors to evaluate this first specific set of indices: porosity, intersection and attractiveness, from the combination of which the WBBI index derives also to support the ambitious objectives of the European Green Deal.

7. Conclusions and Future Development

The present study constitutes an application of the methodology developed in the context of a broader research activity conducted by the authors on the challenges of urban governance to promote the redevelopment of military real estate in a sustainable city perspective, according to the combination of several approaches: Walkable City, City of proximity, Safe and Healthy City and Sport City.

The renewed awareness gained in the disciplinary field, also following the health emergency, led the authors to evaluate a specific set of indices: porosity (PI), crossing (CI) and attractiveness (AI) which constitute the elements of the composite index (WBBI). In particular, the case study of the barracks complex object by processes of regeneration and opening towards civil society, made it possible to compare the pre and post operam (PI, CI, AI and WBBI) of one of the main enclaves of the city of Cagliari.

The extent of such research work can be considered within a wider framework of urban issues and proposals for improving the liveability at urban level. The research hereby carried on and presented, in fact, is part of wider considerations on the permeability of urban fabrics to walkability, particularly after urban planning actions in the past produced enclaves that, today, represent important closures and obstacles to a pedestrian use of space. Such situations can have different origins and characters. Relics of the industrial past of urban areas, as well as large disused installations like hospitals, exhibition areas, non-completed large buildings are typical features of such a landscape. Military installations can be added to this provisional list. In some areas, and Sardinia Region in Italy is one of those, military installations and facilities represent an important part of the artificial landscape, representing, during the Cold War period, important and strategic locations in terms of defence. The changes in military operations and uses as well as, and particularly, those occurred at geopolitical levels, left on the ground an important and massive amount of buildings and complexes, often in close proximity to urban areas, now partly used for military purposes and, in many cases, needing important maintenance, not always possible. Few studies, however, have been realized so far in including military areas inside the urban reasoning and consideration, while their re-use particularly in walkable terms should be evaluated in terms of new opportunities for living parts of a city. In such sense the paper hereby presented was aimed at providing some suggestions on research directions in terms of walkability and a different perception of urban spaces.

The research hereby presented, although focused on a very specific case, as that of military areas and their potential roles of new urban and urbanized spaces must, however, not be limited to considering such single cases, but seeing them as examples of a wider, more general trend in cities around the world. The massive and important urbanization process ongoing in cities around the world, both in the older industrialized countries and in the new ones, is leading to a, both spontaneous and induced, formation of enclaves, as

gated communities or ghettoes, both following a trend to self-isolation of social and economical groups, or as a defense, and identity system. This is very much leading cities to develop isolating parcels of lands that become more and more separated by other neighbouring contexts, making them as individual 'cells' in an urban body, little connected one to each other. The analysis of such contexts, in a broader sense, can be considered of paramount importance in developing urban analyses, finalized to a more efficient and sustainable urban planning.

The future prospects of the research are to extend to the main Italian cases of barracks in metropolitan cities (Figure 1), to support the decision-making processes deriving from the Green Barracks Project (GBP) and then continue at the international level with other similar case studies.

Further evolutions, still to be evaluated and considered, also extending the research group to a wider set of scholars, active in understanding the ways of formation and tackling of new enclaves in urban areas at international level.

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- Strategic Plan of the Metropolitan City of Cagliari, commissioned to the Temporary Business Association (ATI), constituted by Lattanzio Advisory and Lattanzio Communication in 2019: Professor Luigi Mundula (PI) University of Cagliari;

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- Cagliari Accessibility Lab, interdepartmental net the University of Cagliari

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